Lengthening Lifespan/Using Life?

An Ethnographic Exploration of the Emergent Scientific Field of Biogerontology

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Dedication

This thesis is dedicated to my family: my parents, my siblings, and, in particular, my husband, Jamie.

Abstract

This thesis comprises an ethnographic exploration of the emergent scientific field of biogerontology (otherwise known as the biology of ageing) 'in the making' at its different sub-sites. Specifically, biogerontology, as a field on the frontiers of science research in the UK and US, seeks to redefine ageing as malleable and pathological. I examine this approach to ageing in relation to an ethics of care for all of life. By examining public biogerontology (conferences, media, academic publications), with an in depth focus on UK biogerontology, I illuminate biogerontologists' perspectives and concerns, and I show how these are circulated in this public setting. By extending focus to two genetics laboratories where biogerontologists study ageing as a biological process (using model organisms), I provide insight into the mundane practices of biogerontologists, and I also offer comparison between the verbally expressed concerns of public biogerontologists and the practical labours of care in the laboratory setting. Moreover, I explore the fragmented, ambiguous, and complex ordering of care in the laboratory setting, which is part of viewing the field as a continual accomplishment. Whilst 'good science' as 'excellence' is shown to be the primary concern and care of the field, I also show moments in the laboratory setting where biogerontologists extend their care, as a practical and affectual labour, to the animal (models) that they are working with. As well as examining the standardisation of ageing, and the way that the animal (models) are figured as instruments, I conclude by showing that whilst life itself becomes instrumental in science experiment, the moments of care for life in the laboratory break from this instrumental relation. Furthermore, I show that these moments open up space for biogerontologists to reflect more deeply upon the field and its implications for the future of humanity and, also, *all* life on earth.

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Chapter One

Introductions

"For if we see death as no more than a fizzling out of energy, can we really be surprised if people get treated as spent batteries? But what if people are more than just spent batteries?"

(Alastair McIntosh, February 2011, Thought For The Day, BBC Radio Scotland)

Introduction

From the beginning of time, stories about ageing (as a journey made between life and death) have been told, and retold, by humanity across the earth's time and space (Bauman, 1992; Adams, 2004; Gruman, 2003). This thesis is about one of those stories and the world/s created by it. It is about the story told by biogerontologists that ageing (as a biological process reduced to its constituent parts) is plastic and can, and should, be intervened in (see Vincent, 2008; Moreira and Palladino, 2009; Latimer et al., 2011; Latimer, 2014). This thesis also reflects my story as an ethnographer being transformed by (and *with*) her field; an ethnographer transformed by a way of seeing that is different from her own. Whilst I have retained a commitment to a belief that all of life is more than a usable energy source, encountering biogerontologists, their field, and its ambiguities and complexities, has led to the fracture of my (previously) rigid perspective. This perspective was that the scientific pursuit to defeat ageing is one that is lacking in care for the earth and for all of the life that inhabits it. In this thesis I explore how and why biogerontology is accomplished at its different sites (e.g. the laboratory, conferences, publications), alongside exploring what it is that biogerontologists care for. However, this thesis tells the story of a group of biologists simultaneously caught up in both scientific *and* medical rhetoric; in both present *and* future; in both creativity *and* productivity; in both care for the accomplishment of 'good science' *and* care for the accomplishment of science for good.

Early expressions of literature and spirituality have depicted the pursuit of the fountain of youth and/or eternal life. For example, Gilgamesh's Epic[1], John of the Bible's Revelations[2], G.K. Chesterton's[3] 'Everlasting Man' (1925), and the story of the alchemical 'Philosopher's Stone'[4] (and many other entanglements of mythology, religion, and mystic spirituality). However, ageing is now said to be firmly on the agenda in the modern, science and technology driven (predominantly Western) domain (Gruman, 2003). Media reports, alongside policy documents (Centre for Social Justice, 2010; Medical Research Council, 2010), describe that in a rapidly growing population (Pearce, 2010), there are increasing numbers of older people with debilitating physical and mental ailments that render them in need of care and medical treatment. Older people are framed as 'bed blockers' using up finite societal resources (see Latimer, 1997; Age UK, 2014; Triggle, 2016). According to Vincent (2008: 331), ageing and death are "*constructed through the dominant knowledge creation processes of modern society",* and, at this time, research into ageing and age-related diseases is accelerating (Mykytyn, 2010a).

Biogerontology, or 'anti-ageing science' and/or 'anti-ageing biomedicine' as it is referred to by some authors[5] (see Binstock 2004; Binstock et al., 2006a; 2006b; Mykytyn, 2006a; 2006b; 2006c; Mykytyn, 2010a; 2010b; Fishman et al., 2008), is a field seeking to combat ageing itself, rather than the individual diseases of ageing (see Latimer et al., 2011; Latimer, 2014). However, it is an emerging scientific discipline that is facing resistance because of its challenge to the 'traditional' Western notion that the ageing process is natural and/or inevitable (Bostrom, 2005; Fishman et al., 2008; Gems, 2011). Furthermore, it challenges the notion that qualitative ageing is part of the life course (Featherstone and Hepworth, 1989; Moreira, 2015) and to be celebrated as a source of life's wisdom (Bothelo, 2014). Biogerontology continues to fight for

[1] The 'epic' of Gilgamesh originates from ancient Mesopotamia. In the story, Gilgamesh decides that he wants to lives forever and goes searching for eternal life, only to learn that death is part of life.
[2] John was known for his visions that spoke of the deeper mystical reality of living eternally, and the most
[2] John was known for his visions that spoke of the deeper mystical reality of living eternally, and the most quoted line in the Bible (arguably one of the world's most prolific spiritual texts) speaks of this: *"For God loved the world so much that he gave his one and only Son, so that everyone who believes in him will not perish but have eternal life"* (John 3: 16, NIV).
[3] Chesterton wrote Christian apologetics, whilst at the same time drawing on mythology and fantasy. Chesterton appears to be a visionary and mystic challenging the boxes of staunch religion. In his book, 'Everlasting Man' (1925), Chesterton dares to suggest the reality of living in eternity in the here and now.
[4] An alchemical substance that supposedly – 'legend has it' - extends life (Gruman, 2003).
[5] I have chosen to use 'biogerontology' throughout because this is the term that my participants used, and, furthermore, using 'anti-ageing' makes an assumption that scientists are 'anti' ageing.

credibility amongst policymakers/funders as well as the scientific community, and its problematic status is made visible in the following extract from the government's 'Select Committee' report:

> *"…older people, their families, those who care for them, those responsible for their health, and ultimately all of us, will suffer from the Government's failure to acknowledge the problems and opportunities presented by an ageing society. It is particularly disappointing that the Government seem to wish to "pigeon-hole" ageing research, as if ageing were an isolated, discrete problem, and that research into ageing must necessarily compete with research into other areas. Thus the response reproduces the familiar mantra that "given finite resources, there will always be a need to balance competing priorities for research". As we sought to demonstrate in our Report—a point repeated by Professor Kirkwood in his written comments—ageing is a continuum, affecting all of us all the time. He also reiterates the point made in our Report, that generic research into the process of ageing, far from being in competition with research into specific conditions affecting older people, may be "the most direct route to developing novel interventions and therapies". There is no sign of such holistic thinking in the Government response."*
>
> (Select Committee on Science and Technology Sixth Report, 2005/6)

Whilst the *"problems"* of an *"ageing society"* are referred to, this statement does posit research into ageing as being of underlying importance to society and to other areas of science and medical research. Professor Tom Kirkwood (director of the renowned Newcastle Institute for Ageing), a prominent voice for 'mainstream' biogerontology (see chapter two), speaks here with scientific authority as a leading biologist/biogerontologist. Biogerontology research is figured in the extract as the *"most direct route"* to intervening/preventing ageing because it targets ageing as a process that affects all of us *"all of the time"*. The urgent call for the government to consider biogerontology's research aims and objectives, alongside a public cry from biogerontologists for their research to be considered a moral imperative (see Gems, 2011), figures the emergent field of biogerontology as being a critical site for sociological exploration (see chapter two).

Biography of the Research Question

This study's genesis is of importance by way of an exegesis. Whilst the study was borne out of an intellectual curiosity - as is much ethnography (Coffey, 1999) - in social theory, sci-fi, and ecology, to suggest that it was from this alone would be to omit a deeper investment. From a young age, perhaps through being raised in a family with more traditional (but for the most part moderately fickle and exceedingly liberal) Christian values that were based mostly upon the list of the *dos* and *don'ts* that religion offers, I became interested in transcendental aspects of being a 'human-being-here-on-earth'. As punk rock, social justice, and environmental politics became part of my teenage identity, the Christianity, with all of its seeming hypocrisies (and cream tea garden parties), faded away. However, I retained an affinity with the value of 'love thy neighbour', and I carried away with me to university (nearly ten years ago) a precocious view that whilst 'loving thy neighbour' was a good start, the Bible calls the people of this earth to care for the whole of creation, including the birds, the bees, and the O-Zone layer. I took (and still take to a degree) the view that Christians have neglected to do this. During my undergraduate studies, in an effort to avoid a nihilistic view of the world, I sought out souls who seemed to be doing something about what I perceived at the time to be a 'neo-liberal-consumer-culture-shambles' (a 'shambles' that, in hindsight, I had greatly benefitted from). After several years of what I see now as mostly ineffective quasi-activism, coupled with seemingly 'important-at-the-time-mind-expansion', I returned to this person of Jesus (minus the religious rigmarole). Despite drudging through many (what I have perceived to be) awful and, in some instances, hateful interpretations, what he seemed to be saying about the world, love, and 'becoming-with' creation (see Heidegger, 1962; 1977; Latimer, 2013a), through union, relationship, and compassion, became the only thing that made complete sense to me at this time.

It is this journey that has led me to what might be thought of as a mystical[6] Christo-centric spirituality (I still wrestle with the label 'Christian' because of associated religiosity that I believe detracts from what I understand to be its original meaning),

[6] By mystical I refer to, quite literally, a sense of mystery; a sense of awe and wonder and of being moved by; of sitting comfortably with that which I do not understand and being moved by that unknown. This is captured by ancient Hebrew ways of thinking and interpreting. This contrasts the more dogmatic, 'linear' way of thinking often associated with the Bible and Greek interpretation. Given his upbring as a Jew, Jesus would have 'seen' through the eyes of the Hebrew culture and language.

whereby I draw from the *imago Dei* in positioning humans in relation to the rest of, what I believe to be, creation. The *imago Dei* is the story that humans are made in the image of a creator God. It is described (Genesis 1: 26) in the Bible and demonstrated by Jesus Christ[7], or Yeshua Ha-Mashiach[8]. It is a debated concept and posited by some as the *"central problem of modernity"* (Scott, 2003: 194) due to a separation between humans and nature that has been destructive (see Wirzba, 2015). Some geologists are calling the current time 'the anthropocene'[9]. This is a highly debated 'era' where humanity is portrayed as has having a dominating impact upon the earth. Consequently, geologists argue, humanity is trusted to remedy the damage that s/he has done (Stromberg, 2013). In light of this supposed era, many (including peers of mine) yearn for a pantheistic harmony; a harmony not unlike the one promoted by advocates of Lovelock's Gaia (see Lovelock, 2006; Midgely, 2007). Gaia is the personification of the earth in Greek mythology, and, Lovelock believes Gaia, as living, to be self-regulating. However, I believe that amongst other creatures, human beings – as sentient beings - have a unique ability, expressed through the *imago Dei*, to effect/affect 'Mother' earth and/or creation. I believe that, subsequently, humanity can either choose to enrich or exploit the earth (see Wilkinson, 2000; Tennant, 2007; Bookless, 2008). I believe that as a unique part of creation, humanity is *"not superior to the rest of creation [over] or identical with it [in], but in solidarity <u>with</u> nature"* (Hall, 2006: 139) (my emphasis). Thus, I suggest that it is humanity's responsibility to – as part of a relation of 'communion'[10] - servant-heartedly steward and breath life back into the whole of creation; creation being the medium through which all of life is 'united'. This is not a legalistic responsibility, but one that is empowered by affect and/or compassion.

[7] Creation and creativity is a key part of the story that I describe, and I often liken Jesus (analogously and partially) to 'Neo' from the film 'The Matrix'. This is in terms of being an unlimited creator no longer subject to the laws of the cosmos after the 'freeing of the mind' from perceived limitations and, subsequently, demonstrating this possibility to others.

[8] Yeshua (translation: salvation) Ha-Mashiach (translation: the anointed one) is the Hebrew name from which the Western name, Jesus Christ, originates.

[9] Said to follow the 'holocene' (entirely recent) era starting after the last major ice age, the anthropocene, as well as being somewhat of a buzzword, is argued by many geologists to have started at the industrial revolution in the 1800s and by others as starting in the 'atomic age' of 1950s. What is being debated is the time that humanity began to significantly impact on the earth and its eco-systems (Stromberg, 2013).

[10] Communion, and the narrative of an unconditionally and self sacrificially loving relationship between the trinity (emulated by humanity in relation to all of creation) (Wirzba, 2015), is a significant part of this story that informs my approach to biogerontologists' ethic of care.

Within the context of the Genesis story[11], this relation can be likened to a return to the 'Garden of Eden'. This is an analogy often borrowed by biology and/or genomics in relation to re-creating the original perfection of the 'way of the tree of life'[12] (Nelkin and Lindee, 1995). When describing my analytical approach (see next section), I notion towards the parallels and differences between this relation of communion and the more social theoretical/philosophically conceived relation of care that has informed my approach as an ethnographer. I should point out that whilst my approach might appear on the surface to open up the 'creationist/Darwin' debate, I intentionally refrain from engaging this debate, for I believe it to be an out-dated dichotomy forwarded by dogmatic scientists and believers alike. It is my hope that my research opens up space to move away from this kind of totalising, polemic, and often boisterous, debate.

In the final year of my undergraduate studies, my spirituality collided with an interest in social theory and its relation to utopia and the 'frontiers' of science. I encountered an article in the newspaper by Dr Aubrey de Grey who - in what I thought to be a rather utopian fashion – claimed, taking an ethical stance, that the *"first person to live until the age of one thousand was already sixty"* (de Grey, 2004). I developed a concern for the effects that this scientific field would have upon environmental sustainability. I wondered if these scientists really did care for life in the way that they claimed to. Alongside learning about de Grey, and other scientists like him who claimed that ageing was a biological 'problem', I began to read around the field of 'Science and Technology Studies' (STS). Learning about and questioning the socio-cultural processes and implications of science, and more specifically this emerging scientific field of biogerontology, resonated with my research interests. As well as thinking through the culturally transmitted meanings and understandings of ageing, life, and death in relation

[11] *"Be fruitful and multiply and fill the earth and subdue it, and have dominion over the fish of the sea and over the birds of the heavens and over every living thing that moves on the earth"* (Genesis 1: 28, ESV). In the Hebrew text the word used for 'subdue' is 'Kavash'. This literally means to place one's foot on the neck of an enemy 'post conquer'. It has been used as part of a discourse of submission in the face of violence. However, in relation to nature, a more suitable interpretation, situated within the broader context of the Bible, is the idea of subduing nature as it wields its power and laws (for example, the sea – Jesus calms the storm and walks on water). 'Dominion' in Hebrew is 'Radah'. In English, the common understanding of dominion is to 'rule over'. However, in the Hebrew, the word for that kind of 'dominion' is actually 'Malak.' Instead, Radah means to 'descend'; to 'go down'; to wander and spread; to touch. Literally speaking, Radah, as a verb, connotes rulership through going down and walking among the subjects as an equal (Benner, 2006).

[12] In the Bible, this is said to refer to a way of being that enacts a realtion of love, life, and care. This entails being moved/compelled/affected by, rather than following the 'law' (the tree of the knowledge of good and evil). In biology, however, the 'tree of life' refers to a genealogy of species.

to my environmental interests, I began to think about the relationship between these understandings and the way that scientists *do* science (and not just what they write in publications). Believing (quite literally) the 'meaning of life' to be to be at stake, I began to ask questions like: *"Are ageing, and life itself, being re/defined here?"*, "*Are scientists bringing life or death to the earth, its inhabitants, and their future?"*, *"What 'worlds' are scientists like de Grey creating with what they say and do?"*, and *"What do these scientists actually care about?"*. It was at this point – driven by a naïve conviction that somebody needed to question 'big' claims being made by these scientists – that a proposal for my PhD study emerged. As well as being a critical site in relation to my described belief system, biogerontology is a critical site for sociological study because, as an emerging scientific field with significant implications for societal understandings of (social) life, it is imperative to understand the field, its worlds, and its cares and/or concerns (see Puig de la Bellacasa, 2011; Latimer, 2013a; Latimer and Puig de la Bellacasa, 2013). This is at a transitional time for present and future planet earth and humanity (see Adam and Groves, 2007; Carlsson, 2008; Stromberg, 2013; Puig de la Bellacasa, 2010; 2015).

Analytical Approach

I draw from a number of approaches in my analytical approach to the study. First and foremost I draw from an interpretative stance, for I seek to understand the subjective experiences (Schutz, 1967) of biogerontologists. This draws from what Weber refers to as 'Verstehen', which means to see through the eyes of another. This is by way of empathetically understanding human behaviour; achieved by 'getting inside' (Latimer, 2008) a culture and interpreting it. Anthropologist, Geertz, emphasises the place that meaning has in such interpretation:

> *"Believing, with Max Weber, that man is an animal suspended in webs of significance he himself has spun, I take culture to be those webs, and the analysis of it...not an experimental science in search of law but an interpretative one in search of meaning."*
> (Geertz, 1973: 5)

Moreover, Rabinow and Sullivan (1979) emphasise the situated-ness of meaning, which, in turn, denies *a priori* assumptions about behaviour deduced from theoretical reasoning:

> *"Interpretation begins from the postulate that the web of meaning constitutes human existence to such an extent that it cannot ever be meaningfully reduced to constitutively prior speech acts, dyadic relations, or any predefined elements."*
> (Rabinow and Sullivan, 1979: 5)

I draw from this stance in so much as I am concerned with understanding the way that biogerontologists construct (socio-culturally) not just their definition of ageing as a biological puzzle, but also what they do as part of their day-to-day, practical accomplishments in different settings, and, furthermore, the meanings that are circulated through these accomplishments. This includes care as a practical labour and/or an accomplishment (I elaborate upon this later in the current section). Geertz (1979: 193), in his ethnography that depicts Balinese cockfighting and its significance for observing the socio-cultural ordering of Bali, argues that members "*take their form from the situation that evokes them, the floor on which they are placed, as Goffman puts it; but it is a form, and an articulate one, nonetheless"*. For the Balinese, this meant that:

> *"...the floor is itself created, in jury deliberations, surgical operations, block meetings, sit ins, cockfights, by the cultural preoccupations – here, as we shall see, the celebration of status rivalry – which not only specify the focus but, assembling actors and arranging scenery, which bring it actually into being."*
> (Geertz, 1979: 194)

In a similar vein, I focus on studying biogerontologists as 'actors' and their laboratory and conference settings as 'scenery'; the site at which their accomplishments (including meanings and/or values circulated by actions, stories, and/or symbols) are brought into being as they tell an overarching story. It is here that the order and ordering of the field comes in to view. I discuss the practical outworking of this approach in the next chapter (chapter three) in giving an account of my method and methodology.

Observing categorisation and classification is, arguably (see Douglas, 1966; Bowker and Star, 1999; Latimer, 1997; 1999), important when interpreting the socio-cultural order. Douglas (1966: 2) suggests that classification is humanity's *"attempt to relate form to function, to make unity of experience"*. Moreover, Bowker and Star state that:

> *"To classify is human. Not all classifications take formal shape or are standardized in commercial or bureaucratic products. We all spend large parts of our days doing classification work, often tacitly, and we make up a range of ad hoc classifications to do so. We sort dirty dishes from clean, white laundry from colourfast, important emails to be answered from e-junk."*
> (Bowker and Star, 1999: 1-2)

By *"separating, purifying, demarcating, and punishing transgressions"* (Douglas, 1966: 4), Douglas claims, we constitute what is sacred and what is profane. She argues *"reflection on dirt involves reflection on the relation of order to disorder, being to non-being, form to formlessness, life to death*" (Douglas, 1966: 7). I draw from this approach in noting and illuminating the categorisations and classifications biogerontologists enact through their talk and actions. This is of value when thinking about 'dividing practices' (Foucault, 1982) and the 'othering' that that is accomplished through the dividing/ordering of *us* and *them* (see Douglas, 1966; Pallí, 2001). In addition, Latimer (1997; 1999) describes the 'constituting of classes' as a continual accomplishment – for example, the division between 'first-class' and 'second-class'.

Foucault, in examining modernity and how it emerged from particular historical conditions, studied institutions and areas of society[13] for dividing practices, which stem from the way that (what he calls) the 'subject' is *"either divided inside himself or divided from others"* (Foucault, 1982: 326). Foucault (1982) also refers to this division as the process of 'objectivisation', and I draw from this way of seeing in my analytical approach. This is alongside drawing from Foucault's notion of 'problematisation' (see

[13] Foucault reports cases of objectivisation across history – for example, the confinement of the poor, the vagabonds, and the insane in 'general hospital' (Foucault, 1971). This is alongside the classification of diseases under a medical gaze (Foucault, 1963), the isolation of lepers (Foucault, 1977), and the 'othering' and stigmatisation of sexual deviance (e.g. Foucault, 1978). Dividing practices establish identity and accomplish power in that one person (or group of people) is included and (by default as it were) the 'other' person or group is excluded (Latimer, 1997; 1999).

Foucault, 1984) as a tool for critically analysing the field as a 'discursive formation' (Foucault, 1969) for which stories are included and what stories are consequently excluded, and by whom:

> *"Problematisation does not mean the representation of a pre-existent object, nor the creation through discourse of an object that doesn't exist. It's the set of discursive or non-discursive practices that makes something enter into the play of the true and false, and constitutes it as an object for thought (whether under the form of moral reflection, scientific knowledge, political analysis, etc.)."*
> (Foucault, 1984: 456/7)

Whilst Foucault addresses inclusion and exclusion as part of an examination of power (an aspect I draw from in my analytical approach), Garfinkel's ethnomethodology also considers inclusion and exclusion in relation to the practical accomplishment of membership and belonging to a social and/or moral order. Whilst, like Lynch (1997), I draw on Garfinkel's (1967) approach in observing scientists' (as 'members') taken-for-granted and ordinary action as part of the accomplishment of identity and belonging, I later describe this approach in relation to my methodology (chapter three) because of ethnomethodology's practical application. I also draw from Goffman's work on identity and performance – especially his dramaturgical analogy (Goffman, 1959) – within the context of what he terms the *"world of social encounters"* (Goffman, 1967: 5); encounters that constitute the interaction-order. I also refer to the work of Goffman in relation to my methodology, for I am influenced by his focus upon the *minutiae* of action and talk. This is alongside the way that materials are considered to be socio-cultural symbols (Goffman, 1959; Pinch, 2010).

Additionally, in thinking about the place of the material in my study, I draw from Actor Network Theory's (ANT) socio-technical (see Law, 1991; 2009; Latour, 2005) approach to the material. Here, the material (including animals) is included in the social order as part of a *"discursively heterogeneous"* (Law, 2009; 141) network/ 'assemblage' (see Strathern, 1991; Law, 2003; Ong and Collier, 2005; Collier, 2006). For example, Callon (1986) shows that, as part of a particular scientific investigation, scallops in the sea are 'translated' to network actors by scientists and thus the scientists

become the 'spokespersons' for the scallops. Furthermore, the scallops circulate the network assemblage (see also Latimer, 2013b), for scale (i.e. macro/micro) is dissolved (Law, 1991; Strathern, 1991; 1995). Whilst I draw partially from ANT as a methodological progression of ethnomethodology[14] (see also chapter three), as part of my analytical approach I encounter the social order as a heterogeneous and complex re/assemblage 'in the making' (Latour, 1987; Latour, 2005). Here, I refer to biogerontology as an assemblage of different 'actors' (human, non-human) and scales rather than referring to it as a neat and tidy construct. By 'in the making', I refer to the notion that reality is continually assembled and reassembled; accomplished and reaccomplished.

Assemblages can be thought of as comprising 'partial connections' (Strathern, 1991) and/or fragments/fractals: *"objects, subjects, human beings, machines, animals, 'nature', ideas, organizations, inequalities, scale and sizes, and geographical arrangements"* (Law, 2009: 141). This view informs my methodological approach (see chapter three). It is also pertinent to thinking of biogerontology as a configuration producing 'global' (but also situated) socio-technical forms of knowledge. Collier (2006) refers to these as 'global assemblages' in light of the process of globalisation. Globalisation is associated with significant S&T advances, but these also carry increased risk because of new worldwide scope (see Beck, 1992; Ong and Collier, 2005). Collier (2006) states that global assemblages, as configurations/networks emerging from situated institutional debate and reflection, become the medium by which technology and expertise is now capable of transcending territorial boundaries. This is because, he argues, a technoscientific global assemblage is circulated at each of its local sites (e.g. a single laboratory). This, in turn, leads to the increased and widespread global significance (and power) of a given technoscientific form.

Drawing influence from Ong and Collier (2005) and Collier (2006), I approach biogerontology as an emergent global assemblage circulated in local, situated moments and/or enactments. Furthermore, 'global assemblage', as a concept, is of value for

[14] I do not consider myself to be an 'ANT'. However, I do draw from the method of observation and descriptions of common social activities that is integral to both ANT and ethnomethdology. I use the term progression because, temporally speaking, ANT was borne several decades later. Furthermore, ANT's focus upon networks, and the social as not pre-made but as part of an assembling/reassembling (Latour, 2005), is a useful tool for articulating my analytical approach to the field.

thinking about the spread of global capitalism in the twenty-first century (Collier, 2006) and about how Western ideals came to universally hold sway with other nations (Ong and Collier, 2005; Collier, 2006). This is significant for examining the global implications of biogerontology's meaning/s of life and/or ageing that transcend the UK/US. At a later point in the thesis, I refer to the 'global' in relation to the situated-ness of my study (see chapter three). Authors (Ong and Collier, 2005; Collier, 2006) describe global assemblages as concrete structures; however, my approach interprets biogerontology as a global assemblage (continually) 'in the making' (Latour, 1987) as biogerontologists re/assemble and/or re/accomplish 'biogerontology' (and its self-defined socio-cultural ordering/s) at each sub-site.

As part of my study, I have encountered biogerontologists in their day-to-day enactments; becoming a partial member of their social order (e.g. by sharing breakfast, dinner, and cups of tea with them). 'Getting inside' (Latimer, 2008) biogerontology in this way, as part of the interpretation of *my* field, can be thought about in relation to the notion of 'becoming-with' (see Heidegger, 1962; 1977) because there is a mutual 'becoming' over time. Furthermore, I have found Heidegger's meditation on being and authenticity[15] to be a useful tool for thinking *with* in relation to the 'authenticity'[16] of what biogerontologists care for. This is because I consider care to be an authentic, practical, and intentional labour that also has an affective dimension (see also Puig de la Bellacasa, 2011; Latimer, 2013a; Latimer and Puig de la Bellacasa, 2013). 'Being-in-the-world' (Heidegger, 1962) refers to a connection between Dasein (as a spatial being) and its surroundings. It also refers to (what can be thought of as) its 'extensions' (Strathern, 1991; Munro, 2001; Latimer and Munro, 2006; 2009; Latimer, 2008), which become objects of identification with which we 'dwell' in our created world/s (see also Heidegger, 1971). It is these extensions, or objects of identification, that become part of our authentic, practical 'labours' of care.

[15] Given that the nature of Dasein is being-toward a 'horizon' in an ever-changing temporal dimension, as new events persistently impact upon the being of Dasein, Dasein is incomplete until the moment of death because it is ever 'being-toward' death. However, this finitude facilitates, as it were, what can be thought of as an 'authentic' creative impulse (Heidegger, 1962).

[16] In relation to Dasein, Heidegger refers to authenticity as 'eigentlichkeit', which translates in German to 'really', or 'truly', in relation to authentic existence, or 'being one's own', or, as part of inauthentic existence, one's failure to own up to her/his own life and make choices reflecting her/his *true* cares (Varga and Guignon, 2014).

Heidegger (1977) describes technology[17] in terms of humanity's relation to nature (a trope built upon by critical theorists – e.g. Marcuse). Latimer (2013a), explaining Heidegger's distinction, describes 'modern technology' as a relation *to*, rather than a relation *with*. It is this relation *with*, she argues (Latimer, 2013a), that is embedded in Heidegger's (1977) conception of 'techné'. This understanding - alongside influencing my methodological decision to 'go amongst' and/or 'be with' biogerontologists (see chapter three) - enriches the understanding of care (for all life) from which I draw. Whilst 'care' is prone to simplistic interpretation (i.e. 'a concern, interest, and/or practical application of these'[18]), I draw from feminist authors who examine and illuminate its 'affectual' and, thus, practical nature (see Latimer, 2000; Puig de la Bellacasa, 2010; 2011; Latimer and Puig de la Bellacasa, 2013). Puig de la Bellacasa writes:

> *"Concern and care can mean similar things – both come from the Latin 'cura'. But they also express different things. So care does not replace concern… One can make oneself concerned, but to 'care' more strongly directs us to a notion of material doing."*
> (Puig de la Bellacasa, 2011: 89-90)

In my analysis of biogerontology's cares, I draw from Puig de la Bellacasa's (2011)[19] - who draws on Latour (2004b) - differentiation between 'matters of concern' (as 'interestedness', or 'thoughtfulness') and 'matters of care' (in terms of action, or practical labour, bound up with a sense of 'affect' and an ethics of care that is visible through action)[20]. Puig de la Bellacasa (2011) describes ethics (in relation to 'moral' principles) as part of being 'compelled' to care (Latimer and Puig de la Bellacasa, 2013); a relation resonating with the spiritually informed sense/'doing' of 'compassion'

[17] As well as referring to the practical essence of early technology (e.g. a sharpened flint used to hunt), techné can be thought of as skill, craft, or art because it refers to a state, or 'becoming'; of poiesis, which brings forth, or 'reveals', authentic wo/man and enframes her/his possibility. This contrasts with modern technology, which *"puts to nature the unreasonable demand that it supply energy that can [then] be extracted and stored as such"* (Heidegger, 1977: 14). I draw on this distinction is a key analytical tool.
[18] This is a typical dictionary definition of 'care'.
[19] Puig de la Bellacasa (2011) refers to embodied affect in relation to a broader context of literature in sociology (e.g. Haraway, 2008; Stengers, 2010) that draws attention to the 'being-moved' emblematic of what is considered to be the affective dimension of the social.
[20] 'Interestedness' refers to the notion of orientating ones thoughts towards a topic, and 'thoughtfulness' refers simply to thinking about a topic. This is evident in 'public biogerontology' arguments where particular issues are described (see chapter five).

that I have referred to in an earlier section of this chapter. Whilst this understanding of care aligns to a large degree with the type of care implicit in Latimer's (2013a) notion of 'being alongside' (as a mutually affectual relation), Puig de la Bellacasa draws instead in more depth on the more logical 'process philosophy' of Whitehead[21]. She suggests care is rooted in affect and 'present moment contact', which is both sensorial and temporal (Puig de la Bellacasa, 2009). Latimer's (2013a) notion of 'being alongside' focuses on the partial, 'moment-to-moment' aspect of Heidegger's conception of 'becoming-with'. Primarily drawing on Latimer and Puig de la Bellacasa, the idea that care is a practical labour and an 'authentic' 'becoming-with', and/or 'being alongside', is integral to my analysis of biogerontologists' ethic/s of care as I track members across multiple sub-sites (see chapter three).

Inherent in the works of many of the authors (e.g. Geertz, Latimer, Puig de la Bellacasa, Heidegger, Whitehead) that I have, in the current section, referred to is the multiplicity of existing worlds; an idea that at least partially characterises the post-structural tradition from which I draw in order to think about the nature of the social. Key to Latimer's work is the idea that we are always switching between the worlds in which we 'dwell' (see Heidegger, 1971; see also Strathern, 1991), moment-to-moment, which is described as 'motility' (see Munro, 2001; Latimer and Munro, 2006; 2009; Latimer, 2000; 2004; 2013c; Latimer and Puig de la Bellacasa, 2013). To elaborate, this is the moment-to-moment attachment and re-attachment of people to their materials, both physical and non-physical, and the subsequent embodied (or performed) meanings that follow. This not only accomplishes motility, but also subsequent relations of power/discursive practices that follow in relation to inclusion and exclusion. What is included one moment can be excluded the next, and motility means that what is excluded in a moment is not, in fact, excluded; it is included (speculatively) in that moment as an 'absent presence' (see also Deleuze and Guattari, 2003; Law and Callon, 2004)[22], which is a valuable concept for data analysis.

[21] Heidegger and Whitehead both offer - what I perceive to be - 'mystical' critiques of 'totalisation' that open up space for perceiving simultaneous realities/authenticities. Whilst I do not draw on Whitehead's philosophy directly in this thesis, I appreciate his sensitivity to the unknowable and his value of situated care and relation/s that inspired 'relational' 'process theology'.

[22] The essence of this approach is also present in the 'speculative' structuralism of Deleuze (e.g. 1995) and Deleuze and Guattari (e.g. 2003), which also draws influence from Whitehead.

Stengers' (who also draws on Whitehead) 'cosmopolitics' - alongside her meditation on the 'Gaia intrusion' (Stengers, 2013) - is useful to think *with* in relation to the non-totalising approach to the social, and/or to the care for all life on earth, that I have laid out. Stengers' (2010) argues - drawing particularly from the way that a scientific field, like physics, makes demands on and/or affects society - for an 'ecology of [scientific] practices' as a means to unpick science as a 'war machine' that in a knowledge/power relation, systematically destroys other points of view with its 'objective truth'. For example, she describes (Stengers, 2010), the 'truth' of human nature being found 'exclusively' in the human genome (see also, Stengers, 2000). Exploring the heterogeneity and/or complexity of each practice and its cumulative construction/s, Stengers argues (Stengers, 2000; 2010) for a vision of science as a space for human invention and creativity, rather than an instrument of modernity that invalidates other discourses. Thus, Stengers refers (in short) to the co-existence of 'truth/s' as part of a 'cosmopolitical space' where multiple 'modes of existence' (see Latour, 2013b) dwell[23]. Because of biogerontology's scope to re/define ageing and life, this idea of multiplicity is useful for thinking about biogerontology as an emergent field of science at the current time of (what might be eferred to as) ecological enlightenment; a time where the benevolence of science and technology (S&T), and their 'systems', are subject to critical interrogation (Latour, 2004a; 2013a; 2013b).

In addition, alongside Latimer (2013a) and Puig de la Bellacasa (2010), Stengers' work forwards the de-centering of the human from the social order, whilst rejecting science's humanist discourse/s (see Stengers, 2000; 2010; Latimer 2013a; 2013b) that privilege the human, and, furthermore, privilege the relation *to* nature/technology (modern technology) over the relation *with* it (techné) that I have described (Latimer, 2013a, drawing on Heidegger, 1977). This critique, they argue, is especially relevant in light of the (subsequently problematic) 'anthropocene' that I have also described, which inherently places humanity at the centre of the earth's story. Whilst I agree with this in sentiment, I have described my slightly different approach to this topic whereby I believe that humanity does have a unique role to (authentically) steward/serve nature,

[23] Whilst this approach might be interpreted in terms of a post-modernist relativism of sorts, this is, arguably, not what Stengers is trying to articulate. This is because relativism implies a parallel universe of truths, rather than 'all trying to get along together in the mess'. As such, Stengers does not dichotomise the 'socially constructed' and the 'objectively true', but draws focus to the complexity in favour of this, and other, binaries.

which, whilst often abused, holds the potential restore the overarching 'relation of care' that these authors (i.e. Stengers, Latimer, Puig de la Bellacasa) profess in their work.

Moreover, I have made reference to Latimer's (2013a) notion of the partial 'state of being alongside', which is different, she argues, from the totalising 'process of being with'. Pertinent to the way that Latimer (2013a) figures the relation/s between 'human and non-human animals', this 'state' figures a symmetrical 'companionship' (Haraway, 2008) between the human and non-human animal. Such a relation, Latimer (2013a) argues, not only effaces the divide between human and animal, but, also, creates space for both 'species' to be 'moved', and/or transformed, by the other. This approach is of value to my analysis – in relation to what has gone before (Latimer refers to Haraway) – because it attends to moment-to-moment switches (think back to 'motility'). This understanding is integral to the way that I examine biogerontologists' relation/s *with* their animal models, it informs my methodology, and it also characterises my ethnographic experience in the field (see chapter three). Examining this relation, Latimer (2013a) argues, is important because *"comparison works negatively to denigrate (and even efface) the class over which priority is given"* (Latimer, 2013: 81). Whilst I have explained my subtle point of departure from a total symmetry between humans and animals, the relation that I forward is one whereby denigration and/or effacement is disposed of in favour of care, respect, and appreciation. Thus, I also draw in my analysis from Puig de la Bellacasa's (2010) notion of 'ethical doings', which - grounded in mundane routines - are practical and affectual labours undertaken as part of embodied care, respect, and appreciation for other life and/or lives; present and future (see chapter two). Whilst I acknowledge that Haraway's work – particularly her work on the 'cyborg' (1991) and 'companion species' (2008) - similarly contributes to this way of approaching care in relation to biogerontology's animal (models), I do not draw on her in her work in particular detail. This is because the approaches of Puig de la Bellacasa and Latimer – both are greatly influenced by Haraway's work - more than adequately address care for life as a partial, practical, and affectual relations.

To summarise, I began this section by describing the interpretive stance and method of authors like Geertz and Douglas. Whilst this tradition is usually referred to in relation to social constructionism, whereby a more stable ordering of meaning is socially

constructed *in situ,* I am influenced by poststructuralist thinkers, like Foucault (1982; 1984), Law (2004; 2009), and Latimer (2008) – and Heidegger (1962; 1977) to a degree, even though he is not overtly a poststructuralist thinker - in figuring a multiple, heterogeneous, and more fluid understanding of reality; particularly in relation to motility. I also draw from this approach in considering notions of power and thus notions of inclusion and exclusion. This resonates with Garfinkel's (1967) conceptualisation of membership from which I draw. Garfinkel places emphasis on the moral order, and, even though Gafinkel's 'moral order' is a more neutral conception of 'the ethical' than other authors I have referred to, Garfinkel is of value alongside my drawing on writers who also study the ethicality of the day-to-day (i.e. Puig de la Bellacasa, 2010; 2011; Latimer, 2013a; Latimer and Puig de la Bellacasa, 2013).

There is (crudely speaking) a tension between authors who focus on the situated-ness of each socio-cultural context on one hand (e.g. Garfinkel, 1967; Geertz; 1973; 1979; Douglas, 1966) and Foucault (e.g. 1984/1998) who describes an overarching socio-historical narrative. I have made it clear that I borrow from Foucault's critical way of seeing; a way of problematising social order as a discursive formation (Foucault, 1969) - as part of my 'tool box' (Foucault, 1974) (comprising the many analytical tools I have detailed). This problematising is not incompatible with my drawing on interpretivist authors for the reasons described. Furthermore, it could be argued that there is a tension between my overarching spiritual belief system and the poststructuralist and/or multiple approaches and/or constructionist approaches I am influenced by. I argue that my belief, which also encompasses multiplicity as part of the paradox of mystery, exists in a 'realm' that transcends the socio-technical order that I address and so I do not feel a need to 'resolve' this. This is especially given the value that I place on 'becoming-with' (Heidegger, 1962) that which is mysterious and/or unknowable. In terms of the tension between global and local, I feel that this is resolved through the effacement of scale embedded as part of the notion of (global) assemblage that I have described.

Thesis Outline

In the current chapter, I have introduced the site of biogerontology, alongside outlining my personal reasons for initially pursuing this study. I have also explained my analytical approach to the study. In chapter two, I explore relevant literature and socio-

historical detail that corresponds to the organising themes of the study, which provides a solid foundation for my drawing on this (and other) literature throughout the course of the analytical chapters (chapters four, through to seven). In addition, chapter two provides a sound introduction to the field in terms of the socio-cultural conditions of its emergence, alongside providing (further to the introductory themes I have laid out in the current chapter) a framework within which to posit biogerontology as a site for critical study, which includes illuminating gaps in the literature as a starting point for entering the field. The organising themes are: 'Re-defining Ageing', 'Human Biomedical Futures', 'Ordering Biogerontology', 'Simplifying Ageing', 'Life in the Laboratory', and 'Anti/Ageing, Care, and Waste'. In chapter three, I illuminate my methodology and chosen research methods for studying the site (and sub-sites) of biogerontology. Alongside describing how I designed and conducted this study, I also share reflections on ethics and practice, alongside my experience of the field. This includes an account of how I have been transformed by 'being there'. Chapters four, through to chapter seven, comprise the key analytical content of the study.

Within chapter four I examine, drawing on a public debate between two leading biogerontologists as a focus my analysis, the key and competing discourses that comprise what Latimer (2014) refers to as the 'big story' about ageing; the story that it is plastic. This is alongside highlighting some of the smaller stories that are told in this public sphere. I show the temporal aspect of biogerontologists' rhetoric in the way that they circulate projected biomedical futures. Furthermore, I draw on Puig de la Bellacasa's (2011) division between 'matters of care' and 'matters of concern' in showing that biogerontologists primarily express (in this public domain) *concern* for whether good science is accomplished or not. I show how this concern is demonstrated in the way that the 'mainstream' police the borders of the field by constructing boundaries between 'good', *open* science and 'bad', *closed* science. Within chapter five, in offering a rich description of two university-based biogerontology laboratories (Metrotown University and Countryville University laboratories), I show how good science is enacted (as part of a 'world of genetics') via a plethora of mundane practices such as picking, tipping, gassing, feeding, breeding, maintaining, and experimenting; practices that enact an instrumental relation between biogerontologists and their animal models as part of the 'geneticisation' of both ageing and animal (models). Through

exploring the social classificatory systems, and the 'labour of division' (Latimer, 1998), I show that particular, specialist tasks - like 'doing dissection' - are ascribed more value than the 'manual labour' tasks. Whilst I show good science to be a matter of *care* in this setting, I also begin to introduce some of the ambiguities that are present in the way that biogerontologists enact 'good' science. Here, *good* as both excellence, and a relation of care for life, become entangled. Chapter five, which details the 'doings' of the laboratory as part of elucidating the 'mundane' nature of the laboratory setting, serves as a descriptive foundation for the analytical content detailed in chapters six and seven. Moreover, whilst these 'doings' comprise researchers' rigourous preparation/s for 'lifespan experiments', it is not until chapter six that these lifespan and other experiments are discussed in relation to both ageing and the mundane laboratory tasks detailed in chapter five.

In chapter six, further to showing biogerontologists' concern *and* care for good science, I elaborate upon this in relation to the way ageing is figured as standardised in the laboratory setting. I discuss this alongside public representations of these quantifiable, standardisable understandings (or enactments) of ageing, which emerge as: 'lifespan', 'healthspan', and 'neurofunction'. Whereas 'ageing' is discussed in public rhetoric, I show that ageing, as a category, is not used in the laboratory setting, which aligns with the enactment of good, rigourous science that I describe in chapter five. Whilst for the most part, these three quantifiable enactments of ageing are drawn on as part of the accomplishment of 'good science', I explain moments where 'results' obtained do not fit with the scientific model, which exposes the work that bigerontologists do in order to make results 'fit' this model. Moreover, I show that space is opened for moments of ambiguity amongst the 'certainty'. In chapter seven I build upon what I descibe (in chapters four, five, and six) as care for good 'first class' science. In chapters five and six, I introduce moments of ambiguity; moments where care for 'good science' was interrupted. In this final analytical chapter (chapter seven), I elaborate upon these moments of ambiguity, and I show that biogerontologists make switches between a more instrumental relation and a non-instrumental relation with their (geneticised) animal (models), which are made to stand for humans and genes (and, thus, all of life) as part of 'producing' results that pertain to broader understandings of life and ageing. It is 'all of life' (and what this means) that is at stake in my study. In this final chapter, the

switching between 'worlds of care' shows that care itself is ambiguous and complex. This is as biogerontologists, in momentarily disentangling from institutional agendas as part of 'ethical doings' (Puig de la Bellacasa, 2010), are moved outside of these agendas by the animal (models) that they are 'alongside' (Latimer, 2013a). I finish by suggesting that relation is 'toward the 're-enchantment' of science and/or a recovery of techné (Feenberg, 2004).

It is also important to introduce the reader to the key contribution/s of the thesis. These contribution/s - gleaned from the four analytical chapters and a holistic reading of these four chapters that tell a story of 'emergence', 'presence', 'care', and 'complexity' - emerge from the unique ethical interrogation of both public *and* private biogerontology, and also biogerontologists' seeming lack of concern/care for broader social and ecological consequences. By studying biogerontologists' interactions, accounts, and practices at multiple spaces, I show throughout the thesis that *life* itself is re/assembled, for the most part, in relation to a productivist discourse of 'youthfulness' and 'usefulness' that is enacted in relation to 'good science' as rigour, excellence, control and standardisation. However, by studying the complexity of biogerontologists' world-making *in situ,* I show that moments of 're-enchantment' (as moments of care for life *and* moments of being affected by life) are enacted at the bench as part of what I call 'the laboratory present'. Given the analytical approach of the thesis, which renders biogerontology a 'discursive formation' (Foucault, 1969) (see chapter one), the ways that *life* is figured - as part of '*life*span' experiments at '*life* science' laboratories - are critical because they extend to more broad conceptions of what life is made to mean. This research is thus concerned with *all* people and 'the-whole-of-life' (including future generations), particularly in relation to the preservation of not only humans and animals, but also the planet. Thus, the findings reported comprise a unique contribution to biogerontology-specific STS literature and also to wider STS literature. I elaborate upon these contributions and also the key debates engaged in the concluding chapter (see chapter eight), the chapter summaries written throughout, and in the next chapter as I interrogate key literature/s.

Chapter Two

Organising Themes

Introduction

Building on my suggestion in the previous chapter that biogerontology is a critical site, in the current chapter I provide an overview of biogerontology's socio-history alongside key literature that concerns itself with the thesis' organising themes. The literature that I analyse in the current chapter is predominantly STS-based literature that draws focus to the sociological study of biogerontology. However, given biogerontology's emergent status there are a limited number of authors contributing to this body of literature. I have also drawn on a wider STS literature, and, in addition, literature that is relevant to the relation of care (particularly in relation to life, nature, and the environment) that I laid out as underpinning the thesis' cares, concerns, and/or objectives. These literatures, and the worlds that they subsequently create, become research materials themselves.

I have arranged the chapter using six themes. The first three themes draw focus to biogerontology-specific socio-historical events and STS literature (the definition of ageing, biogerontology's projected futures/expectations, and the ordering of biogerontology). The fourth theme is the reduction, determinism, and standardisation in relation to the field. This draws on the nature of the biological study of ageing alongside literature pertaining to the themes of anti/ageing, biogerontology, and biology. The final two themes are more directly related to the theme of care (biogerontology and ageing in relation to nature and life science, and ageing in relation to anti-ageing, care, and a discourse of usefulness). Thus, in this chapter I draw together multiple accounts of the field from different sources in order to illuminate the field in more depth. By drawing on 'what has gone before' (Latimer, 2008), I show why the site is a critical site. I finish by critically constructing *my* site in relation to the literature. Whilst I refer to the literature here in a concentrated fashion in this chapter, I also draw upon relevant literature throughout the thesis, for it can never be fully separated from the data.

Redefining Ageing: Biology, Medicine, and Biogerontology

It is argued that the Enlightenment period ushered in *"a scientific foundation for prolongevitism"* (Gruman, 2003: 157), and Gruman and other authors (see Binstock, 2003; 2004; de Grey, 2005; Fishman et al., 2008; Moreira and Palladino, 2009; Mykytyn, 2010a; Gems, 2011; Sethe and de Magalhães, 2013) suggest the impulse to transcend ageing/death, as a key facet of humanity, is visible across the span of history (though this claim is far beyond the remit of my study). Pre-WWII[24], 'The Club for Research on Ageing'[25] was established by American gerontologists, from which a series of lectures emerged that were significant in bringing together scientists with a special interest in ageing as a biological mechanism. Independently of one another, biologists in the mid-twentieth century (i.e. Medawar, 1952; Cowdry, Lansing, and Shock, cited in Wolstenholme and Cameron, 1955) began to study ageing as a biological puzzle within its own right (Achenbaum, 1995). This was as opposed to studying the individual diseases of ageing - one of the focuses of gerontologists - as biomedicine (Mykytyn, 2010a). Medawar (1952), a Nobel Prize winning immunologist, drawing on Weismann's (1882) theories of 'evolutionary ageing' and 'programmed death' (Holliday, 2006), is arguably the first biologist to propose the notion that ageing is a biological puzzle/problem[26] that underlies specific age-related illnesses.

In the following decades, biologists studying the problem of ageing (i.e. Greider and Blackburn, 1989; Rudman et al., 1990; Finch, 1990; Kirkwood and Rose, 1991; Partridge and Fowler, 1992; Kenyon et al., 1993; Hayflick, 1994; Kirkwood, 1999) published seminal texts. These arguably constituted an early phase of biogerontology's literature, occurring at a time when biologists began to refer to the field as 'biogerontology' (Moreira and Palladino, 2009; Mykytyn, 2010a). Subsequently, Aubrey de Grey, a computer scientist drawing on biological 'theories of senescence', formed (with a group of biologists) the research group 'Strategies for Negligible Senescence' (SENS) in 1999. Because of frequent online and media appearances, de Grey has become known by the public as a spearhead for redefining ageing as a

[24] There were less scientific initiatives during the time of WWII because attention and resources were focused elsewhere.
[25] This went on to becoming the better known 'Gerontological Society of America', or 'GSA'.
[26] Whilst 'puzzles' and 'problems' can be thought of as the same thing in relation to biology, the idea of a biological problem (as a puzzle) can be distinguished from the idea of ageing as a pathological medical problem.

phenomenon that can be and should be slowed and/or stopped (and even reversed) (see de Grey, 2002; 2003; 2005; Vincent, 2008).

Vincent (2008) draws on public data and reports that biogerontologists, through their redefinition of ageing as not only plastic but pathological and/or as a disease, are also redefining ageing as unnatural. Moreover, other authors (Binstock et al., 2006; Mykytyn, 2006; 2006b; 2006c; Fishman et al., 2008; Moreira and Palladino, 2009) suggest that the biology of ageing is instrumental to the 'Anti-Ageing Science Movement' (AASM) (Mykytyn, 2006c), which is comprised, Mykytyn (2006c) shows, of both medical and science practitioners. This 'big story' (Latimer, 2014) about ageing pertains not just to biology but also to biomedicine. This is because ageing is figured as the mechanistic 'root cause' of multiple age-related illnesses (Mykytyn, 2006c; Moreira and Palladino, 2009) like cancer, Alzheimer's, and Parkinson's. This is alongside age-related somatic deterioration, or 'senescence' (as it is also known) (Hayflick, 2004; Binstock et al., 2006a, Vincent, 2008; Moreira and Palladino, 2009).

In light of biogerontologists redefinition of ageing according to their perspective, Estes and Binney (1989) suggest ageing has been 'biomedicalised'. As well as the emergence in the twentieth century of biological studies of ageing, a simultaneous and interrelated focus on ageing in biomedicine is reported (Moreira and Palladino, 2009; Mykytyn, 2010a). As early as the 1930s, researchers at Cornell University studied 'Caloric Restriction'[27] as a way of controlling lifespan in humans with a view to 'treating' ageing and age-related illnesses (Mykytyn, 2010a). In addition, 'The Josiah Macy Foundation' [28] later commissioned several surveys and subsequently published 'Problems of Ageing: Biological and Medical Aspects' (Cowdry, 1939). Ageing research, Estes and Binney (1989) state, was both institutionalised and biomedicalised. This was, they contend, in the latter half of the twentieth century when a 'National Institute of Health' for Ageing emerged in the USA (in 1968). A five-year plan was

[27] *"Calorie restriction or Caloric restriction (CR) is the practice of limiting dietary energy intake in the hope that it will improve health and retard aging"* (http://www.sciencedaily.com). It is argued that CR works by inducing 'survival mode' in the body (Masoro, 2002). At several conferences, I met scientists and other proponents of CR who have a specially measured diet in order to try to delay their own biological ageing process.

[28] The Josiah Macy Jr. Foundation was set up in 1930 in the USA. It is: *"dedicated to improving the health of the public by advancing the education and training of health professionals"* (statement taken from the foundation's website - http://macyfoundation.org/).

drawn up by the new institute in order *"to promote intensive coordinated research on the biological origins of ageing"* (Lockett, 1983: 85). Whilst Estes and Binney (1989) describe 'biomedicalisation', Moreira and Palladino (2009), who draw on historical and archival data, describe biogerontology as evoking a more complex relation between biology and medicine. They suggest that biogerontology presents an *"advancing critique of biomedicine"* (Moreira and Palladino, 2009: 249) because of its challenge to the more traditional disease-specific biomedical model.

Specifically, biogerontology's redefinition of ageing as a biological problem and also an underlying mechanistic cause of age-related illnesses not only reframes ageing – forging a new relation between biology, medicine, and the lives of older people – but presents a *"paradox"* (Moreira and Palladino, 2009: 350). This is because biogerontologists publically report this new way of thinking about the *"diseases that are commonly associated with advanced age, such as cardio-vascular disease, cancer and dementia"* (Moreira and Palladino, 2009: 350). This subverts a 'disease specific' model and pays attention to the underlying basic biology. However, the paradox arises because this 'big story' of ageing (Latimer, 2014) also works to construct these individual diseases as part of a *"wider set of 'degenerative diseases' that are only connected contingently to the organism's chronological age"* which also *"call[s] into question the status of ageing as a biological process"* (Moreira and Palladino, 2009: 350) (my emphasis). Furthermore, drawing on their genealogy of the field of biogerontology, Moreira and Palladino (2009) argue:

> *"The development of biogerontology seems to undermine the possibility of any straightforward conjunction of biology and medicine which the phrase 'biomedicalization of aging' conjures almost by definition."*
> (Moreira and Palladino, 2009: 350)

Thus, Moreira and Palladino (2009) are figuring a more complex relation between biogerontology, biology, medicine, and ageing than many other authors describe (see Estes and Binney, 1989; Binstock et al., 2006a; Fishman, 2008; Mykytyn, 2006c).

Whilst Latimer (2014) describes biogerontology's 'big story' that ageing is plastic, elsewhere, she (Latimer et al., 2011) illuminates multiple biological 'theories of ageing', and these can be thought of as smaller stories. I unpack these later within the current chapter. Also referring to the field's 'stories', Mykytyn (2006c), after conducting interviews with 'anti-ageing practitioners', reports three key stories being told about the field: 1) a biological framing of ageing where it was described in terms of 'physiological symptoms', 2) a quest to save humanity, and 3) a problematic relation to science as a broader field because of the allocation of science-based funding (funding that might otherwise go towards anti-ageing science and medicine) going instead towards as *"band aid"* Mykytyn (2006c: 644) type treatment. This term, Mykytyn (2006c) describes, is used by practitioners to refer to treatment for the separate illnesses of old age.

The first story that Mykytyn (2006c) reports aligns to the biological aspect of biogerontology, whilst the second aligns to its biomedical aspect. The third highlights a problematic relation between biogerontology and mainstream science. This disagreement, she asserts (Mykytyn, 2006c), stems from 'standard' science and medicine practitioners' failure to adopt a redefined understanding of ageing. The issue of legitimation, for the sake of the field's funding, is raised here. Whilst I refer to 'biogerontology' in my study (Vincent, 2008; Latimer et al., 2011; Latimer and Puig de la Bellacasa, 2013), which is framed by some authors (see Vincent, 2008; Moreira and Palladino, 2009; Latimer et al., 2011; Latimer, 2014) as a synergy of *bio* (biology) *gerontology* (medicine), many other authors (see Binstock, 2004; Binstock et al., 2006a; 2006b; Mykytyn, 2006a; 2006b; 2006c; Fishman et al., 2008; Mykytyn, 2010a; 2010b) refer (arguably making an assumption about the *anti*-ageing intentions of practitioners) explicitly to the field as anti-ageing science and/or medicine. However, Vincent (2008), Lafontaine (2009), and Latimer et al. (2011) refer to the anti-ageing discourse implicitly embedded in biogerontologists' imagination, language, and practice.

Human Biomedical Futures: The Promise/s of Biogerontology

The redefinition and/or problematisation of ageing are connected to ameliorative notions of a 'better future' (Moreira and Palladino, 2009; Mykytyn, 2010a) and, therefore, the Utopian impulse often evident in expressions of 'prolongevity' (Gruman,

2003). In relation to projected, or speculative, societal futures, authors suggest that societal factors have played an extended part in biogerontologists' focus upon ageing as a site for intervention (Binstock et al., 2006a, Fishman et al., 2008; Moreira and Palladino, 2009; Mykytyn, 2010a). For example, it is suggested the prosperous Western 'Baby-boomer' generation (post-WWII children) grew up with high lifespan expectancy and, consequently, Mykytyn describes, *"concerns were mounting over population ageing"* (Mykytyn, 2010a: 13). Moreover, it is argued that this 'boomer' discourse of growth and success – also synonymous with the neoliberal agenda (Latimer, 2015) - simultaneously encouraged a focus upon being 'young, happy, healthy, and free' (Haber, 2001-2), as part of an ethic of 'liberation' (Binstock, 2004). This is alongside Boomers' propensity to question the medical system and its 'futures'.

Mykytyn (2006c) shows that this milieu opened up new space for the challenge of norms – for example, stoically accepting the ageing process. Mykytyn (2006c) partially attributes the increased focus on ageing in both medicine and science in the 1990s (and its associated promises) to this environment. In addition, Moreira and Palladino (2009) report that during the 1990s there was an *"alignment of evolutionary models and genetic research which Richard Dawkins's 'The Selfish Gene' (1976) had by then popularised very successfully"* (Moreira and Palladino, 2009: 360). This, they suggest, renewed scientists interest in such ways of thinking about ageing (see Kirkwood, 1999), with relevant debate playing a key role in biogerontologists' focus on ageing's 'risk factors' and 'biomolecular pathways' (Moreira and Palladino, 2009). Furthermore, they contend that this is emblematic of a shift in biomedical discourse during the twentieth century; a shift from a discourse of disease *intervention* to a discourse of disease *prevention* as part of a 'healthy future'.

Mykytyn (2010a) reports several prominent discoveries and publications – circulated more widely due to the frontiers and promise of the Internet (Fischer, 2004) - as being a key tipping point. This is between, first, scientists working independently of one another studying ageing as a biological puzzle, and, second, the emergence of 'anti-ageing science and medicine'. In the 1990s, biologists Finch (1990), Hayflick (1994), and Kirkwood (1999) published what are often referred to as seminal books (Moreira and Palladino, 2009; Mykytyn, 2010a) (aimed at both scientists and non-scientists)

showing that ageing was highly problematic and pathological. In addition, key discoveries have been noted in both scientific and public domains through publications and media articles. Key examples include the discovery of a potential gene (DAF-2) that regulates ageing (Kenyon et al., 1993) and learning about the effect Resveratrol (Strong et al., 2013) and Rapamycin (Harrison et al., 2009; Bjedov et al., 2010) have upon the biological ageing process in yeast and mammals (both 'drugs' are said to increase lifespan).

Mykytyn (2006c) describes that at this time of rapid acceleration in the biology of ageing, the AASM was formed. This is a collaboration of scientists and also medical practitioners that seek to redefine ageing as problematic and pathological. Drawing on laboratory studies, the movement's rhetoric addresses *"ageing as a target for biomedical intervention"* which shifts *"concepts of nature, life, patienthood, and the responsibilities of medical practitioners"* (Mykytyn, 2006c: 644). Moreira and Palladino (2009) critically highlight a distinction between biogerontologists and the AASM. They argue that whilst the AASM posits ageing as problematic and modifiable, biogerontology figures ageing as unnatural and thus a starting point for pursuing healthy medical futures.

Implicit in the dual (biomedicine/biology) narrative is a shift between the laboratory-based animal studies and biomedical interventions for humans. Adam (1990: 24) suggests *"the locus of reality is the present"* and that the past and future *"…are constantly created and recreated in the present"*. It is argued by authors (see Guice, 1998; Brown and Michael, 2003; Borup et al., 2006; Hedgecoe, 2006; 2010) that scientists shape or 'design' the future by creating social expectations. This is through spoken and written public accounts that are based upon projections of laboratory findings, which become 'expectations'. With a flurry of media attention surrounding 'anti-ageing' at the turn of the century (Mykytyn, 2010a), expectations and promises were 'hyped up' (Vincent, 2008) - for example, de Grey's claim in a BBC news article that *"the first person to live to 1000 might be 60 already"* (de Grey, 2004). Further to lifespan predictions, Mykytyn (2006c; 2008) argues that scientists have publically predicted a future 'reality' where there is no sickness or disease because ageing, as the underlying mechanism of these, will finally have been 'defeated' (Bostrom, 2005;

Binstock et al., 2006a; Lafontaine, 2009). Mykytyn (2010a) reports that at this time of such accelerated emergence, scientists' language has shifted from *if* to *when* as part of the debate about solving/curing ageing. This shift poses a challenge to traditional understandings of ageing.

Authors (Binstock et al., 2006a; Fishman et al., 2008; Vincent, 2008; Mykytyn, 2010a) make visible biogerontologists' drawing on biology-based studies in public. It is argued that biogerontologists draw on these studies as part of creating expectations about human medical futures. Furthermore, in relation to what is noted in the public setting, authors report differing sets of categories (pertaining to prolongevity) that, they claim, order the field. Moody (2002: 293) categorises 'weak' and 'strong' life extension. Here, strong equates to an average lifespan[29] of 120 and weak equates to an average lifespan of 240. Binstock (2004) and Binstock et al. (2006a) differentiate between, drawing on Kuhn (1962), three 'paradigms' within biogerontology: 1) 'Morbidity Compression', 2) 'Decelerated Ageing', and 3) 'Arrested Ageing.' The first, which borrows from Fries (1980), refers to a reduction of the period at the end of life where one's health and wellbeing is significantly affected by age-related illness. The second, which uses biogerontologists' terms (e.g. Miller, 2002; Gems, 2011), is where the *"processes of ageing are slowed and average life expectancy and/or maximum life span are increased"* (Binstock et al., 2006a: 437). Miller (2002: 155), as part of examining biogerontologists' future predictions of reality, claims that decelerated ageing will *"produce 90-year-old adults who are as healthy and active as today's 50-year-olds"*. The third, which Binstock et al. (2006a) also figure as 'radical' life extension, refers to stopping and reversing ageing. The category 'radical' is linked in the literature to de Grey and SENS. These categorisations elucidate an ongoing shift and/or relation between the 'processes' of ageing on one hand (biology) and also a healthy lifestyle predicted (biomedical futures). The latter, Moreira and Palladino (2008) argue, is by way of inspiring hope.

Mykytyn (2010a) divides biogerontology's history - a reading that is also based upon the study of public and archival data - into four categories ('pre-1990', '1990-1995', '1996-1999', and '2000'). She argues that biogerontology's emergence as a 'concrete'

[29] Lifespan, or what can be thought of as 'chronological ageing' (CA) (Moreira, 2015), is often used interchangeably with 'ageing' in authors' reports. However, I do not take this connection for granted.

field was catalysed by its aims and hopes being publically articulated at conferences and in publications by biogerontologists. She argues that these hopes for a healthy human future were framed over time as being increasingly close to becoming an actual 'reality' in current society:

> *"…while anti-ageing (AA) research challenged mainstream frameworks of ageing and made possible swelling discussions of AA objectives and methods, AA made relevant its desirability, and the appeal of AA possibilities that made it attractive to popular media; the emergence of AA concepts and practices in these various arenas reveals the complex and reciprocal relationships that give rise to scientific imagination, innovation, and practice."*
> (Mykytyn, 2010a: 19)

Mykytyn (2010a; 2010b) reports that the promise of a healthy future began in the 1990s, however, she shows that by the twenty-first century, these promises had become 'expectations'. She highlights (Mykytyn, 2010a) that this was a result of a co-constitutive relationship between important, groundbreaking discoveries in biology and also the excitement about the field gained in the political and public spheres (see Brown, 2003). Thus, she likens the momentum surrounding biogerontology's promises to other 'cutting edge' fields such as stem cell research, nanotechnology, and gene therapy (Mykytyn, 2006b). Such momentum and excitement creates what Guice (1999) refers to (drawing on the interactionist term) as a 'self fulfilling prophecy'.

Further to biogerontology's projected biomedical futures that have been discussed here, the socio-cultural implications (see Turner, 2009) have also attracted a sociological and/or ethical critique of biogerontology. For example, there is concern about the distribution of 'anti-ageing' amongst different socio-economic groups across the world. Zoloth (2015), an ethicist publically and directly addressing biogerontologists, defends the ideal of preserving health over obtaining and preserving material possessions. She argues that it is an imperative that the biogerontological pursuit should not be at the expense of developing drugs to treat other illnesses. This is a common critique of biogerontology expressed by gerontologists (Fishman et al., 2008). Moreover, Chapman (2004) and Rajan (2006) also show concern for asymmetrical access to healthcare

across the world, with first-world countries reaping the benefits of pharmacological intervention as a priority. Furthermore, from a feminist perspective, Holstein (2001-2) points out that any 'access divide' to future ageing treatment in the future might have a greater effect upon women. This is because, she argues, women are likely to suffer to a greater degree because they currently feel a greater deal of pressure to cover up signs of ageing. In addition, Zoloth (2015) points out that biogerontology opens up space for 'Big Pharma' companies to capitalise on potential advances (e.g. an 'anti-ageing pill') (see also Binstock et al., 2006a). In a similar vein, Boorse (2005) critiques proposals for 'radical longevity' because it *"affects our view of self, humans in community, and our role in the natural world"* (Boorse, 2005: 55).

These perspectives on biogerontology's prospective 'futures' supplement those of several authors (e.g. Binstock, Fishman, Mykytyn, Moreira and Palladino) and contest the reported ameliorative aspect of biogerontology. In addition, Turner (2009) calls for further discussion of the social, cultural, and ethical implications of biogerontology. In particular, this is in relation to what societal understandings of ageing, life, and death will look like for future generations. Believing that life is more than 'mechanics', he suggests that 'institutions' like family, work, and spirituality/religion will be impacted by significantly increased lifespan and also a reductionist approach to ageing. Additionally, he also suggests that an increased population equates to danger for the planet and its resources (e.g. increased global warming). Whilst Turner (2009), who draws only on public data, raises important questions, he does so based only upon an appraisal of 'radical' biogerontology (i.e. de Grey and SENS).

Ordering Biogerontology: Legitimation and Boundary Work

'Boundary work' is a central facet of science, for scientists 'demarcate' between science and non-science. This is because of the 'high stakes' involved for scientists attempting to maintain a distinct set of disciplinary attributes (Gieryn, 1999). Specifically focusing on boundary work in biogerontology, authors (Binstock et al., 2006; Fishman et al., 2008; Vincent, 2008; Mykytyn, 2010a) report that legitimating boundary work is accomplished with a view to attracting more funding for biogerontology research. Fishman et al. (2008) suggest that this (within and outside of the field) has been successful in the USA:

> *"The hard-fought establishment of the N.I.A., scientific advancements in genetics and biotechnology, and consistent 'boundary work' by scientists have allowed biogerontology to flourish and gain substantial legitimacy with other scientists and funding agencies, and in the public imagination."*
> (Fishman et al., 2008: 295)

However, Binstock et al. (2006a) suggest that biogerontologists remain speculative. They argue *"most practitioners and biogerontologists [would not] perceive themselves as undertaking anti-ageing interventions"* (Binstock et al., 2006a: 426). Despite key discoveries - such as Kenyon et al.'s (1993) finding that DAF-2 regulates biological ageing and Blackburn's (Greider and Blackburn, 1989) finding that biological ageing occurs because of the progressive damage to telomeres over time - Fishman et al. (2008: 296) argue that new findings and methods in this area are *"not [yet] enough to constitute a new discipline":*

> *"Individuals, groups, and institutions need[ing] to work toward legitimation within the larger scientific and social arena, through garnering political support, allying themselves with credible and respected scientists, and other elite members of society, and convincing those around them (often through rhetorical strategies) and their discipline is indeed worthy of scientific inquiry."*
> (Fishman et al., 2008: 296)

In light of biogerontology's emergence and prominence in the 1990s, there was not merely an expansion in 'anti-ageing' research and its corresponding discourses (Mykytyn, 2006c), publications, and emerging 'Institutes' like the NIH (Binstock et al., 2006a; Mykytyn, 2010a), but there was also an increase in attempts to gain more credibility for the field. Thus, these advances were, Mykytyn (2006c) argues, perceived highly necessary in order to protect the credibility of gerontology as an established field. This was at a time where the need for scientific legitimation was heightened due to debate surrounding cloning (partially due to the cloning of 'Dolly the sheep' in 1996) as advances in the field of molecular biology/genomics brought about recurrent ethical discussion (see Ramsey, 1972; Evans, 2002). However, authors (Binstock 2004; Binstock et al., 2006a; Fishman et al., 2008; Mykytyn, 2010a) report biogerontologists

and/or anti-ageing science and medicine practitioners also desired distance between credible research/practice on one hand and products that *"'your doctor doesn't know about'"* (Mykytyn, 2010a: 16) on the other. The latter are described as non-scientific 'quackery' by biogerontologists in Fishman et al.'s (2008) archival analysis.

The American Academy of Anti-Aging Medicine (A4M) was set up 1993[30], and Fishman et al. (2008) suggest that it posed a challenge to biogerontologists because of its association with non-science/medicine, uncertified disciplines, and unregulated over-the-counter anti-ageing products. The 'Silver Fleece Award' was awarded to the A4M by self-professed 'mainstream' biogerontologists wishing to distance credible science and medicine from non-science/medicine. In addition, Fishman et al. (2008) argue that biogerontologists' credibility is *"still somewhat fragile"* (2008: 296) because of, first, the challenge to traditional understandings of ageing as natural and/or normal, and, second, a conflation of the field's aims with ideas of immortality circulated in 'Sci-fi' films/novels (Olshansky et al., 2006) (e.g. Logan's Run[31]). Furthermore, credibility, Fishman et al. (2008) argue, remains tenuous because of the damage done by the 'Snake Oil' industry[32].

As well undertaking boundary work in order to distance credible medicine/science from non-medicine/science, the 'mainstream' biogerontologists, authors (Binstock et al., 2006a; Fishman et al., 2008) show, police the border between their own 'mainstream' objectives and the 'other' objectives of the 'radical' (i.e. de Grey) anti-ageing practitioners:

> *"Our concern is that when proponents of anti-aging medicine claim that the fountain of youth has already been discovered, it negatively affects the credibility of serious scientific research efforts on aging."*
> (Olshansky et al., 2002: 295)

[30] By 2007, the A4M had approximately twenty thousand members across ninety countries. The A4M is significant because it reveals a mainstream societal interest in 'anti-ageing' (Fishman et al., 2008).
[31] 'Logan's Run' is a science fiction movie that asks questions about immortality though a story where - due to overpopulation – every person in society must die at thirty years old.
[32] The 'Snake Oil' industry is used to refer to products with fraudulent health benefits. Vendors of such products often thrive in unregulated settings, and, due to 'anti-ageing' being a relatively new enterprise (in modern S&T), this area has been popular in the absence of solid regulation.

Additionally, Mykytyn (2006c) highlights that the AASM faces resistance from those within biomedicine, yet the movement, she argues, retains collective strength. Fishman et al. (2008: 298) argue that this is because of a *"reliance on the rhetoric of scientific breakthroughs"*. This is alongside a mainstream consensus to stay within the mainstream 'limits' (Warner et al. 2005) of biogerontology. Furthermore, a dependence upon desirable, but not unrealistic, projected futures accompanies breakthroughs and conservative safeguards (Mykytyn, 2010a). Binstock et al. (2006b: 434) argue that there are three different *"rhetorical labels"* that are circulated by biogerontologists: 1) 'Medical Treatments', 2) 'Enhancements', and 3) 'Preventions'. The first of these is taken up by biogerontologists because it is safe and carries *"cultural moral authority"* (Binstock et al., 2006b: 434). The second, they argue (drawing again from the 'radical' ideas of de Grey and SENS) provokes accusations of 'unnaturalness' and encourages visions of unnecessary intervention. These reasons, they state (Binstock et al., 2006a), are integral to the attempts by mainstream biogerontologists to create distance between themselves and the 'radical'. The third label, they show, has been taken up by the mainstream because it intentionally *"skirts the controversies about 'whether ageing is a disease and needs treatment' and 'enhancement is unethical'"* (Binstock et al., 2006b: 434). The discourse of prevention fits with biogerontology's 'big story' (Latimer, 2014) that ageing is plastic, and it is drawn on widely by multiple biogerontologists across the otherwise fragmented field (Binstock et al., 2006a; Fishman et al., 2008).

Further to dividing practices, and what some authors have framed as the 'Mainstream vs. Pioneer' debate (Binstock et al., 2006b, Fishman et al., 2008; Mykytyn, 2010a), biogerontology's legitimation is also entangled with the field's engagement with politics and publics. Earlier in the thesis (see chapter one), I made reference to biogerontology's presence in mainstream politics, with Kirkwood advising the 2005/2006 'House of Lords Select Committee Report'. This demonstrates a level of support for biogerontology from those who are making key policy decisions at a time where the increase in numbers of older people in need of care is considered to be a national crisis demanding urgent attention. To recap:

> *"As we sought to demonstrate in our Report—a point repeated by Professor Kirkwood in his written comments—ageing is a continuum, affecting all of us all*

> *the time. He also reiterates the point made in our Report, that generic research into the process of ageing, far from being in competition with research into specific conditions affecting older people, may be "the most direct route to developing novel interventions and therapies". There is no sign of such holistic thinking in the Government response."*
> (Select Committee on Science and Technology Sixth Report, 2005/6)

With biogerontology on the public and political agenda in the twenty-first century, the number of public occasions/appearances in the UK has increased (Mykytyn, 2010a; Latimer, 2014). For example, radio, television[33], magazine and newspaper, and public engagements – for example Kirkwood's set of four 'Reith Lectures' (2001) and Woollard's Royal Society Christmas Lecture (2013) on ageing and genetics (see Latimer, 2014). Simultaneously, mainstream biogerontology emerges at a time when posthuman[34] and transhuman[35] discourses are popular. This is particularly in relation to an immortalist 'impulse' (Lafontaine, 2009), which has appealed to particular groups of Americans focused on human enhancement and transcendence (Fishman et al., 2008). However, Fishman et al. (2008) argue that these groups are often part of the 'quackery' that the mainstream, who are seeking support and legitimation through what they perceive to be 'credible' means (e.g. the House of Lords), wish to distance themselves from. Mykytyn (2010a) suggests that the Internet has become a key space for debate; particularly space created by online forums, letters, and journals. In 2005, there was an important debate between SENS and the self-proclaimed 'mainstream' (approximately thirty biogerontologists). The mainstream accused SENS of being a 'farrago' (Warner et al., 2005; cf. de Grey, 2006), whilst de Grey - representing SENS - accused the mainstream of holding the field of biogerontology back with 'conservative' aims.

[33] For example, Channel Four's documentary entitled '*Do you want to live forever?*', which predominantly focused on the life and research of Aubrey de Grey and SENS. It was promoted on SENS' website (the documentary was first aired 3rd February, 2007).
[34] The 'posthuman' discourse refers to a stage/state that transcends humanity as a stable category. This is an idea championed by the 'posthumanism' movement, with some authors contending that we are already post-human (for varying reasons).
[35] The 'transhuman' discourse, as part of 'transhumanism,' refers to a – mostly - intellectual set of ideas pertaining to the enhancement of 'the human' through S&T/transcending human capacity and capability.

Reduction, Determinism, and Standardisation

I have referred to biogerontology's 'big story' that ageing is plastic (Latimer et al., 2011; Davies, 2012; Latimer, 2014) and that it is regulated by an underlying biological mechanism (see Binstock et al., 2006a; Fishman et al., 2008; Vincent, 2008; Latimer et al., 2011; Latimer, 2014; 2015). The 'reductionist' approach constituted by science is widely acknowledged in relation to science and/or biology (e.g. Rose et al., 1984; Rose, 1997; Shapin, 1997). This is exemplified by the multiple and interrelated 'theories of ageing' that reduce ageing to molecular entities (Latimer et al., 2011) - for example, the theory of cellular ageing (e.g. Blackburn and Greider, 1989; Hayflick, 1994). Proponents of this theory describe telomeres that sit at the end of each chromosome in the human body. They have the role of protecting the part of the chromosome that stores the DNA code from shortening during the cell replication process. The code is also shielded in this process from free radicals that can cause abnormalities (e.g. cancer). An enzyme, known as *telomerase reverse transcriptase,* replenishes telomeres when they are lost during the replication process. Over time, however, the effectiveness of this enzyme decreases and telomere chains begin to shorten, which, Blackburn argues, causes biological ageing (Blackburn and Greider, 1989). The telomeres, when functioning correctly, are said to function like the tip of a shoelace (Wall, 2010) because they keep the chromosomes in tact during cell replication.

Cynthia Kenyon (et al., 1993) (Professor at the University of California) is globally renowned for her discovery that the 'DAF-2' (encoding for 'insulin-like' growth factor) single gene mutation has doubled the lifespan of *C. Elegans* (a type of nematode worm). According to biologists, genes are sections of DNA (DNA is 'packed' into chromosomes) coding for specific proteins, which, in turn, create an organism's physical attributes (Ridley, 1999). Kenyon et al.'s (1993) claim that genes regulate the ageing process has been influential in the field of biogerontology (Mykytyn, 2010a), with a number of biogerontologists drawing on this discovery. *C. Elegans* (as an animal model) has been a starting point for much biogerontology research (e.g. Gems and Riddle, 2000; Weinkove et al., 2008; Tullet et al., 2014; Virk et al., 2016). According to these authors, ageing is reduced to a 'phenotype' (like 'eye colour' or 'height'). Scientists describe a 'phenotype' as the physical expression of a particular 'genotype' (a set of genes that code for the expression of the phenotype). Kenyon et al. (1993) shows that 'DAF-2', when transcribed – this is when DNA is copied to RNA, which carries

instructions from DNA as protein is made in cells - is expressed as 'DAF-16'. This, in turn, has been shown to have an effect upon the length of a *C. Elegans* life. Here, ageing is reduced to a biological process comprised of these multiple aspects/parts.

Star (1983) describes how scientists represent and simplify (often quantifiably) the 'chaos' that they find when examining and reducing highly complex biological phenomena to figures, graphs, and charts. Similarly, Latimer (2013b) shows that biologists make an organism's genes stand for its life. This is in the sense that the organism's life becomes biologically determined, which, Latimer (2013b) shows, is translated into the clinic, as patients are constituted by practitioners according to normal and/or pathological traits. Rose (1997: vii) reports: "*the rise of the present enthusiasms for biologically determinist accounts of the human condition date to the late 1960s"*. Arguably, this way of thinking about life in biology did not stem from a particular advance in the field, but from a discourse of 'eugenics' discourse made popular in the West in the early twentieth century (followed by several decades of disrepute after Hitler's Nazi regime) (Rose et al., 1984; Rose, 1997; Evans, 2002). As part of the 'cellular theory of ageing', some biogerontologists describe ageing within the context of 'cell senescence' (see Vincent, 2008; Latimer et al., 2011); a term that scientists use to refer to the physical deterioration of cells over time. This process, they argue, causes physical signs of ageing and age-related diseases (e.g. Finch, 1990; Hayflick, 1994; de Grey, 2005; Davis and Kipling, 2006).

It is argued that this kind of reduction and/or determinism in biology has an effect on the way that members of society construct reality (e.g. Martin, 1991; Vincent, 2008; Lafontaine, 2009; Latimer, 2013b). Particular authors show that biogerontologists' use of words with negative connotations for older people (words like 'senescence') might promote ageism in society (Latimer et al., 2011; Vincent, 2008). Lafontaine suggests that a *"biologisation of culture"* (Lafontaine, 2009: 53) has had an effect upon the way that both ageing and death, as synonymous (Seale, 1998), are deconstructed by the way that biology reduces (see also Bauman, 1992). This is in the sense that ageing and death are broken down to their constituent biological parts, which has implications, Lafontaine (2009) and Vincent (2008) argue, for the way that both ageing and death are reconstructed accordingly in society. For example, Latimer, (2013b) suggests, humans

become observable according to their genes, and, thus, when a gene for ageing is proposed (e.g. Kenyon et al., 1993), the implications of biogerontology's reductions for society are potentially far reaching (Latimer et al., 2011). Reducing ageing in this way is not only compatible with 'simplified' (Star, 1983) representations of 'science', but also defining ageing as a stable category in society. However, Moreira (2015), drawing on archival, historical, and secondary interview data, reports that ageing, a once stable category defined in terms of 'standardisable' chronological ageing (CA) throughout the twentieth century, has become an unstable category. This, he highlights (Moreira, 2015), is a reflection of an increasingly individualised society:

> *"…[CA has been] undermined by forces of globalisation, labour market de-regulation, re-structuration of public services and individualisation processes so as to produce de-institutionalised and/or destandardised life course trajectories."*
> (Moreira, 2015: 1)

Moreira (2015), following the paradox between chronological and biological ageing that he has previously stated (Moreira and Palladino, 2009), suggests that whilst CA is still prevalent, the destandardisation of ageing has contributed to a decreased of reliance on CA. He argues that CA, increasingly distrusted by experts, is less applicable in relation to understanding ageing as a qualitative, individualised life course. Moreover, he suggests: *"understanding the generation and validation of age measurements becomes crucial if we are to further intergenerational and socio-economic justice"* (Moreira, 2015: 22).

Commenting more broadly on scientific practice, Porter (1995), describes the way that science's universal measurement of reductive theories and hypotheses translates to governance and facilitates the public's trust in these. He asserts that it is universal trust in scientists' expertise that is integral to reliance on experts' 'numbers':

> *"Without such honest mediators, the system could scarcely function. But in a regime of trust, [these] discretionary measures could be far more useful than some result of indiscriminate objectivity produced by a surveyor."*
> (Porter, 1995: 24)

Moreira and Palladino (2009) suggest the influence of evolutionary histories and/or genetics-based studies in biology (scientists often use animal models as part of this practice) pertains to a reductionist approach in biogerontology. As part of this understanding, they show that ageing is figured as 'standardised' (CA) (Moreira, 2015) 'lifespan'.

Davies (2013) examines the 'figure' of the inbred mutant mouse as a laboratory animal model. She claims that the mutant mouse operationalises non-standardised, heterogeneous modes of accomplishing science; modes that embrace complexity. She argues that such complexity might encourage a turn towards context-based experiments and open-ended questions in science; a way of seeing that she considers wholly positive. Therefore, she suggests that the use of animals in the laboratory might have positive implications for biology research:

> *"All the animals embody the capacity to be modeled into standardised strains, as well as the potential for unexpected biological excess…The unexpected discoveries raise discussion about the roles and relations between people, expertise, and animals."*
> (Davies, 2013: 243)

However, in Davies' (2013) study, mouse 'caretakers' talk about *"accidently breeding a line"* (Davies, 2013: 242) and blame the laboratory's Vivarians for *"carelessness"* (Davies, 2013: 242). Furthermore, 'lively' mutant strains (unsurprising in the 'life science' department) were described (negatively) as *"unscheduled births [that] disrupt research"* (Davies, 2013: 243). 'Mutability' in her study was, for the most part, sidelined in the laboratory setting because biologists desired standardised results from their experiments. This highlights animal models (mutant strains in particular) as problematic to scientists. However, this is of interest when thinking about the

standardisation and/or reduction of ageing in biogerontology, especially within the context of working with animal models in the biogerontology laboratory.

Life in the Laboratory: Biology, Nature, and Animals

A grouping of literature already described in this chapter shows biogerontologists' engagement with both biology *and* medicine (e.g. Binstock et al., 2006; Mykytyn, 2006c; Fishman et al., 2008; Vincent, 2008, Mykytyn, 2010a), with Moreira and Palladino (2009) suggesting a complex and/or paradoxical relation between these two 'areas'. Despite public claims made regarding biomedical 'cures' for the 'disease' of ageing (as opposed to cures for individual age-related diseases), biogerontologists' story that ageing is malleable, as described, implicitly reduces ageing to its biological parts. Thus, the laboratory setting is critical. Whilst biogerontology faces critique for pursuing (in accordance with Western society's definition of ageing) an 'unnatural' solution to the 'problem' of ageing, Mykytyn reports the (legitimating) stance taken by biogerontologists when approached with such criticism:

> *"A hierarchy of nature has emerged in anti-ageing medicine such that liberation from the pain of humanity is a more 'natural' or 'human' pursuit than the biological decline of ageing as 'natural.'"*
> (Mykytyn, 2008: 313)

I have described the smaller story that 'ageing happens because of a depletion of telomeres over one's lifespan' (Greider and Blackburn, 1989) and the story that 'ageing is genetically programmed' (Kenyon et al., 1993; Gems, 2011). The way that ageing is reduced as part of these smaller stories is framed within a context of the biology and/or *life* sciences (Latimer et al., 2011; Latimer and Puig de la Bellacasa, 2013). This field, like ageing itself, opens up an arguably paradoxical space of both naturalness *and* standardisation (Candea, 2013; Davies, 2013).

Literature drawing on historical and archival data (see Binstock et al., 2006; Fishman et al., 2008; Moreira and Palladino, 2009; Mykytyn, 2010a) reports biogerontologists describing instances of animal experimentation as part of persuasive, public claims. To recap, this is part of circulating human biomedical futures (Mykytyn, 2010a). Animals

that are used 'experimentally' in the laboratory are referred to as animal 'models'. This is because they are being made (by scientists) to 'stand' for humans (see Rader, 2004; Friese, 2009; Friese and Clarke, 2012; Friese, 2013; Lewis et al., 2013). As described, Kenyon et al. (1993) is known for her discovery that that DAF-2 mutation regulates ageing (as a phenotype) in *C. Elegans*. Kenyon studied under 'Nobel Peace Prize' winning Sydney Brenner (in 1963), who is known for being one of the first biologists to use *C. Elegans* as an animal model.

Linda Partridge (Partridge and Fowler, 1992; Gems and Partridge, 2001) (an award winning Professor of Genetics based at University College London) set up the 'Partridge Family Lab'[36]. She is known for first discovering an increased lifespan in *Drosophila Melanogaster* (the common fruit fly) in the instance of reduced activity of the fly's insulin/IGF signaling pathway (see Gems and Partridge, 2001). This is similar to the pathway that Kenyon found to be of significance in her study of *C. Elegans*. Use of the fruit fly in science predates the common use of worms in research, with Thomas Morgan (1901) being the first biologist known to use it as a 'model'.

Biogerontologists also report conducting research with mice (see Bjedov et al., 2010; Strong et al., 2013) and cell cultures (see Kirkwood, 1999; Davis and Kipling, 2006; Faragher et al., 2011). Whilst biogerontologists can (broadly speaking) be grouped in terms of two key background traditions (see Moreira and Palladino, 2009): 1) biologists with a background in evolutionary biology (e.g. Medawar/Kirkwood), and 2) biologists with a background in experimental biology (e.g. Kenyon/Partridge). These groupings are not mutually exclusive and they often overlap - for example, Finch's work on ageing, evolution, and the genome (Finch, 1990). In contrast, de Grey's research background is computer science. Moreira and Palladino (2009) suggest the primary difference between the two categories is expressed via the debate about whether ageing itself is a disease. They show that experimental biologists (generally speaking) figure ageing as a disease and evolutionary biologists (generally speaking) figure ageing as natural. Philosophers of biology report that evolutionary biology is awarded less status than experimental biology (molecular biology) (Grene, 1987). This debate is significant in the 'genetics age' (see Rose et al., 1984; Atkinson et al., 2009; Latimer 2013b). This

[36] There have been many laboratories set up by ex-postdoctoral researchers of the 'Partridge Lab'. Members (and ex-members) refer to themselves as being part of the 'Partridge Family'.

'age' has led to a shift in clinical practice (see Moreira and Palladino, 2009; Latimer, 2013b). This is in the sense that genes become deterministic diagnostic 'tools' and the means by which to diagnose what is 'normal' and what is 'abnormal'.

Animal models play a significant part in the smaller stories about ageing. It is argued that animal bodies are 'transposable' to the human body (Friese and Clarke, 2012). This means that the animal model becomes an *"analytical tool for describing and comparing the social, material, discursive, and social aspects of [such] bodily reconfigurations"* (Friese and Clarke, 2012: 46). Furthermore, Friese (2009) argues: *"the very processes involved in making a model produces, reproduces, and transforms social actors"* (Friese, 2009: 385). She also suggests that caring for animals in the laboratory setting enacts, therefore, a relation of care for members of wider society. Therefore, the impact of this 'practice' of care, Friese (2013) asserts, has implications for all living organisms (rather than only the sick body). In addition, she argues (Friese, 2013) (drawing on observational data) that care in the biology laboratory setting is part of the enactment of 'good' science (see also Shapin, 1994, Thompson, 2013):

> *"By caring for the well-being of animals within the experimental context, Elspeth[37] believes that she has improved the quality of data produced and thus its potential for clinical usefulness… According to Elspeth, care cannot be separated from science through a division of labor that links husbandry with technicians alone; rather, care must be seen as part of experimentation itself."*
> (Friese, 2013: 131-132)

Here, good husbandry is part of what Candea also calls *"good animal science"* (Candea, 2013: 123), which is something that Haraway (2008) touches upon after encountering a group of scientists whose *"practices of care…are central to their labour as scientists"* (Haraway, 2008: 90). In addition to highlighting care practices, Friese (2013) suggests that the potential for the 'conditioning' of a (model) organism is embedded in the experimental process, which introduces a reflexive relation between scientists and their animal (models). Latimer (2013a), drawing on Heidegger (1962;

[37] 'Elspeth' works at a leading British University that works using mice as animal models. One example of the way that she cares is her use of a technology called 'telemetry'. This is a wireless device that tracks mouse movement (inserted using anesthesia to eradicate pain) to ensure that the mice use the space safely.

1977), describes a co-constitutive relation between the 'human' and 'non-human' as 'becoming-with'/'being alongside' (see chapter one). Latimer (2013a), as part of a feminist approach in STS (see also Martin, 1991; Haraway, 1991; 2008; Puig de la Bellacasa, 2011; Despret, 2013; Latimer and Puig de la Bellacasa, 2013), opens up space to discuss the *practice* of care in science. Moreover, Puig de la Bellacasa (2010: 2015), drawing on Haraway (see 1991; 2008), highlights the importance of naturecultures and/or the entanglement of the human and the animal, the land, and/or the collective for the analysis of technoscience; especially given that laboratory animals become 'cyborgs' of sorts (Haraway, 1991; 2008). This is pertinent when examining biogerontology as life science, but also biogerontology as a field with implications for present *and* future generations and the way that these understand life.

Anti-Ageing, Care, and Usefulness

I have iterated Moreira's (2015) claim that the late twentieth century is the starting point for the 'destandardisation' of ageing. This is as part of the replacement of CA with the notions of the 'life course' (see also Kohli and Meyer, 1986; Featherstone and Hepworth, 1989; Hutchinson, 1999). To elaborate, the life course can be thought of as the socially defined unfolding of variable events in the life of an individual. Such an approach stands at odds with the reduction and/or standardisation (explicit and implicit) in biogerontologists' big and smaller stories (Latimer, 2014), as biogerontologists work to create 'biomarkers' for ageing (Moreira, 2015). Yet the idea of the life course is still imagined in relation to CA (Featherstone and Hepworth, 1989; Moreira, 2015) and the physical signs of old age and individual age related illnesses. These signs are perceived in Western society to be an inherent aspect of 'ageing' (Blaikie, 1999). Lafontaine (2009) suggests that biogerontologists frame old age as a threat because of these potentially difficult and stigmatising physical signs of ageing. Butler highlights and examines inherently ageist connotations of '*anti*-ageing':

> *"Anti-ageing medicine promotes and reinforces ageism because it puts a profoundly negative connotation as the natural and inevitable occurrence of growing old, emphasising its negative and depletive aspects."*
> (Butler, 2001-2: 64)

Whilst some authors uncritically refer to biogerontology as 'anti-ageing' (e.g. Binstock et al., 2006a; 2006b; Mykytyn, 2006c; 2010a; Fishman et al., 2008), others (Butler, 2001-2; Vincent, 2008; Latimer et al., 2011) unpick the assumptions of *anti*-ageing in this way, alongside highlighting the *"embedded ageism in anti-ageing science"* itself (Vincent, 2008: 331). Additionally, Vincent (2008), Latimer et al., (2011), and Latimer (2014) go further in deconstructing the language biogerontologists use; illuminating the potential for embedded ageism in biogerontologists' stories. They suggest a more complex relation between science and society and argue that biogerontology might be used to reverse ageism if scientists foster a more reflexive approach to their choice of language.

Vincent (2008) (drawing on data from a range of sites, such as conferences, literature, interviews) explores the word 'senescence'[38], which is a word used to represent biological ageing, for its ageist meanings. He shows that it connotes deterioration and decay (Vincent, 2008). The word senescence, Vincent (2008) argues, is 'borrowed' (see Beer, 1986) from 'society' by biogerontologists and it is used, he shows, by scientists to describe senescent, deteriorating cells. For example, he imagines senile, retired cells with their 'zimmerframes'. However, this contradicts notions of the 'third age' that are forwarded by another grouping of authors (e.g. Higgs and Rees-Jones, 2009). In contrast to ideas about cells with zimmerframes, Vincent (2008) also explores the use of the word 'apoptosis'[39]. Apoptosis, according to biogerontologists, refers to biological ageing as a *"controlled demolition process"* (Adrain et al., cited by Vincent, 2008: 336). Conversely (to 'senescence'), this is used by biogerontologists to describe a 'good death':

[38] Senescence, as described in Vincent's paper (2008: 335): *"The noun 'senescence' and its derivative adjectives 'senile', 'senescent', and the verb to 'senesce', and the noun 'senectitude', and the term 'senile' to label a patient with a medical condition, have a long history. The Oxford English Dictionary gives the etymology of the word from the Latin, 'senescere' — to grow old. It is also the root of various positive associations as in 'senior' or 'senate'."* Vincent (2008) reports multiple definitions of the word by scientists, and each definition involves the notion of decay and deterioration as a cell loses its ability to divide and replicate itself (Vincent, 2008: 336).

[39] Apoptosis, described less variably by scientists in Vincent's study, is: *"a form of programmed cell death induced by external or internal signals that trigger the activity of proteolytic caspases, whose actions dismantle the cell and result in cell death…"* (Gene Ontology, 2007; cited by Vincent, 2008).

> *"The individual (cell) [plays] a part in the overall life of the collective (body)… Its death is at the right time and the right place is a necessary and desirable outcome for the health of the whole."*
> (Vincent, 2008: 337)

Whilst the difference between senescence and apoptosis appears minute, Vincent (2008) shows a significant difference in the meanings circulated by each. Use of the word senescence, Vincent (2008) argues, promotes ageism and the associated redundancy of older people. However, he also argues that whilst using the word circulates a story about death, it also ascribes worth to death as a valued aspect of life. Furthermore, Latimer et al. (2011) draw on Vincent (2008) and they suggest (after observing biogerontologists at multiple sites, including the laboratory setting) that biogerontology, as an emerging field, might affirm ageing:

> *"Biogerontology, by helping us to understand how those processes leading to chronic and disabling diseases of old age are potentially a site in which clinical medicine and acute health care can have some positive effects, may have the chance of reaffirming ageing, and by association, older people, in healthcare contexts."*
> (Latimer et al., 2011: 16)

Whereas the ethical, in terms of its appropriateness (see Kass, 2003; Caplan, 2005; Binstock et al., 2006a), has been a site of contention for biogerontology (see de Grey, 2002; 2003; 2005; Binstock et al., 2006a), Vincent (2008) and Latimer et al. (2011) present a different case for the scrutiny of the ethical. This is in terms of firstly, their exploration of the way that biogerontologists create worlds using language, and secondly, their examination of the plasticity of language as a means by which biogerontologists might go forward (either appropriately or inappropriately).

Latimer and Puig de la Bellacasa (2013) make a distinction between what they call 'the ethical' and 'Ethics', which I have already described in detail (see chapter one). To recap; the ethical, as opposed to the Ethical refers to the *practice* of care that also incorporates an affective dimension (see Puig de la Bellacasa, 2010; 2011; Latimer and

Puig de la Bellacasa, 2013). I have also described this within the context of Puig de la Bellacasa's (2011) distinction between 'matters of care' and 'matters of concern' (chapter one). Drawing on data collected in a biogerontology laboratory, Latimer and Puig de la Bellacasa (2013) describe 'fuzzy' enactments of care, such as 'changing the nappies', 'manual labour', and 'organising tasks', which are all necessary for biogerontology's 'Wow! Moments' in the laboratory (Kenyon's 'DAF-2' discovery might be thought of as one of these).

Debate surrounding eugenics is prevalent in discussions of biogerontology (see de Grey, 2005; Binstock et al., 2006a). This is in relation to biological determinism and selective breeding. Whilst some sociologists critique the implications of genomic technologies from a humanist perspective that celebrates autonomy (see Bowring, 2003; Habermas, 2003), Latimer (2013b) calls into question the way that geneticists and genetics counselors, in light of the 'new genetics' (see also Rabinow, 1992), hold the power to reshape society's constituting of what/whom is included as normal and what/whom is excluded as pathological. I have already described that certain authors (Binstock et al., 2006a; Vincent, 2008; Moreira and Palladino, 2009; Latimer, et al., 2011) posit this debate about what is made normal and/or natural (and consequently who gets included/excluded) as being of central importance to biogerontology's discussion as it emerges as a scientific field. Additionally, authors (see Latimer, 1997; 1999; Blaikie, 1999; Bauman, 2004; Featherstone and Hepworth, 2005; Vincent, 2008; Latimer et al., 2011; Puig de la Bellacasa, 2015) describe/critique the value that is placed upon being a 'useful' human as part of making a productive contribution to society.

This story about productivity, authors argue (see Vincent, 2008; Latimer et al., 2011), is one circulated by biogerontology in relation to fundamental concerns in biology, such as reproduction, evolution and/or natural selection (see Rose et al., 1984; Rose, 1997; Grene and Depew, 2004). These theories, as I have described, foreground the approach of many biogerontologists. Furthermore, Friese (2013), in her study of the practice of care in the laboratory, suggests a divide between care on one hand, and ethics and practice on the other hand. This is not dissimilar to Latimer and Puig de la Bellacasa's (2013) distinguishing between 'Ethics' and 'the ethical'. Friese (2013) argues that this divide perpetuates perceptions of life as 'useful', and/or an object of instrumentation, to

scientists in the laboratory, and experiments, she highlights, are predominantly undertaken with a view to efficiency. Care, when it is undertaken in the laboratory, according to Friese and Clarke (2012) and Friese (2013), becomes 'standardised' and consequently 'transposable' to biomedicine and biological understandings of the human. However, this perspective contrasts with the definition of care that I draw from because one's being moved, or 'affected', is non-standardisable (see chapter one).

Furthermore, Puig de la Bellacasa (2010; 2015), as part of exploring the practices of ecologically-minded communities, considers care within the context of naturecultures and the unforced temporal rhythm of working *with* the land. Based upon a study of permaculture practices, she argues that taking time to *care* for the soil (and other nature/s) subverts the fast, efficient pace of 'productionism'. Moreover, she highlights that *"care time is [also] irreducible to productionist time"* (Puig de la Bellacasa, 2015: 707). This becomes significant for any consideration of technoscience because, as she proceeds to state:

> *"The pace required by involved soil care poses the challenge of a relational encounter of different timelines that might affect the notions of the future that dominate in technoscience."*
> (Puig de la Bellacasa, 2015: 709)

Here, the idea of a relational encounter with the land; with other creatures; and/or with other life becomes integral for care practices. Elsewhere, Puig de la Bellacasa (2010) describes 'ethical doings' (as care) in naturecultures that originate from members' "*awareness of their interdependency*" (Puig de la Bellacasa, 2010: 167) with other lifeforms and/or the 'collective'. Such an understanding of care enriches the one that I have already laid out, whilst also contributing to the discussion of usefulness and, also, the relation between humanity and nature/life that is central to my study and its origins (see chapter one).

Returning thus to usefulness and disposal, such ideas (theoretically speaking) align with critical commentary surrounding waste that is also pertinent to thinking 'ecologically'. Thinking about, or *with*, waste has become especially central to discussion in relation to

sustainable consumption (e.g. Cohen and Murphy, 2001; Burgess et al., 2003; Southerton et al., 2004; Eden et al., 2008; Evans, 2011). However, this is not merely in relation to nature, but in relation to the consumption of persons (Latimer, 2001; Bauman, 2001; Bauman, 2004; Beaucroft, 2004), with Bauman suggesting that the nature of human waste becomes similar to that of material waste. This is in terms of waste as no longer 'useful', and Bauman (2003; 2004) argues that this wasteful relation is a condition of modernity. This idea is compatible with the analytical approach of this thesis because it corresponds to the ordering of persons and inclusion and exclusion (see chapter one). Moreover, Evans (2011) illuminates the complexity and multiplicity of imaginings of material waste in differentiating between the relations of care existing as part of two approaches to waste: thrift (reduction with a focus on saving more) and frugality (prudence imbued with a more thoughtful, holistic ethicality). Furthermore, Latimer (2001), drawing on Hetherington (1992), highlights the complexity of consumption as a dividing/ordering practice that elicits the inclusion, exclusion, and disposal of people, materials, and/or nature. This is pertinent to a consideration of 'ageing' people and/or 'ageing' bodies in society; especially in relation to biogerontologists' arguments pertaining to the usefulness of people (Kirkwood, 1999) and, as STS writers argue, when biogerontologists use language that reinforces the story about usefulness and disposal (Vincent, 2008; Latimer et al., 2011).

Summary: Constructing the Site

A key grouping of studies that I have drawn on report, drawing primarily on publically available data, on the emergence of biogerontology/'anti-ageing science and medicine'. Some of these studies predominantly consider US biogerontology (alongside its borders and boundaries) and this is based on accounts emerging from historical and archival data only. The non-critical, US based studies view the field of biogerontology as a ready-made, pre-existing structure. This is contra to Latour's understanding of science as 'in the making' (Latour, 1987) that I draw from in my analytical approach (see chapter one). With a primary focus on UK biogerontology, I seek to understand biogerontologists' 'worlds' as biogerontology is continually accomplished. Whilst some authors examine the implications of biogerontology's emergence for understandings of ageing - whether beneficial for society or otherwise - only Latimer's (et al., 2011; 2014; 2015) research is based upon data gleaned from multiple settings. The majority of

biogerontology-based social science research (e.g. Binstock, Mykytyn, Moreira and Palladino) is based on the described historical/archival studies of public biogerontology. As well as studying public biogerontology in depth, I study the day-to-day practices of the biogerontologists in the laboratory setting alongside data yielded from the public setting. This is as part of a multi-sited and comparative approach. Moreover, I offer, with Moreira and Palladino (2009), Lafontaine (2009), and Latimer (et al., 2011; 2014; 2015), and Vincent (2008), a more critical elucidation of the field.

Whilst some authors, for example Turner (2009), question the socio-cultural and ethical implications of radically increased longevity, critique is offered based upon de Grey and the SENS agenda (see de Grey, 2004). However, whilst tracking de Grey's public appearances, I extend focus to 'mainstream' biogerontologists and their laboratories. A number of key commentators (e.g. Binstock, Fishman) offer little to no analysis of the *minutiae* of biogerontologists accounts, though this contrasts particularly with the critical analytical approach of Vincent (2008) and Latimer (et al., 2011; 2014; 2015). Most authors referring to the ethical aspects of biogerontology do not address these aspects in relation to kinds of care examined by Vincent (2008), Latimer (et al., 2011; 2014; 2015), and Latimer and Puig de la Bellacasa (2013). Whilst Vincent (2008) explores a relation of care/concern within the context of publically accessible data, following Latimer (et al., 2011; 2014; 2015) and Latimer and Puig de la Bellacasa (2013), I seek to understand these relations by observing them in the laboratory setting. In addition, a 'hands on' approach facilitates observing dividing practices, care practices, value systems, and/or the moral order (Garfinkel, 1967) (see chapter three).

With a focus upon care in the laboratory setting, particularly in relation to animal (models) as part of a turn towards studying the 'affectual' dimension (i.e. Puig de la Bellacasa, 2011; Latimer, 2013a; Latimer and Puig de la Bellacasa, 2013) of care as practical and affectual labour, I build upon a cluster of (mostly feminist) studies that observe the day-to-day of the laboratory as part of exploring care. Aside from Latimer (et al., 2011; 2014; 2015) and Latimer and Puig de la Bellacasa (2013), these studies of the *life* in the *life* sciences do not specifically attend to biogerontology. Whilst Latimer et al. (2011) extend focus to a relation of care based on critical study of biogerontology, their broader research interest pertains to healthcare systems. Whilst Latimer and Puig

de la Bellacasa (2013) refer to multiple sub-sites, their study privileges laboratory interactions (in comparison to public data analysis). Whilst Latimer (2014) discusses both laboratory and public biogerontology, she privileges the study of the *minutiae* of discourse in the public setting, particularly in relation to a modern, neoliberal agenda (2015). However, my approach draws together an equal and comparative focus on the different sites of biogerontology. This makes my study unique, particularly in relation to my ecologically-based concern (see chapter one) for the way that *life* is valued and what (and how) *life* is made to mean.

In this chapter, I have shown that biogerontology is a critical site, and, in addition, I have examined prior literature in relation to my research interests and approach (see chapter one). This is in order to highlight to the reader why my study is not only significant, but why I have chosen to comparatively explore biogerontology's different sub-sites as part of this ethnography. This is with a focus on the continual accomplishment of biogerontology 'in the making' (Latour, 1987) and the continual accomplishment of a relation of care. Particularly, I seek to examine the way that life is cared for and how life is figured. Constructing the site in this way facilitates the emergence of *my* field and consequently the construction of the following research questions:

1) How, when, where, and why is biogerontology accomplished? How is it ordered? Does biogerontology differ across its different sub-sites?

2) What meanings and/or values do biogerontologists make, and how, when, where, and why are these meanings circulated? Particularly, what do biogerontologists make ageing and life mean, and how?

3) How, when, where, any why do biogerontologists, as humans, enact a practical relation of care toward 'life' (life = humans, animals, and/or *all* life on planet earth)?

Answering these research questions requires an ethnographic approach. This is by way of studying the practical accomplishment of care (see Puig de la Bellacasa, 2010). It is

only by 'being there' – and, as I describe elsewhere (chapters one and three), 'being alongside' (Latimer, 2013a) biogerontologists - that it is possible to observe the continual accomplishment of biogerontology alongside the moments of care enacted by biogerontologists. Whilst ethnography is synonymous with circular hypothesis/research questions (Wacquant, 2002), my questions (derived from analysis of previous literature and archival data) acted as a guideline with which to embark upon the study, and, furthermore, a point of reference to return to during data analysis. In the next chapter, I describe my chosen methods and methodology in considerable detail.

Chapter Three

On Method: 'Getting Inside' Biogerontology

Introduction

In this chapter I offer an account of the study's methodology. Corresponding to the analytic approach given (see chapter one), in what follows, I describe a 'global' approach to ethnography and, consequently, to studying ethnographically the 'site' of biogerontology (see chapter two), alongside *my* field (Latimer, 2003). My approach is different - if only philosophically speaking - from what is well known as multi-sited ethnography (Marcus, 1995), which I explain in due course, alongside illuminating and accounting for multiple sub-sites, methods, and reflections comprising [my] *pre*, *during*, and *post* fieldwork processes (Cohen, 1992). More specifically, this chapter comprises a methodological account for my approach, including a revisit to theoretical and methodological influences on my approach and a description of fieldwork processes in the form of a natural history (Silverman, 2000). Furthermore, in this personal account of the field, I offer methodological reflections, and I also extend a reflexive voice throughout the thesis (see Coffey, 1999). I describe many sub-sites, for example multiple conference and laboratory settings, yet, because of examining many settings, I pay detailed attention to the two laboratory settings[40] only. Throughout this chapter, I refer to theoretical, philosophical, and analytical approach detailed in chapter one.

Ethnography

Ethnography has been employed as a means of 'writing culture' (Geertz, 1973; Clifford and Marcus, 1986) - which refers to the ethnographer's writing of representations of socio-cultural reality - and, therefore, a means of writing science as culture (see Latour and Woolgar, 1986; Latour, 1987; Law, 1994; Lynch, 1997; Latimer and Puig de la Bellacasa, 2013, etc.). In recent decades there has been a divergence in the ethnographic

[40] I detail the Metrotown and Countryville laboratory settings because it is these that are subject to my prolonged gaze, including 'tracking' laboratory members and also key materials published at each institution by these members. There is not the space in this text to describe all of the public settings.

tradition from a strictly Malinowskian[41] approach (see Melhuus et al., 2010), to studying groups of people across different sites, spaces, and temporalities using multiple methods. Whilst many laboratory studies – for example, Latour and Woolgar's study of the Salk Institute (1986) or Law's study of 'Daresbury Laboratory' (1994) - have cast their gaze to a single geographical site, the multi-sited and/or multi-modal approach of authors such as Marcus (1995), Dicks et al. (2006), and Latimer (2008), when drawn upon in STS (e.g. Haraway, 1991), extends focus to processes external to individual laboratories (e.g. publications, public rhetoric), which become sub-sites. Latour's study of the 'Pasteurization' of France (Latour, 1988) tracked the reach of Louis Pasteur's 'theory of germs' in multiple scientific, public, and political domains. Whilst not an ethnography, but a historical study, it is an example of a study that tracked different sub-sites of a field as (global) assemblage (Ong and Collier, 2005; Latimer, 2008).

Talk of 'ethnography' evokes a broad range of descriptions and definitions, with - for example - some researchers equating it more broadly to qualitative, observational research of natural settings (Denzin, 1997) and some framing it as a site-specific activity that encompasses *in situ* interactions and behavior (see Hammersley and Atkinson, 1983). Whereas I agree with the first description, I also take the view that ethnography is a way of being in relation to the field in that the ethnographer begins at the point of initial inquiry and continues until the ethnographic text has been written (and rewritten) (see Goffman, 1959; Clifford and Marcus, 1986; Pallí, 2004; Latimer, 2008). Thus, my ethnographic journey began when I began to plan the research. Since then, with a much more concentrated year designated for fieldwork in the middle, I have continuously engaged with biogerontology, its biogerontologists, its surrounding literature, and its discourses. I consider these all to be data. This has been as part of a process of writing, and rewriting, the field of biogerontology as *my* field (Clifford and Marcus, 1986; Latimer, 2008) in the form of field-notes, a field diary, transcription, and thesis chapters.

Thus, the fieldwork process began at *The Older Person's Conference* and, after that, everything became fieldwork; everything became data. The current text is a

[41] Malinowski (often referred to as the 'father' of ethnographic methods of the twenty-first century) conducted ethnographic study of different islands (e.g. the Triobrand Islands) by partaking in long-term immersion at a 'single site' (cf. Marcus, 1995; Melhuus et al, 2010).

reconstruction of my interpretation based on four years of immersion and analysis - as writing. Ethnography can only ever comprise one, partial, perspective of a field; a perspective effected/affected by the ethnographer's unique personal experiences and motivations, their circumstantial point of entry to the field, and their particular experiences and interpretations of meanings (as culture) when immersed (Geertz, 1973). Whilst the undertaking of ethnography is situated (Clarke, 2003) in local sites, my approach entails deconstruction and subsequent re-construction of the text's 'registers' (Latimer, 2008; see also Marcus, 1995) so as to extend claims beyond individual sub-sites (see also chapter one). I engaged with multiple research methods (e.g. participant observation, interviews, document analysis) as part of 'getting inside' (Latimer, 2003; 2008) the field as a 'discursive formation' (Foucault, 1969) in order to elicit and represent its 'webs of significance' (Geertz, 1973), and I describe these methods in more detail throughout this chapter.

In terms of ethnography as practice, my interpretative approach to ethnography draws from the methods, and theory, employed by Goffman (1959), Garfinkel (1967), and Geertz (1973) (see chapter one). Ethnography entails being there and seeing, which is essential for studying inter/actions as members' 'practical accomplishments' (Garfinkel, 1967); accomplishments that lead to an establishment of the 'moral order' (in relation to breaches in this order)[42]. Ethnomethodology can be described as *"the routine, taken-for-granted expectations that members of any social order regularly accept"* (Denzin, 1969: 922) and/or *"the study of folk or members' methods for producing recognisable and reasonable social orders"* (Laurier, 2009: 633). Additionally, in Garfinkel's (1967: 37) own words: *"procedurally it is my preference to start from familiar scenes and ask what can be done to make trouble"*. This implies the significance of a (return to) focus on making the familiar (of ordinary action) strange in biogerontology as a promissory field of science caught up at times with, often institutional, notions of grandeur and/or 'heroics' (Featherstone, 1992). As well as an in depth description of action, including talk, this includes an in depth description of social interaction and the meaning co-created and reflected as part of the 'social situations' of biogerontology as a social institution (Goffman, 1961) and/or biogerontology as a socio-cultural formation

[42] This is an approach based on Garfinkel's renowned breaching experiments, which *"disrupted the intelligibility of various places, such as acting as lodgers within their own home or refusing to pay the display price of items in shops"* (Laurier, 2009: 635).

(Goffman, 1959; Geertz, 1979). Geertz (2005) 'found' himself amidst cock fighting in Bali, only to realise in hindsight the significance of this ordinary ritual (alongside the multiple layers of meaning thus circulated). By writing a 'thick description' of the events that he stumbled upon – as opposed to eliciting them and/or searching them out - as an intruder, he was able to gain insights in the meanings circulated in Balinese culture. By thick description, Geertz does not refer to a 'rich description', but he borrows from Ryle's (cited in Geertz, 1973) process of writing down many possible descriptions/interpretations of an 'act' with a view to interpreting the act in relation to its socio-cultural context (e.g. the meaning of a wink). I draw influence from the way that Geertz interprets action for its meaning, rather than simply writing a description of it. Moreover, the meanings that Geertz found would not have been interpreted in the same way had he arrived in Bali and carried out a questionnaire inquiring of the Balinese way of life. Ethnography – and the rich, thick, undirected[43], description of 'naturally occurring'[44] behavior that observation, amongst other methods, also affords – facilitates, as Jerolmack and Khan (2008) suggest, a deeper insight into a given 'reality' in light of the fact that *"what people say is often a poor predictor of what they do"* (Jerolmack and Khan, 2008: 2). Following Jerolmack and Khan, I thus agree that *"ethnographic work prioritizes the observation of social action—including accounting—within the real world"* (Jerolmack and Khan, 2008: 36).

Here, what is referred to as 'accounting' by Jerolmack and Khan is significant because accounts are a key aspect of everyday inter/action and also because they are important for studying the 'keeping', 'breaching', and 'repairing' of communities' 'moral order' (Garfinkel, 1967; Scott and Lyman, 1968; Munro, 2011). Accounts are not just talk, but they are constitutive of the social order. An ethnomethodological approach (e.g. Scott and Lyman, 1968) likens them primarily to the 'repair work' that they accomplish (Munro, 2011), yet a critical approach opens up space to view accounts in terms of politics, governmentality, and *"asymmetries in power"* (Munro, 2011: 7). Thus, paying attention to accounts given by members, given as part of routine accomplishments,

[43] Whilst Geertz' 'finding' of cock-fighting (and the meaning/s he subsequently discovered) was largely undirected, it would be difficult to say that my study was undirected given the biases that I have made explicit in the 'biography' of the research (see chapter one). Arguably, no research is completely undirected because is not possible for a researcher to separate oneself from their own history and/or subjectivity (Hastrup, 1990). I elaborate later within this chapter.

[44] The idea of naturally occurring data is, arguably, a fallacy because of the role that the researcher plays in constructing the field (David and Sutton, 2004).

becomes a tool for observing politics and/or observing the way that the social - or 'webs of meaning' (Geertz, 1973) - is ordered and organised at institutions (see Gilbert and Mulkay, 1984), which includes scientific institutions, their institutional talk, and their inscriptions (Latour and Woolgar, 1986; Gilbert and Mulkay, 1984; Lynch, 1993; Miller, 1994). This is especially within the context of inclusion and exclusion (see Latimer, 1997; 1999) of members, or 'actors', in any given social space or institution. Alongside the study of accounts, thick description of ordinary action and interaction comprises the building blocks of the participant observation aspect of my ethnography. I elaborate later in the current chapter.

Latimer (2008) describes an approach to constituting the field that explores the complexity and multiplicity of discursive practices, conduct, and identity-work in any given field. Drawing on Garfinkel (1967) and extending his approach, Latimer (2008) uses 'registers' by way of figuring the parts of an assemblage and, also, particular enactments and perspectives. This is of value particularly for data analysis:

> *"While these registers are present in the site under study, and can include such things as artefacts in use, documents, gestures, talk, accounts, what these registers can be taken to register are ways of doing and thinking: all that makes up the social as a particular set of relations."*
> (Latimer, 2008: 6)

Ethnography entails recording these registers across different sub-sites and ways of collecting data. Data is deconstructed for its registers, which are reconstructed over time, comprising the 'text' as the data, which is written and rewritten because, Latimer argues, *"second, third, fourth time around, we read the text very differently"* (Latimer, 2008: 7). Each register can be thought of as a 'representation' of an event, or a construction, for we are always making, what Geertz describes as, *"constructions of other people's constructions"* (Geertz, 1973: 9). Thus, ethnography can be a complex undertaking, and the reality of 'tracking' (Marcus, 1995; Latimer, 2008; Latimer, 2013b) biogerontologists at different temporal and/or spatial 'occasions' in this way (Garfinkel, 1967) is inevitably going to be messy. Law affirms heterogeneity and subsequent mess in method:

> *"In practice research needs to be messy and heterogeneous…because that is the way it, research, actually is…it needs to be messy because that is the way the largest part of the world is."*
> (Law, 2003: 3)

For Law (2003), it is not simply a matter of reporting 'concrete' realities, for multiple presences and absences present themselves in each moment, with absences hidden, or 'othered'. Thus, there is mess in the multiples. With multiple 'out-therenesses' (Law, 2003), or what Mol (2002) calls the 'problem of difference', this is different from free-fall relativism (see chapter one). Thus, our methods are also, mirroring the nature of our reality, 'unruly assemblages' (Law, 2013), which corresponds to Feyerabend's (1975) argument that neat, concrete knowledge is merely myth. Such an approach supports the complexity of biogerontology that I go on to illuminate in this thesis. Lee (1998) asserts that perceived completion is inaccurate and he promotes the acceptance of ambiguity and incompleteness in both social research and theorising social worlds, or 'world system frameworks' (Marcus, 1995). This partialness creates a call to *"destabilise the distinction between lifeworld and system"* (Marcus, 1995: 96) and to 'follow the people', 'follow the thing', 'follow the controversy', and 'follow the story' (Marcus, 1995). This 'following' is also referred to as 'tracking' (Marcus, 1995; Latimer, 2008).

An example of an ethnography that pays attention to 'tracking', and also processes external to the laboratory setting, is Latour and Woolgar's (1986) study of scientists at 'The Salk Institute', and this included tracking scientists at the laboratory and observing how the scientists conducted research. This is alongside examining the relation between everyday practical laboratory research and aspects of practice such as academic papers, the prestige of the academy, and laboratory finances. Latour and Woolgar (1986: 40) assert that the study "*concerns the way in which the daily activities of working scientists lead to the construction of scientific facts"* through transcriptions, or 'inscriptions', of their experiments by "*transform[ing] a material substance into a figure or diagram*" (Latour and Woolgar, 1986: 51). This is based upon an orientation in science towards the *"production of papers"* (Latour and Woolgar, 1986: 71). Through tracking science in this way in order to show science as constructed via complex socio-technical processes, Latour and Woolgar, and, later, Latour (1987), show that science is always in

construction through a series of 'associations'; both material and non-material. For example, they refer to 'facts', which come from 'inscriptions', which are created by scientists, who use machines in laboratories, and these facts are used as evidence for those inside (i.e. scientists) and outside (i.e. government, infrastructure) a particular network. In addition, Lynch (1993), who was influenced by Garfinkel's ethnomethodology in tracking the ordinary-ness of science, suggests the multiplicity and complexity of science's 'constellations' of knowledge:

> *"Knowledge can include all sorts of behavioural manifestations, testimonies and textual products of a group's activities, and it is far from easy to select a definite constellation of these to represent a group's epistemic commitments."*
> (Lynch, 1993: 76)

Like Latour and Woolgar, Lynch (1993) made note of members' everyday practical actions that happen in a laboratory; from exchanges in the corridor, to taking care of equipment, to noting results. Law (1994) studied Daresbury Laboratory for its 'order' and 'orderings' – although he opens with this suggestion: "*perhaps there is ordering, but there is certainly no order*" (Law, 1994: 1). This reiterates the continual process of ordering, rather than the existence of a concrete order. Law (1994), drawing particularly on Latour's approach, tracked heterogeneous networks and/or *"network effect[s]"* (Law, 1994: 33) and non-human materials/actors - for example, managers, laboratory assistants, microscopes, and computers. Additionally, the study also tracked Daresbury's (and modernity's) 'modes of ordering' – for example *"Enterprise", "Administration", "Vision",* and *"Vocation*" (Law, 1994: 75-82). Law focuses less on knowledge construction practices, and he studies social interaction in the laboratory in depth. This affords an explication of Daresbury's rankings and hierarchies and also provides the space to *"[tell] a few tales"* (Traweek, cited by Law, 1994: 4) about some of the individuals at Daresbury and their effect upon the way that Daresbury is organised. An example of such an individual is Giovanni Alberti the *"visionary", "genius",* and *"charismatic leader"* (Law, 1994: 66).

Law is highly reflexive in the way that he approaches the laboratory, and his partial approach to studying science - and consequently modernity - can be thought of as a

precursor to the partial and/or global approach to ethnography that I have already described in this chapter in relation to my methodology and its underpinnings. Furthermore, I draw from the ethnomethodological approach of Lynch (1993) in the study of *how* biogorontology is accomplished in the day-to-day across different socio-spatial and temporal landscapes (see also Laurier, 2009; Hall and Smith, 2013). Whilst discussion of the temporal is prevalent in theoretical discussion (e.g. Adam, 2011), the spatial and/or mobilities turn in sociology and, in particular, qualitative research, is of key significance in 'mapping ordinary action' (Smith, 2010). Thinking *with* space is of value to my approach as part of the exploration of the socio-spatial layout of biogerontology and its sub-sites (see chapter five). This is in terms of biogerontologists' relation to their surroundings, their materials, and other researchers as part of experimental practice and the re/accomplishment of the division of labour/labour of division (Latimer, 1998). Furthermore, thinking *with* time is of value as part of examining the worlds that biogerontologists' create (past, present, and future) – alongside their concerns/cares and the pace/s of both technoscience *and* nature (Puig de la Bellacasa, 2015) - both in present-moment practice, but also in public rhetoric.

Getting Inside, Making Connections, and Sampling

Returning to my ethnography of biogerontology, and its many sub-settings, I embarked on gaining entry to the field at the start of my postgraduate studies[45]. I have described in the biography of the research question (see chapter one) that I was drawn to a newspaper article written by Dr Aubrey de Grey (2004), who claimed that the first person who will live to one thousand years old is already sixty. At the time lacking a nuanced knowledge of the field, I began looking up ageing-related conferences, and I ended up attending *The Older Person's Conference* (October, 2010). *The Older Person's Conference* was a multi-disciplinary conference where researchers from different fields were invited to share their research on ageing in the form of posters and presentations. Here, I met Dr Ted Tucker, who called himself a 'biogerontologist'. Prior to this, the common term I had heard used in social science literature was 'anti-ageing scientist' (see chapter two).

[45] This began as part of an MSc research project (Davies, 2012) that explored the way that ageing was being reimagined by biogerontologists, alongside the legitimation devices biogerontologists used.

I kept in touch with Dr Tucker, and I looked up – and thus began to 'track' - his research by reading his papers and studying his website; not only because he told me that ageing was *"definitely a disease"* - a new, and 'disconcerting' (Verran, 2013) idea that drew my attention - but because he became, in that moment, my point of entry to the field. Dr Tucker invited me to spend two days at his laboratory studying the way that 'Werner's Syndrome'[46] (WS) cells 'senesce' (see chapter two). I spent time with Dr Tucker and his colleagues feeding cells and creating assays so that they could be studied under the microscope. I helped to capture the lesions and fissures in the older cells with imaging software. This opportunity was ideal because it gave me the chance to practice fieldwork as a laboratory pilot study of sorts and also the chance to begin to learn some of the field's language, alongside its codes and conventions. Moreover, through a continued dialogue with Dr Tucker and his colleague, Professor Derek Cadbury, I began to learn about some of the divisions within the field. With humorous talk of 'The Nutters', I learned that UK biogerontologists do not work together harmoniously.

The more nuanced understanding I was rapidly gaining through Dr Tucker and Professor Cadbury, and also the (now) directed reading of scientific papers and institutional websites, aided me greatly in the process of planning my formal fieldwork because I became progressively more aware of which biogerontologists to contact, which papers to read, and which conferences/public events to attend[47]. In addition, I began to sign up to multiple mailing lists and newsletters[48]. Dr Tucker and Professor Cadbury at this early stage[49] became my guides to the field – a little like the character of 'Doc' in Whyte's ethnography (1955). This created new challenges such as having to be intentional about not becoming enrolled to their agendas and/or their perspective.

Because of my connection with Dr Tucker and Professor Cadbury, I had an opportunity to present a postgraduate led 'summing up' at an informal biology and humanities

[46] Werner's Syndrome (WS), also known as 'adult progeria', is marked by premature physical ageing. Young adults who have inherited WS can appear as seventy or eighty years old.
[47] I realised, through encountering the field, that many papers that I had initially planned to read (as per my initial research proposal) were not mainstream, or even well-known in some instances, biogerontology texts.
[48] For example, de Grey's SENS newsletter, the MICRA (Manchester Institute for Collaborate Research on Ageing) newsletter, the BSRA (British Society for Research on Ageing) newsletter *etc*.
[49] Whilst Dr Tucker and Professor Cadbury were my primary contacts to begin with, our dialogue decreased as I tracked Metrotown and Countryville biogerontologists and the other biogerontologists who became part of my study.

conference at which Professor Cadbury was the keynote speaker. Over the conference dinner that evening, I connected further with Professor Cadbury, explaining my research aims to him in more depth. Whilst he did not fully understand the purposes of sociological research, he was happy to help me in finding out more about the field. As well as being very helpful, he became a source of much knowledge and wisdom and suggested that I begin my formal fieldwork a bit earlier than planned at *The Countryville Ageing Conference* – a multidisciplinary conference organised by Countryville University's biogerontology department - because he could organise for me to present a paper drawing focus to the sociological aspects of ageing and biogerontology. I accepted the offer, and whilst it felt like I was being thrown in at the deep end, I knew that it was a great opportunity because the biogerontologists speaking at the conference, he told me, were some of the biogerontologists at the forefront of the UK field. Whilst preparing for this event, I began to read many papers written by these scientists (or at least tried to, for these were complex) and Professor Cadbury often forwarded emails with relevant newspaper articles and online links.

Gatekeepers are usually a significant part of ethnographic research (Johnson, 1990), and whilst Professor Cadbury was not a formal gatekeeper in my study, but rather one of the first key informants, he was in hindsight the closest thing to a gatekeeper in my study because I was able to use him as a point of reference when meeting other biogerontologists. Furthermore, the pre-fieldwork relations that I cultivated with Dr Tucker and Professor Cadbury meant that I was not entering the more formal segment of fieldwork as, what could be thought of as, a 'cold-caller', but I was arriving with a measure of context, understanding, and social capital (Bourdieu, 1986). This was valuable when it came to presenting the paper at *The Countryville Ageing Conference*. As I did not want to take a strong position in front of my potential informants, I gave a paper on the potential negative social implications of calling ageing a disease, drawing loosely on the ideas of Vincent (2008) and Latimer et al. (2011). This provided a 'counter' to the arguments biogerontologists presented.

Unsurprisingly, my paper sparked much interest from several biogerontologists who were present, and I was invited by Professor Ronald Radcliffe to join them for lunch. Professor Radcliffe was the keynote speaker and he had been particularly vocal during

the 'Q&A' section of my paper. Dr Doug Kennedy and Dr Sally Starr from the biogerontology department at Countryville University also joined us. Over lunch, we shared perspectives on the implications of ageing, although I tried to remain vague so as to remain neutral (keeping my cards to my chest, whilst sounding knowledgeable so that they would take me seriously). It seemed to me that giving my conference paper had sparked a strong reaction amongst the biogerontologists. They had sought me out, and they were interested in what I had to say. As well as trying ardently to enroll me to their perspective (this is something that I became used to) that ageing was bad and that research to slow it was a good thing, the trio asked what I was doing at the conference. I explained, giving my broad but not at all untrue cover story (Bosk, 1979), that I was a PhD candidate from Cardiff University and that I was interested in the social, cultural, and ethical implications of their biogerontological work.

This contact, or 'face-work' (Goffman, 1967), was fruitful and, subsequently, Dr Kennedy and Dr Starr invited me to study their laboratory for a week. They even offered their own spare rooms for accommodation purposes. I took Dr Kennedy up on this offer because he lived very close to the university and I stayed with him, his wife, and their young children during fieldwork. Moreover, because of this conference, I sent an email to another of the biogerontologists giving a presentation (Professor Hurst, Metrotown University) asking for his presentation slides. This email exchange led to Dr Hurst inviting me to study his laboratory for a week. My snowball[50] sample was at this early point a success, even if it had been a little risky to let the field and its members guide me. It was risky because I had no set schedule of data collection lined up and I had to rely on opportunities opening up, rather than plan them in advance.

My snowball sample stemmed from the one incidental encounter with Dr Tucker at *The Older Persons Conference*. With laboratory observation in the diary, and interview dates being planned with particular biogerontologists, I found out the hard way that whilst it undoubtedly generated data painting a more accurate picture of the field's

[50] A snowball sample (Atkinson, 2001) is commonly used in qualitative research as part of gaining a more 'authentic' sample. It is the process of organically finding one research subject through another subject. In my case, as described, the scientists led the way, and, through the continual connections, I let the 'field' define itself. As I spent time with scientists it seemed that they were very happy to pass on information about 'who to talk to'.

ecology[51], this method can be inconsistent. I learned a key lesson because the ease of these encounters lured me into a false sense of security. Following *The Countryville Ageing Conference*, I faced multiple rejections from scientists that I connected with via email, which came in the form of either an outright 'no', non-response, and, in several cases, a non-response after an initial provisional 'yes'. I can only speculate as to why this occurred. It could be due to chance, or to the fact that large volumes of emails in academia can often lead to significant filtering systems, or to the lack of 'face work' that resulted from the unique opportunity that I had to present a paper at *The Countryville Ageing Conference*. It could also be due to biogerontologists' lack of understanding of sociology and a lack of desire to engage with me in light of their (as I was to learn later) strict timescales/pressures.

On one occasion, a biogerontologist whom my supervisor (Joanna Latimer) was in contact with agreed to be interviewed as part of my study. This turned into a rejection when I tried to make contact with the same biogerontologist. I learned later from a scientist that in the academic culture of science, PhD students have less to do with making arrangements like this, and, therefore, that 'breaching' (Garfinkel, 1967) this code in this way may have inhibited my chances of interview. This substantial rejection was disappointing and demoralising, and at one point I began to seriously doubt both myself and my study[52]. This was something that I had to overcome, and I learned to develop a 'thicker skin' in the process. The sample did pick up after a bout of rejections, yet, as well as being part of a learning curve, these rejections were also a source of data because they added to my understanding of biogerontologists' academic culture.

Incidentally, things 'picked up' when I 'recruited' another interview participant (Dr Beer) at *The Mainstream Biogerontology Conference*, where - as with my experience at *The Countryville Ageing Conference* - I spent time talking with him over a meal. This strengthens the idea that, in terms of recruitment, 'face time' leads to more success than impersonal email exchanges with potential informants. The rejections that I faced from

[51] When I wrote the initial research proposal, I wanted de Grey to be a key informant because my understanding of the field, based upon media/publications and the social science literature (e.g. Vincent, 2008; Turner, 2009), led me to believe that he was at the forefront of all ageing research. I realised through encountering the field that he was somewhat of an 'outsider'.

[52] Connecting with peers/colleagues helped me to see past this, for I had been immersed in a field - myself an 'outsider' - for too long.

potential informants were a far cry from my being offered accommodation and morning porridge with Dr Kennedy's children; from being beckoned and invited to sit with Dr Beer and Dr Turner at *The Mainstream Biogerontology Conference* dinner. There was a 'becoming-with' and/or 'being alongside' (Heidegger, 1962; 1977; Latimer, 2013a; see chapter one) that happened through this 'face time'; through this 'touching' of worlds (Puig de la Bellacasa, 2009). After building relationships over time with biogerontologists, I noticed that they began to pay more attention (even if sociology was still not understood and/or taken seriously) when I spoke. There appeared a more genuine in interest in what in the world I was doing, which replaced stilted questions about what I was doing in their world.

Participant Observation

Whether equated synonymously with ethnography or not, 'participant observation' has long been drawn on as a tool for gaining insight into everyday practice, 'natural facts' (Garfinkel, 1967; Lynch, 1997), and access to cultural and symbolic meanings (Douglas, 1966; 1999; Hammersley and Atkinson, 1983; Atkinson, 1990). Earlier in the thesis (chapter one), I described the interpretative perspective of 'Verstehen' (Schutz, 1967, drawing on Weber; see also Collins, 1984). Maso (2001) describes Verstehen in these terms: *"the more insight I inquire into experiences… the more I shall be able to imagine myself in these experiences"* (Maso, 2001: 141). With a focus upon data collected from observation in a natural environment, participant observation is of value as part of studying the 'taken-for-granted' (Garfinkel, 1967) (or *how* biogerontology and being a biogerontologist is accomplished) and thus what is relegated to the background (Douglas, 1999), or the 'black boxes' (Latour, 1987).

More specifically, as part of participant observation, the observer describes the surroundings, experiences, and informal interviews (or 'encounters') in naturalistic settings that exist independently of the research situation (Hammersley and Atkinson, 1983). Whilst I am not a biogerontologist, I entered the field as a participant observer, rather than as a non-participant observer, which is arguably a fallacy (see Atkinson and Hammersley, 1994). Hammersley and Atkinson (1994: 249) go on to argue that *"all social research is participant observation, because we cannot study the social world without being part of it"*. I am a social scientist, and I entered the field as a participant

of the general social order of each site rather than as a participant of the technical activities. Whilst I generally observed technical activities, there were times I did participate in these. An example of this is when I tried to 'pick' the worms and 'tip' the flies.

Delamont (1992: 218) describes participant observation as *"spending long periods watching people, coupled with talking to them about what they are doing, thinking and saying, designed to see how they understand the world"*. My methods, as part of observing the accomplishment of biogerontology at its multiple geographical and non-geographical sub-sites over time, can be likened to those given in the description that Delamont offers. But rather that simply understand a pre-constructed world in the same way that Delamont and also a particular grouping of 'Sociology of Scientific Knowledge' authors (i.e. the Bath/Edinburgh schools)[53] do, my analytical approach goes beyond Weber's Verstehen, as it were, in order to see how biogerontologists 'make' (and remake) the world as a continual accomplishment. Thus, I go beyond notions of the 'socially constructed' by observing, in naturalistic settings, their continual making (and remaking). Similarly, Latour (2005) refers to tracking networks, or 'associations' 'in the making' (see also Latour and Woolgar, 1986; Latour, 1987; Lynch, 1993; Law; 1994). Later in this chapter I describe my experiences of tracking biogerontology, which is *my* field, in a greater depth.

The Laboratory and Conference Settings

Whilst the aforementioned laboratory studies, where researchers are present in a community for an extended and concentrated period of time, are still conducted, there has also been a turn towards what has been termed 'postmodern'[54] (Melhuus et al., 2010) and/or 'multi-sited' ethnography (Marcus, 1995; Hannerz, 2003; Latimer, 2008). The postmodern turn involves a move away from viewing culture as boundaried/bounded and it also involves researchers observing communities as complex objects (Abu-Lughod, 2000). In terms of participant observation, this would mean

[53] I retain an awareness of the Bath/Edinburgh School - characterised by the work of Collins (e.g. 1985; Collins and Pinch, 1993; Collins and Evans, 2002) - of science studies/SSK, despite not drawing on this tradition in any depth. The approach to ethnography/participant observation (i.e. Collins) drawn on by these authors can be likened to the approach of Delamont that I describe.

[54] I avoid the term postmodern because, as I have described, it can imply a relativist free-fall. Howeover, have described an approach whereby actors are positioned by the world in which they are entangled.

spending short, intense periods of time – 'compressed time mode' (Jeffrey and Troman (2004) - at many physical sites as part of the study. Following my invites from Dr Kennedy, Dr Starr, and Professor Hurst, I spent time in the biogerontology departments of two UK universities: Metrotown and Countryville. I spent a week at each carrying out intensive observation.

Further to my invite from Professor Hurst, I primarily spent the week studying the laboratory of which he is the head: the Metrotown Worm Laboratory (MWL), which is part of the Metrotown Institute for Healthy Ageing (MHAI). The institute is situated in Metrotown University's Faculty for Environment, Genetics, and Evolution. Metrotown University is a world-leading university situated within an affluent part of a thriving UK city. Biogerontologists at the institute study as part of three laboratory groups: the '*C. Elegans*[55] Laboratory' (Worms), the '*Drosophila Melanogaster*[56] Laboratory' (Fruit Flies), and the 'Yeast Laboratory'. Whilst my invite was to the MWL, which became my 'basecamp' and my laboratory of focus at this site, I also spent a portion of time observing the Metrotown Fly Laboratory (MFL) because the groups at the MHAI all studied using the same laboratory space[57]. Professor Hurst, before he set up the MWL and was made Professor of Biogerontology at Metrotown, was a post-doctoral (PD) student of the head of the MHAI. The MHAI head and Professor Hurst are well known across the UK biogerontology community. Consequently, the MHAI has attracted several prestigious ageing-related research grants.

Countryville University's biogerontology department, or the Countryville Fly Laboratory (CFL), is 'officially' - for teaching and administration purposes - part of the Countryville Faculty for Medicine and health, yet its genetics-based research is situated within the Countryville Environment Centre (Life Sciences). Countryville is a small UK city surrounded by rolling hills and countryside, and the quaint university campus is located a few miles from the city centre. Countryville University, as well as attracting bright students based upon its high-ranking teaching profile, attracts staff and students who are drawn to, in the words of one of the co-heads of the CFL (Dr Kennedy and Dr

[55] *C. Elegans* is a particular strain of nematode worm. I mostly use the term 'worm' throughout the thesis.
[56] *Drosophila Melanogaster* is Latin for the common fruit fly. I mostly use the term 'fly' throughout the thesis.
[57] I did not interact with members of the MYL during my time, for the MYL only comprises a few members, and I did not interact with these members.

Starr), *"the countryside and community"* (Dr Kennedy). The two heads are permanently employed as lecturers. The university's financial provision is modest and resources are scarce, with Dr Kennedy's research being funded by a fellowship that he was awarded before his appointment and Dr Starr's research being funded by a minimal departmental allowance. The focus of the MWL and the CFL is the study of genetics of their animal 'models'[58] (flies and worms).

Table 1: Key Informants at the Metrotown and Countryville Laboratories

Informant Pseudonym	**Laboratory**	**Role[s]**
Professor Fred Hurst	MWL	Professor of Biogerontology/Head of Laboratory
Dr Kate Turner	MWL	PD Researcher
Dr Ariel Hall	MWL	PD Researcher
Dr Amelie le Strange	MWL	PD Researcher
Dr Jackson Mahoney	MWL	PD Researcher
Dr Gonzalez Abraham	MWL	PD Researcher
Ms Orla van Nes	MWL	International Graduate Student
Ms Eva Francis	MWL	PhD Student
Ms Michelle Elliot	MWL	MRes Student
Ms Hannah Tennant	MWL	Laboratory Technician
Mr Dylan Jones	MFL	PhD Student
Ms Esme Wade	MFL	Laboratory Technician
Dr Sally Starr	CFL	Lecturer in Genetics/Co-Laboratory Head of the CFL
Dr Doug Kennedy	CFL	Lecturer in Genetics/Co-Laboratory Head of the CFL
Mr James Johnson	CFL	PhD Student
Mr Xavier Atkinson	CFL	PhD Student
Ms Thea Goodworthy	CFL	PhD Student
Mr Kurt Holiday	CFL	MRes Student

In addition to participant observation undertaken in the laboratory setting (see Table 1 for key informants), I attended nine public events (conferences/symposiums/public debates - see Table 2). At these I participated as a delegate. Whilst several were day

[58]An animal model is an animal organism that is used by scientists to stand for a person in a scientific experiment. I discuss this further as part of analysis (see chapters four, through to seven).

events, others lasted several days, which gave me a chance to stay at the conference with other delegates. This included many biogerontologists; some of whom I was 'tracking' as informants and others who became informants. Some conferences were science-based and others dealt with ageing from a more multi-disciplinary point of view. I found the non-science-based conferences more useful because I could understand all of the presentations, including those given by biogerontologists. At the science-based conferences, most of the presenters used highly complex scientific language/theories that I did not understand, and at times - particularly when I was unable to comprehend to the point of being able make any notes - I left sessions feeling demoralised by this lack of understanding.

Whilst it is not possible to offer a rich, and/or 'thick', description of each conference/public event setting due to word restrictions, this kind of setting was fairly standardised. Typically, the conferences were held at universities across the country – apart from the *Public Sector Ageing Conference* – and often the university hosting the conference had particular buildings, accommodation, and dining halls that were set up for conferences. These often took place outside of undergraduate term time. Conferences lasted anywhere from one to five days. Registration took place on the morning of the first day, which was usually followed by coffee, biscuits, and 'networking' (which was encouraged). There were usually morning sessions, followed by a coffee break, followed by a session before lunch, followed by a conference lunch, followed by an afternoon session, followed by a coffee break and, lastly, the final session, which usually ended at around 5pm. For conferences that lasted for more than one day, there was a conference dinner each night. Whilst most evening events were fairly ordinary (i.e. a standard university buffet/meal), the SENS conferences (organised by Dr Aubrey de Grey), which were the most expensive, offered three courses of fine dining each night alongside entertainment and a 'free bar'. Also, *The Mainstream Biogerontology Conference* offered one night of fine dining with musical accompaniment. These meal times provided a great opportunity to mull over the day's presentations and exchange ideas with other delegates. Conference sessions/lectures were held in large lecture theatres, with speakers presenting using a PowerPoint presentation as their materials. At a few larger conferences, there were multiple sessions at a time and delegates were able to choose which lectures to attend. At most of the

larger conferences there were marketing stalls, with companies selling their wares in the foyer. Conducting fieldwork at the conferences was hard work, with days sometimes lasting fifteen hours. Receiving so much information from each session and then processing this information, alongside writing rigourous field-notes, proved exhausting. Data yielded from tracking biogerontologists and their debate was rich at these events. Furthermore, the informal discussion and the connections that I built also became valuable aspects of conference data.

Table 2: Conferences and Speakers/Key Delegates at Conferences

Conference Name	**Organiser[s]**	**Key Speakers/Delegates**
The Older Persons Conference (OPC)	Multi-disciplinary conference organised by Butefield University's Ageing Network	Dr Ted Tucker Professor Derek Cadbury
The Countryville Ageing Conference (CAC)	Multi-disciplinary conference organised by the CFL	Dr Sally Starr Dr Doug Kennedy Professor Ronald Radcliffe Professor Fred Hurst
The Living Longer Symposium (LLC)	Debate organised by the Kings College Bioethics Department	Dr Aubrey de Grey
The Public Sector Ageing Conference (PSAC)	The Newcastle Institute for Ageing	Dr Tom Kirkwood
The Mainstream Biogerontology Conference (MBC)	The Mainstream Biogerontology Association	Dr Ronald Radcliffe Dr Kate Turner Dr Kevin Beer Dr Ariel Hall Mr James Johnson
The 'Strategies for Negligible Senescence' (SENS) Conference 2011	Dr de Grey/SENS	Dr Aubrey de Grey
The 'Strategies for Negligible Senescence' (SENS) Conference 2013	Dr de Grey/SENS	Dr Aubrey de Grey
The 'Public Debate'	The University of Oxford's Medical Society	Dr Aubrey de Grey Dr Lynne Cox Professor Richard Faragher
The Countryville Ageing Symposium (CAS)	Co-organised by several departments across Countryville	Dr Jim Day Dr Sally Starr

	University	Dr Doug Kennedy

My research consisted of concentrated times of occasional fieldwork rather than regular and frequent visits. A concentrated period of time involves a more totalising engagement both emotionally and practically. Ideally I would have liked to spend more time at each laboratory, however, I had to work with what I was offered. Tracking each laboratory's institutions, papers, conference appearances, online, media, and political presence meant that data from one week at two laboratories was more than adequately rich. I would not have had the time to engage with more than two laboratories in this way. Additionally, the conference setting afforded a concentrated visit, coupled with the collection of related material (such as presentation slides and pamphlets) that I could analyse before and after the conference.

Ethnographic Interviews

Further to participant observation, I conducted nine (see table 3) formal 'ethnographic interviews' (Spradley, 1980), otherwise referred to as 'narrative' interviews (Sandelowski, 1991). This was alongside countless 'informal interviews' that occurred (during coffee breaks, poster exhibits, and waiting in line for registration at conference presentations). In this section, I provide an account of the nine formal interviews. These were conducted not merely for the purposes of rigour and triangulation (Denzin, 1978), but also because on these occasions, situated within the broader context of the field, biogerontology is accomplished as biogerontologists give 'performances' (Goffman, 1959) during long, narrative accounts (Gilbert and Abell, 1983). The ethnographic interview (Spradley, 1980) is an unstructured interview situated in the participant's natural environment, which in this case was (mostly) interviewees' offices. Detailed fieldnotes were taken before and after each interview as I requested (at laboratories separate to Countryville or Metrotown) to spend part of the day observing the laboratory. This time was granted in every case. In most cases I was given a tour and invited to sit in the corner to observe for approximately an hour. Whilst I did not consider these times to constitute participant observation, I did use the fieldnotes taken in these instances as a tool for triangulating/'verifying' the data that I collected during times of participant observation at Countryville and Metrotown. In addition, these fieldnotes helped me to remember each interview context during data analysis.

I visited the Countryville and Metrotown laboratories (on occasions separate to extended participant observation) in order to conduct the interviews. This meant that I was able to focus on participant observation at these laboratories during the weeks that I was there to observe. Furthermore, even though I had only been invited to observe for a week at both Countryville and Metrotown, the interviews gave me a good reason to visit again to 'track' the researchers at different times. These follow up visits provided rich data because I had already established a good rapport. There were no awkward silences or the uncomfortable waiting around that I found during an interview at Lemworth University. Over the course of my designated fieldwork year, I visited Countryville three times; twice for a conference and multiple interviews and once for a week of participant observation. I visited Metrotown three times; twice for undertaking interviews and once for a week of participant observation. As a result of this extended contact, my rapport with a number of the PD researchers facilitated a consistent email exchange throughout the year, which included the researchers sending recent papers and relevant links.

Recorded with a Dictaphone, my unstructured interviews lasted between forty minutes and one and a half hours. I began each interview with an open question (*"So, could you tell me about your research?*"). Once interviewees began to talk freely, the interview required little input from myself. This facilitated interviewee-led interviews and very lengthy accounts. After leaving each interview site, I transcribed each interview as soon as possible. I mostly transcribed the interviews myself so that I could become acquainted with the data. On one occasion, I paid for transcription because of time pressures, however, I had to read and re-read the interview many more times to get the same grasp for the content. Therefore, I learned the lesson that outsourcing transcription is no more efficient than transcribing the data myself. Transcribing these long, qualitative interviews took a long time, but I came to develop a deep familiarity with each, and I became able to recall specific accounts from interviews when analysing other data. In interviews, biogerontologists often used language that I was not familiar with, and whilst transcribing I regularly cross-referenced scientific spellings and meanings using online sources. This led to a deeper understanding of the field overall. Whilst transcriptions remain mostly as verbatim, I tidied up accounts – with a view to

making transcripts easier to study within given time limits - by taking out non-intentional repetition and stutters, 'Ums', and unhelpful, clumsy wording.

I made sure that I interviewed biogerontologists at different hierarchical levels (see chapter five). This included six 'heads', two PD researchers, and one PhD student. Each interviewee was given a copy of an integrated information page and consent form in advance of the interview. This was so that participants had a chance to read and digest the information before I arrived. I found that the biogerontologists (particularly the heads) did not take the consent forms very seriously, with some smirking as they signed (as if to say *"aaahhh cute"* to my little social science project). I found that in the interviews, compared with the scientific explanations I was privy to during participant observation, biogerontologists simplified their explanations. Whilst this is to be expected because I am not a scientist, I discovered afterwards that my supervisor had been given more complex explanations in interviews by some of the same scientists. I can only speculate that this was due to my being a young PhD student, rather than a Professor of Sociology undertaking research as part of a collaborative research project. I also noticed the distinctly performative element of the interviews, because scientists often gave very recognisable (often word-for-word) accounts that they had given elsewhere in public. Whilst I have created pseudonyms for all participants (see Table 3) that I interviewed formally in the study, I have been careful to change details that would expose participants' identities due to their giving of accounts in public settings.

Table 3: Formal Interview Participants

Informant Name	**Institution**	**Role[s]**
Dr Doug Kennedy	Countryville University	Lecturer in Genetics/Co-Laboratory Head of the CFL
Dr Sally Starr	Countryville University	Lecturer in Genetics/Co-Laboratory Head of the CFL
Mr James Johnson	Countryville University	PhD Student
Professor Fred Hurst	Metrotown University	Professor of Biogerontology/Head of the MWL
Dr Kate Turner	Metrotown University	PD Researcher
Dr Ariel Hall	Metrotown University	PD Researcher
Dr Jim Day	Lemworth University	Lecturer of Biology/Head of the

		Lemworth Ageing Laboratory
Dr Kevin Beer	Pebbleside University	Lecturer of Genetics/Head of the Pebbleside Worm Laboratory
Dr Natalie Bloor	Simmondsfield University	Head of the Simmondsfield Ageing Institute

Textual, Visual, and Material Data Collection

I have mentioned already in this chapter that the formal 'year' (or so) of fieldwork (September 2012 - January 2014) was embedded in a longer period of immersion that started in October 2010. Since this initial entry point, following meeting Dr Tucker at *The Older Person's Conference*, I have continuously gathered and analysed textual, visual, and material data. This ranges from policy documents, conference pamphlets, academic papers, websites and 'online' promotional videos (see Hine 2000; 2007), pens, and even a soft-toy rat (from the stall of a private company that breeds and sells animals to laboratories for experiments). I gathered this data by attending events (e.g. pamphlets and pens), tracking biogerontologists'/laboratory websites (particularly those of key informants), accessing relevant online journals and forums, and regularly using a search engine to looks for words like *"biogerontology"* and *"anti-ageing science"*. Friends, family, colleagues, and key informants also regularly sent me what they thought to be relevant articles. I ended up with lots of this type of data, and I became quite overwhelmed with it all at one point during the study. Whilst I filtered the data that I analysed in depth, an overall engagement with the entirety of this data nevertheless enriched my understanding of biogerontology, its impacts, and its networks in the UK. This helped me to fulfil my aim to pursue a highly triangulated and thus rigourous study. I decided to focus on key papers produced by the key informants (particularly those based at Metrotown and Countryville), online videos that had had numerous views, papers that tracked key debates in the field, newspaper articles that described new discoveries in biogerontology (e.g. The 'DAF-2', 'Rapamycin', and 'Resveratrol' discoveries (see chapter two), which, as well as being reported in the media, were broadly referred to by biogerontologists as victories. Whilst I read (and tried to understand) numerous academic papers written by key informants in the laboratory and interview setting, I have been unable to reference them for the sake of maintaining informant anonymity (the same goes for visual data). However, I read these

papers not merely for the purposes of triangulation, but also in order to enhance my own understanding of scientists' expert lexicon, which in turn enhanced my ability to analyse the other data that I collected.

I have stated that 'multi-sitedness' (Marcus, 1995) is an increasingly common trope in ethnography, and drawing on different types of data gleaned from different sub-sites is especially interesting because it adds complexity to the spatio-temporal dynamics of a given data-set. This is because, firstly, it permits tracking a field, its effects, and subsequent public reactions and debates at (and between) different time frames (e.g. scientific papers published at different dates, alongside 'current' news articles). Secondly, the use of online data troubles traditional spatial boundaries of a research field (Melhuus et al. 2010). The kind of data that documents provide is desirable not only as part of a discourse analysis approach (Fairclough, 1992; Silverman, 2001), but also because it is wholly naturally occurring (Lincoln and Guba, 1985). Websites were a key part of attending public events. Each event had an accompanying website that detailed an event synopsis, a timetable, and a registration form. Websites played a part in helping me to choose which events to attend for participant observation. The websites also aided my preparation for each event because I was able to 'read up' in advance about the speakers and topics. Whilst integral to this ethnography, and providing much more than just 'cross checks and balances', I draw on this type of data much less in the analytical chapters because it played a supplementary role to the rich, in depth observational data collected.

In addition, following Hurdley (2007), taking photographs became a part of my fieldwork. I have a keen interest in photography, and in each setting (obtaining permissions where necessary) I took many photographs as part of a visual analysis of the settings (Dicks et al., 2006). This was for a number of reasons: 1) to remind myself of each setting when writing up fieldnotes, 2) to include particular photographs as data; as 'illustrations' (Hurdley, 2007), and 3) for the purposes of the scientists, who wished to have laboratory shots taken, including the annual laboratory photo. The latter became part of my membership to the group, as I became the 'lab photographer'. For example, Professor Hurst asked if I would spend the week taking photographs of 'science in action' for his website. I enjoyed this because it gave me a role for the time that I spent

at the MHAI. Similarly, the experience of arranging the MWL researchers to get together one afternoon for a 'group shot' became quite the occasion. This occasion seemed to embed my membership. This in itself gave me further insight into the high value that laboratory members placed upon a sense of 'togetherness' and marking (photographically) this particular moment in time for the laboratory.

Fieldwork Experiences: Notes on 'Being Inside'

Whilst I have described and accounted for my chosen research methods and settings individually, it is appropriate to describe at length the experience of 'being inside' the field. I do not differentiate between experiences inside and outside the 'official' fieldwork period[59], as for me it is all part of the same on-going immersion that began upon meeting Dr Tucker at *The Older Person's Conference*. As a young neophyte ethnographer, being in the field and knowing what, when, and how to record, was at times overwhelming, so it was of value to not 'go in cold' when my fieldwork officially started. There was so much; how could I even know where to start? Malinowski (1922) suggests an initial period of 'incoherence' is normal and that an extended period of time in the field allows an ethnographer to find familiarity and participants' investment of significance in activities that once seemed incoherent. However, as part of the 'mess' Law (2003) describes, *non*-coherence is a more appropriate way to describe this initial period. I embraced an initial time of non-coherence, yet I did become familiar with the routines of each setting and what was significant to biogerontologists and the broader biogerontology community. However, I was mindful to not hone in on these, because, as Geertz found in Bali (1979), it is the seemingly 'insignificant' things that often emerge as the most significant.

I was careful to record every single detail at every possible moment in order to gain as rich a snapshot as of each occasion over the concentrated time that I spent at each site. To recap, this approach to fieldwork, especially as part of shorter periods of concentrated immersion, is known as 'compressed time mode' (Jeffrey and Troman, 2004). This contrasts with 'recurrent time mode', where a sub/site is engaged at regular intervals over time (Jeffrey and Troman, 2004). At all times during fieldwork I wielded a reporter's notebook, which became my part of 'materials' (Goffman, 1959). It felt

[59] This was (approximately) the second year of my PhD study.

more normal to carry a notebook at conferences compared with in the laboratory setting (as a non-scientist). When I was not engaged in interaction with participants/setting members, I was busy writing notes in my notebook in 'real time'. However, during conference presentations, there were times when I did not understand was being said by the biogerontologists giving the paper, so, instead, I used this time to describe the physical surroundings and catch up on fieldnotes. I wrote detailed field notes of each encounter with people and also setting materials, practice, and details of each physical setting. This is because *"fieldnotes (re)constitute that world in preserved forms that can be reviewed, studied and thought about time and time again"* (Emerson et al., 2010: 353). I also kept a field-diary throughout the fieldwork period, which monitored my thoughts and feelings and also (seemingly) interesting anecdotes - amongst other things.

Writing detailed fieldnotes meant that recounting each 'occasion' in as much accurate detail as I could was possible. I revisited fieldnotes regularly during the designated fieldwork time (as opposed to revisiting them at the end of the this time). Whilst I wrote fieldnotes mostly *in situ*, I noted interactions that I took part in after they happened and as quickly as possible so as not to forget. On a number of occasions, visiting researchers assumed I was a researcher at the MWL. In these moments, I was asked what laboratory project I was working on. I would reply by saying that I was in fact a social scientist. This elicited interesting conversations about social science and its purpose. Lunchtimes and other interaction-rich times were the most difficult to recall because they were often extended times of interaction (often up to an hour). In these moments, I would pen key quotes verbatim and write key bullet points to jog my memory for a full write up in the evening. This is because I did not want cut short the afternoon's observation time. Whilst I recall feeling self-conscious writing notes at first during fieldwork (especially in the laboratory setting), I soon realised that in the laboratory setting most people were carrying out experiments, sitting in meetings, or writing. Thus, merely sitting and watching would be less 'natural'. I have already indicated that I found some aspects of the laboratory setting difficult because some interactions were scientifically complex and therefore difficult to understand. Sometimes I asked for clarification and at other times I looked up spellings/theories afterwards if I was unsure. There were lots of basic textbooks available. Many times I resigned to the fact that I was not going to understand a specific point.

I enjoyed fieldwork very much, but I also found it grueling at times. I endeavoured to arrive at conferences and laboratories as early as possible each day and I attempted[60] to stay until the last person had left so as to get the fullest picture of each occasion. Evenings (where possible, for on occasion I was invited to socialise with researchers[61]) were devoted to writing up/fleshing out fieldnotes and writing long, reflective entries in my field diary. This was balanced with making sure that I had a good night's sleep each night because I needed to be sharp for each new day. Whilst at first my presence was a novelty at the laboratory settings (Professor Hurst introduced me at the 'Lab Meeting' as the visiting sociologist) I soon transitioned (or so it seemed) into being 'part of the furniture'. I also became a confidante to several of the researchers, who shared aspects of their personal lives with me[62]. One evening, I was invited to an art gallery with the MWL researchers. At conferences, because I was a delegate at each, I was already a member (as opposed to being a standalone ethnographer). Conferences are, in any case, highly social settings because of the culture of 'networking' in between presentations and at meal/coffee breaks. I learned early on - especially as a young, single (at the time) female - to maintain appropriate boundaries when talking to strangers at conferences after an episode at the SENS Conference 2011[63], where a biogerontologist asked me if I wanted to share his conference suite and try his homemade 'elixir of life'. He offered to be a participant in my study, but I declined because I felt uncomfortable and wanted to prioritise my well-being over adding 'one more interview' to my dataset.

Table 4: Laboratory Fieldwork in Practice

Where	**What**	**When**
Metrotown Worms Laboratory/Metrotown Fly Laboratory/Countryville Fly Laboratory	I sat observing researchers at the bench as they carried out tasks such as picking worms and tipping flies for the purposes of lifespan experiments. Whilst I often refrained from talking, I occasionally asked questions when it	Mornings/afternoons. Mostly PhD students and laboratory technicians. Tipping at both laboratories was mostly done on Monday, Wednesday, and Friday mornings.

[60] On several occasions, transport issues prevented this.
[61] This looked different in different settings. During my time at laboratories/interviews, eating was more informal, yet at conferences the conference dinner was a formal occasion.
[62] This was (perhaps) elicited by my gender and sensitive nature.
[63] The SENS 'group' - or, as I heard mainstream biogerontologists describe on several occasions, 'the nutters' - is known for its eccentric characters/personalities. I received 'strange looks' at times when I told mainstream biogerontologists that I was going to a SENS conference.

	felt appropriate. Often researchers began to tell me about their research/other aspects of their lives. I wrote notes where possible. Sometimes I took photographs for my own recollection of the scenario.	
Metrotown Worms Laboratory/Countryville Fly Laboratory	I sat/stood observing researchers carrying out administration tasks/publication writing at their desks – often in offices, whilst researchers sat at computers. Often the researchers would use this space to 'chat' to me/ask questions. I wrote notes afterwards.	Laboratory heads would often be in offices all day, yet my access was limited by their invitation – often 1 hour. PD and PhD researcher desk spaces were more open and I was invited to come and go freely.
Metrotown Healthy Ageing Institute (MHAI)	I spent time observing in the MHAI common room for coffee breaks, lunch breaks, and the 'Lab Meeting'. I wrote notes during the meeting, and I would write up notes from lunch/coffee afterwards.	Coffee breaks were regular, particularly in the morning. Lunch breaks occurred at approximately 12/1pm, and the meeting happens on Wednesday.
MHAI Microscopy Room	I watched as MWL researchers created slides/assays, which were viewed via a large microscope on a computer screen.	There were several occasions where I was invited to observe these sessions that had been pre-booked in the calendar by researchers. These sessions took 1-2 hours.
Researcher Meetings at Metrotown Worms Laboratory and Countryville Fly Laboratory	I was invited to sit in to silently observe meetings between heads and researchers. I watched as the heads asked researchers about how their research was going. I wrote thorough notes in shorthand.	I was invited to these meetings on several occasions. The meetings were approximately 1 hour long.
Metrotown Worms Laboratory	As 'lab photographer' I took photographs of the researchers and the laboratory for the purposes of the laboratory's website.	Photographs were taken throughout the week. (These photographs were not used as data so as to protect researchers' anonymity).

Generally left to my own devices, I had a lot of autonomy at each laboratory setting (see Table 4 for more specific descriptions of what laboratory-based fieldwork entailed). I was told that I could ask people questions about what they were doing. I did so where appropriate, but I balanced this with not wishing to interrupt those crucial moments that required their focus. A PD researcher at the MWL told me that, generally, 'new' people were welcome (as long as they did not make equipment more scarce) because new people broke up the often mundane, day-to-day routines. There was no risk that I would make equipment scarcer because I was unable to participate practically in experiments. I had initially planned to play the role of laboratory assistant, but I quickly realised that this was highly ambitious, and my participation was generally limited to fetching items and making cups of tea. The laboratory assistant at the MWL had obtained an MSc in genetics in order to be able to carry out her role as a technician. I was permitted to try fly 'tipping' and worm 'picking' – which I describe later in the thesis (chapter five) - but I found these activities very difficult. However, at each laboratory I was shown to a seat in the laboratory space that I could use as a 'base', and the respective 'heads' of the MWL and the CFL both asked one of their researchers (as 'guides') to look after me[64]. Whilst I had initial contact with the 'heads-of-lab', the heads worked mostly in their offices. Upon arrival at each laboratory, each laboratory 'guide' introduced me to rest of the team. Whilst I spent a significant portion of time at the bench, I also spent time chatting in scientists' offices and 'hanging out' in the (MWL's) common room and kitchen spaces. Moreover, at the MWL, I was invited to sit in on the weekly 'Lab Meeting'. I was also permitted to attend a 'Progress Review' meeting between Professor Hurst and Orla. During these meetings I had to work quite hard to understand what was being said. I had to develop a short hand style so I did not fall behind with my writing.

Rabinow (1997) suggests that there is no 'absolute' effacement of one's 'own self' from research. Throughout the fieldwork process, I was mindful of the effect/affect that my 'self' had upon the conduct of research and the unique relation that I had with each key informant. So long as an ethnographer remains aware of these things (Coffey, 1999), they are not problematic, because each ethnographer will, unavoidably, elicit a different set of relations. *My* place in the research became pertinent when one biogerontologist kept pursuing conversation with me about his 'radical' socialist days. I realised that I

[64] At the CFL this was James Johnson, and at the MWL, this was Kate Turner.

had (perhaps) elicited this kind of discussion because I had casually mentioned an academic interest in activism. Furthermore, my very presence invoked several 'deep' philosophical/theological conversations about the 'meaning of life' and also the sustainability of the planet. I did not begin these conversations, but they 'just kept happening'. Whilst during fieldwork I dressed (what felt to me at the time as) smartly in order to 'fit in' with the formal setting (i.e. woolen pullovers, floral skirts, a dufflecoat, and suede shoes adorned with coloured beads), in hindsight I realised that my own dress choices did contrast significantly with the laboratory dress code to a degree. I have since reflected on how my 'alternative' appearance might have been recognised as 'other', which, in turn, might have contributed to the occurrence of the specific, repeated conversation topics I described. In addition, my status as a young, female PhD researcher is cause for reflection. I have mentioned that I felt that scientists simplified things (sometimes patronisingly so) for my benefit. For example, Professor Hurst turned to me during his 'Progress Review' meeting with Orla and said: *"you'll probably find this impenetrable"*. I realise that some of these personal characteristics were beneficial to my research because I was deemed to be so little of a 'threat' that I was permitted to see/hear everything.

Studies of science have not excluded a focus upon gender (e.g. Traweek, 1988; Keller, 1998). Whilst I do not discuss gender at any length (because it did not come into view as a key topic for discussion), to fail to acknowledge its presence during fieldwork would be naïve. Alongside the combination of being a young, female PhD student (the effects of which I have already speculated upon), I was privy to a number of conversations centred around the difficulties faced by women with children, or women who wanted to have children, in maintaining an equal playing field in the laboratory. I was warned that the female researcher is only able to make it 'to the top' if she remains childless, which was described to me using an example of a well-known lady in the field who did not 'have time' to have children. I was also told that a female scientist is required to change to part time hours in order to look after children *and* carry out research. It felt like my own gender and status as an academic elicited these conversations, instigated by Dr Kennedy, who shared these 'facts' with me in his office in order to warn me of the 'hard road' ahead as a female academic. I was disconcerted by these 'warnings' (which also included a more general caution that it was hard to go

further than PhD level) because I felt that Dr Kennedy was speaking into my life beyond his remit. Aware of my tendency to enter debate if I am irritated, I remained quiet. On a related note, female PD researchers at the MWL opened up to me about their experience of planning pregnancies and/or maternity leave around research posts, which became a space for bonding.

At many points during fieldwork, biogerontologists openly shared with me their opinion that social science was 'pointless', or, more politely (depending upon the researcher) asking me what the *purpose* of my research was (over and over again). They responded to my replies with perplexed expressions and more questions related to my hypotheses and research design. This contributed to (what seemed like) a consistent tension between, on one hand, my intent to remain open to being taken in any direction by my research, and, on the other hand, a constant requirement to account for what I was studying/'finding'. I tried to be vague about the direction of my research (though scientists did not like/understand vague) because I did not want to prematurely foster an analytical direction for my research, nor did I wish for researchers to change their behaviour any more that they were doing already on account of my presence.

It was easy to ascribe a totally 'self'/'other' relation between my world and this 'other' world that I came to inhabit during fieldwork. Yet, despite the obvious distance between the two worlds, it felt at times like we all belonged to the same world: the academy. When I spoke with researchers (particularly PhD students) about shared activities, for example, teaching, marking, and writing papers, there was a strong degree of connection. However, when writing was discussed I felt a sense of mastery because that is what we do (and not what the scientists do). At the CFL particularly, I spent a lot of time with PhD students, and I found an ally of sorts in James (my guide). This connection was helpful one day at *The Mainstream Biogerontology Conference*. This is because some scientists (who had previously been friendly) kept their distance from me when the main 'speakers' were around[65]. I became 'old news' and I was sitting on my own until I happened to meet James during a coffee break. Furthermore, whilst at the MWL, the boundary between social science and science was blurred further when a PD

[65] This, in hindsight, was entirely normal given that the conference was a yearly get together for a community that have been studying together for years. On this occasion perhaps I was feeling tired (and, thus, sensitive) because of the long days and nights that participant observation often entails.

researcher (who had, in her words, *"dated an anthropologist"*) asked if I had *"read any Bruno Latour?!"*. This was disconcerting (Verran, 2013) because, I thought to myself, this is *my* world. She started telling me how to carry out research: *"you have to become initiated really so that you're not the other, so you understand all this"*.

Writing was a significant part of fieldwork and analysis: *"the anthropological practice consists of two intimately linked processes, or fieldwork and writing…for a culture to materialise, it requires an external other"* (Hastrup, 1990: 45). Thus, I reconstructed the text in, what Hastrup (1990) refers to as, the 'ethnographic present', whilst retaining an awareness of the self-other relation. Arguably, any notion of 'going native' is always constructed and is thus an illusion (Wagner 1975). Consequently, writing in the ethnographic present is of value for creating a 'reality' (which stands in 'the present' outside of history) (Hastrup, 1987). Hastrup (1990) claims (following experience as an anthropologist) that a researcher's identity shifts as part of the process of observing any given culture. I (naïvely) set out to not be changed by biogerontology 'writing itself onto me' (Hastrup, 1990) and/or affecting me in this way. However, I know in hindsight that I was changed by biogerontology, and also the ethnographic process. This is inevitable and not necessarily a bad thing. I found myself to a degree 'becoming-with' the biogerontologists that I was studying (see Heidegger, 1962; 1977; Latimer, 2013a; see chapter one). Moreover, I noticed that my presence transformed (to a degree) the scientists that I was 'alongside'. I noticed one scientist use some (almost verbatim) sentences from the conference paper I gave at *The Countryville Ageing Conference* (when it came to describing potential negative social implications of 'anti-ageing'). Whilst I observed biogerontologists in order to learn about *their* world/s, they not only welcomed me, but picked me up from the station, made my bed and morning porridge, and took me out to dinner as part of discussing my research (and at times, my life). I was 'moved' by their world and they were 'moved' by mine.

I felt welcomed into the laboratory setting (especially with PhD students and PD researchers[66]) and I had to resist the urge to avoid writing anything negative about

[66] This was perhaps because we were at similar ages/stages in our academic careers.

anybody in the research community[67]. In addition, Hastrup (1990) claims it naïve of a researcher to imagine that s/he is not going to change field that she is immersed in. I will never fully know the effect of my presence in the field, but I do know that several biogerontologists had never learned what 'sociology' was before I arrived (and so I was able to teach them). After fieldwork, I had a greater level of appreciation for science. I realised – perhaps through constant reflection upon my relations in the field - that before undertaking the study, I had (perhaps unconsciously) viewed scientists *en mass* as arrogant and ill-intentioned. This might have emerged from a particularly perspective about modern science held in relation to care for the earth (see chapter one). Whilst biogerontologists made a number of statements (particularly in the public setting)[68] that supported my preconceptions, having one-to-one relationships and shared moments with individual biogerontologists was a touching experience. This re-iterated the value of studying biogerontologists' different sub-sites. Additionally, a significant portion of my analysis (see chapter seven) is dedicated to showing that scientists *do* care.

I have described that on a number of occasions (i.e. Dr Tucker's statement that 'ageing was a definitely a disease' and also when a researcher asked if had read Latour) I was 'disconcerted' (Verran, 2013), much like when Verran initially observed a significant difference between Western and Yoruba logic in African classrooms. Another particular example of this is when the word 'ageing' was absent from discussion in the laboratory setting. This was disconcerting because biogerontologists refer constantly to ageing in the public setting. Ageing was only mentioned in the laboratory setting during a moment of curiosity about why I, the *"anthropologist"* (Amelie MWL PD researcher), was scribbling hastily into a reporter's notebook. This led to Amelie stopping her research in order to ask me what in the world I was doing *there* studying *them*. *"Oh!!! You're interested in AGEING!?"* was the response when the penny dropped that I was *there* to study *them* because they were studying ageing[69]. Furthermore, Law and Lin (2009: 13) suggest *"disconcertment can be treated as a bodily indicator of metaphysical difference"*. Consequently, these moments reminded me of my distance

[67] Note that, as part of 'becoming-with' biogerontology (Heidegger, 1962; 1977; Latimer, 2013a), my thinking has changed. Now, with Latimer (2008), I see potentially problematic discourses as effects of institutional positioning.

[68] For example, statements about sterilising people, and statements about future generations' non-importance.

[69] Some 'serendipitous' (Rivoal and Salazar, 2013) moments came from this, as the researcher proceded to give me a list of helpful institutions/websites.

(as a non-scientist and researcher) from biogerontologists. Keeping this distance was tricky at times, particularly when it came to spending time with people my age (e.g. PhD students). I had to resist the urge to try hard to be friends with researchers, for it is my natural urge to maintain a friendly tone in my interactions. However, this was not my purpose for being there. Thus, I did not shy away from natural rapport, yet I did not try to build it. At the start of my designated fieldwork year, I received some valuable wisdom from a sociologist at *The Countryville Ageing Conference*. She had seen me have lunch with the biogerontologists. She reminded me to *"keep a cool distance because you have to see them as Martians and not get enrolled to their belief systems"*. This was sound advice that stayed with me as I traversed the field.

Data Analysis

Whilst I regularly read and re-read the data (alongside relevant literature) throughout the designated fieldwork process, I embarked upon a more concentrated data analysis period following a biogerontology conference held in September 2013. I began by gathering fieldnotes written at each sub-site, detailed transcriptions of interactions, informal and formal interviews, and notes and transcriptions taken from document and media analysis. In these early stages, I used a CAQDAS software package[70] to (loosely) code data into themes for my own reference and to familiarise myself with the data. I subsequently chose to code the data by hand because I felt that CAQDAS offered an unwelcome distance between the data and I (Weitzman and Miles, 1995). Throughout, I was careful to ensure that I coded data in a way that did not compromise the text's meanings. After multiple readings (and then extra readings on trains, in the bath, and so on), I subsequently took the time to meaningfully interpret what was being said, done, and/or represented. This is alongside paying attention to *how* these things were being said, done, and/or represented by each actor that I tracked as part of the study.

Clarke's (2003; Clarke and Star, 2008) situational approach to fieldwork and analysis – a postmodern reworking of grounded theory (Glaser and Strauss, 1967; Mathar, 2008) – was of value given the 'heterogeneous and complex character' of my method (Mathar, 2008) and, thus, the data generated. It was particularly useful when comparing data

[70]I used a package called 'HyperRESEARCH', which is similar to NVivo, but for use with Apple hardware.

across different sub-sites. Clarke's approach encourages the same theoretical and thematic coding associated with grounded theory, but it also encourages a more critical and multiple approach to analysis; one that seeks more 'reflexivity', 'uncertainty', 'modesty', and 'representation of contradictions' (Clarke, 2003; Mathar, 2008), and accounts for *"partialities, positionalities, heterogeneities, situatedness, and fragmentation-complexities"* (Clarke, 2003: xxiv) (compatible with 'motile' worlds – see chapter one). Clarke's building up of data from individual situations to the 'global' (contextualising the 'local' in relation to the 'global'), with systematic connections made as part of this analysis process, corresponds to Law's (2004) '[method] assemblage' that I draw from by way of combining Marcus' (1995) multi-sited method approach, Latour's understanding of 're/assembling the social' (Latour, 2005), and Ong and Collier's theory of global assemblage (Ong and Collier, 2005; Collier, 2006).

What this looks like in practice is analysing different 'registers' (Latimer, 2008) (see earlier in this chapter) alongside one another. This entails the creation of countless spreadsheets, flowcharts, and spider diagrams; grouping similar registers, and making 'situational maps', where *"all actors (individual or collective) and actants (elements, bodies, discourses) are mapped and then their relationship to each other analysed"* (Mathar, 2008: 5). This paints a picture of each sub-site and also the position of each in relation to the other sub-sites and the global site that emerges from the situated data. As well as written and/or transcribed data, I analysed photographs, pamphlets, and other promotional materials. Using these visual mapping tools (mostly 'blue-tacked' to my bedroom wall) is helpful when *"studying multiple media in the 'multi-modal social world'"* (Dicks et al. 2006: 94). Mead (1977) warns against 'drowning' in data, and whilst at times these maps were overwhelming, I kept going (alongside reading and writing). Consequently, key themes, patterns, and discourses began to emerge from local 'situations' as I related all of the parts to the whole (Baszanger and Dodier, 2009).

Writing was a key part of my data analysis. Most days, I would write something in relation to the data that I had deconstructed, mapped, and reconstructed as a single text (Latimer, 2008). I spent three months intensively studying data and after this time, when key themes began to emerge (e.g. biogerontologists and their relation to their animal models; the quantification of ageing; a discourse of eugenics), I began to write near

'chapter length' pieces on each of these so as to neatly present data - drawing loosely on 'neuro-scientific' techniques for analysis (see Leaf, 2013) – in order to consolidate my thoughts and in order to boost conscious and non-conscious thinking (about the data). Eventually these themes presented themselves in more sophisticated arrangements and after many drafts, the thesis' chapters (that you will read in due course) emerged. During the time of conducting the study and writing this thesis, I have been managing chronic fatigue and pain. However, this became a tool for deep thought (and thus cognitive analysis) because I was forced to rest for long periods of time. Whilst this was mostly frustrating, especially when I wanted (and was pressured by time) to 'produce, produce, produce', I realise (in hindsight) that some of my best and most creative and analytical thinking was accomplished during these slower times because I was immersed in the ethnographic process to the point that I could not avoid thinking about my study/data. Whilst I attempted to put my research questions to the back of my mind during the designated analysis period (so that I was not directed in a particular way), this is never fully possible, and I re-iterate the fact that the reflections that I present in this thesis cannot be separated from my 'self'.

Ethical Considerations

In terms of 'Ethics' [with a big E[71]], I adhered to the Ethical guidelines set out by Cardiff University, and I was faithful to those laid out by the British Sociological Association. Biogerontologists were not deemed 'high risk' or vulnerable, and the information that was collected was not of a sensitive nature[72]. Data collected can be divided into 'public' (data yielded from public events/documents/materials) and 'private' (data yielded from participant observation and interviews). Informants that were part of the private data collection process have been anonymised and thus pseudonyms for people and institutions have been used. There is no need for public data to be anonymised because it has been intentionally been put in the public domain. Where particular informants have been part of both private and public data collection processes, I have used pseudonyms throughout. Whilst the notion that there can ever be true anonymity is debatable, I was very careful with the data (given the potentially controversial nature of some of the topics discussed by public figures) and I did not let

[71] Drawing on Puig de la Bellacasa (2011) and Latimer and Puig de la Bellacasa (2013), I draw on this distinction (see chapter one) throughout the thesis.
[72] Using discretion, I left sensitive, personal conversations out of my fieldnotes.

this inevitable aspect of research become paralysing. I tried to gain ethical approval as early as possible so that I could include as much as data as possible, even data collected at the study's very early stages. Consent for data obtained from (interaction with) Dr Tucker and Professor Cadbury already existed as part of a continuous research link between their laboratory and Cardiff SOCSI. All participants were informed individually about the research and their consent obtained. Written consent was also obtained for each laboratory (from the laboratory head) and verbal consent was obtained from researchers in each laboratory (i.e. PhD students, PD Researchers, and laboratory technicians). Participants were made aware of the study's aims and implications and were given the option to withdraw from the study at any time. As previously mentioned, on the whole, biogerontologists did not seem to take 'consent' (or my 'Ethics' for that matter) very seriously. One biogerontologist threw the form on the table saying, in an almost mocking tone: *"you can take anything you want"*. However, I maintained an endeavour to take 'Ethics' seriously for the sake of the rigour of sociology, Cardiff SOCSI, and also informants for whom they *did* actually matter. On a more pragmatic note, I was careful to make sure I did not encroach on any 'medical' territory. This was so that I did not have to play the 'ethics game' (Reed, 2007) that studying health and/or medicine is reported to entail.

The key Ethical consideration of the study refers to public data collected at conferences and other public occasions, alongside published documents (online or otherwise). I initially thought about how consent at public occasions could be obtained, but after consulting other social science research (see Collins, 2004; Binstock et al., 2006; Fishman et al., 2008; Vincent, 2008; Hurdley, 2010, Dimond, 2014) I became more confident that informed consent from the conference organisers was not needed. Because I was able to access these sites as a member of public, I decided that I did not need consent to attend and record my observations. Hurdley (2010), in her study of corridors, pondered similar Ethical questions and came to the conclusion that she would not record conversations amongst people that were intended to be private, but rather she would focus on the general ambience and the assemblage of materials at each site. I maintained this principle in avoiding recording private conversations, which involved sacrificing much (what would have been) excellent data. I obtained consent, in hindsight, for informal interview data I collected at these public occasions. The E/ethics

of biogerontology was a significant part of public discourse, and I was be careful not to let my emotions have an effect upon the way that I viewed biogerontologists on the occasions they gave statements that I found difficult (e.g. one biogerontologist said that humans should be sterilised if there was a population crisis). Biogerontologists actively promoted their views in public. This meant that even potentially controversial data did not need to be handled in an overly sensitive manner.

When thinking about published data, Eysenbach raises *"new issues in research ethics and privacy of research subjects, as the borders between public and private spaces are sometimes blurred"* (2001: 1103). Eysenbach explored notions of Internet privacy amongst online medical self-help communities in relation to social research and found that researchers were accused, in these online forums, as lurkers "*taking advantage of people in distress"* (2001: 1103). This highlights a potential problem with using public data. Eysenbach, however, advocates a discretionary model whereby each context is taken into individual consideration in relation to the vulnerability of specific research populations and whether those involved are *"seeking public visibility"* (2001: 1104). Biogerontologists in my study are not a vulnerable group (often it seemed to be quite the opposite) and seeking public visibility is inherent in the nature of the field as a promissory science (see Mykytyn 2006; 2010; Binstock et al., 2008; Fishman et al., 2008; Vincent, 2008). Thus, I did not see any problems with using publically available documents and media, alongside conference materials, as part of the study (especially as a lot of this data would be for triangulation).

I have described 'Big E' Ethics, but what I also refer to as 'small e' ethics (see chapter one) played a key part in the way that I thought *with* E/ethics and care in relation to my methodology. I have mentioned I developed a good rapport with many informants (especially those nearer my age/stage in the academic 'ladder'). There was one moment where Eva, a PhD student at the MWL, turned to me and said: *"you're not studying ageing, you're studying <u>us</u> aren't you?"*. I said in reply that I was studying both, and she laughed. However, this interaction did lead me to doubt the good rapport. Eva kept her distance until we later bonded over a conversation about her PhD study. I knew that I had nothing to hide, but that I also had to watch that my own desire to protect these new acquaintances from the 'symbolic violence' that can sometimes be associated with

ethnography (Reinharz, 1984) did not interfere from my reporting things as I found them. Whilst Eva's response was perhaps more of a reflection of her shyness (as opposed to expressing a distinct reservation about taking part in my study), this moment highlighted a more general concern that in any case of participant observation, there may be informants who do not want to partake even if the 'head' of laboratory has given consent. This approach is often overlooked in favour of the greater good achieved through responsible research (cf. Humphreys, 1970). Whilst I risked interrupting the 'natural' order of the setting (to a greater degree) by being more overt about my position, I argue that, given the effect that my 'self' already had on the social order, to pay too much attention to this potential ethical tension would be to indulge the idea I that could be a 'fly on the wall'; particularly in the laboratory setting where I was visibly 'the researcher'.

Summary

In this chapter, I have described my chosen methods and methodology and why they are appropriate for my particular study. This is alongside explicating my experiences of not only getting inside my field, but also being inside my field, as I uncover biogerontology's *"always emergent conditions of the present"* (Marcus and Saka, 2006: 101). I began by giving an account for ethnography in relation to prior ethnographies that 'track' (Goffman, 1978; Marcus et al., 1995; Latimer, 2008) science 'in the making' (Latour, 1987; 2005). I described the importance of the relational aspect of connection making with biogerontologists and of 'being alongside' (Latimer, 2013a) biogerontology and biogerontologists for the purpose of not merely gaining access to the field, but also for the purpose of (more) genuinely encountering the field. I described in depth the different methods that I employed as part of the study (participant observation, interviews, and visual/textual analysis) and I also described the different sub-sites in varying degrees of detail (e.g. the conference setting, the laboratory setting). I focused particularly on describing the Metrotown and Countryville laboratories because these were the two laboratories/groups of biogerontologists that I tracked in much detail during my time of immersion in the field. Moreover, I gave an account of my data analysis, and, finally, I detailed the ethical considerations that were relevant to the study. Throughout, I retained a reflexive stance in relation to my chosen methods/methodology. This chapter precedes the first of the thesis' four analytical

chapters. In what follows, I draw from the data yielded as part of this study in order to answer my research questions (see chapter two). Furthermore, I begin my analysis at the place at which this fieldwork journey began: the public setting.

Chapter Four

Public Biogerontology

Introduction

In this chapter, the first of four analytical chapters, I explore biogerontology in the public sphere, or what I refer to throughout as 'public biogerontology'. I examine the accomplishments of biogerontologists in the public setting, which includes an extended focus on accounts, materials, and interaction. I begin my analysis at public biogerontology not only because it was my point of entry to the field, but because it is the point of entry to the scientific field of biogerontology for non-biogerontologists. I draw on a public debate held between two biogerontologists as a locus for discussion of the wider field. The debate draws together stories that biogerontologists tell across the field, including biogerontology's 'big story' Latimer (2014) that ageing is plastic. In what follows, I examine this public debate, alongside other public instances of biogerontology, for stories that are told; stories that make visible biogerontologists' aims, concerns, values, and expectations. I show that ameliorative 'human biomedical futures' are imagined by biogerontologists in relation to discourses of 'anti-ageing'. Moreover, I illuminate the way that biogerontologists enact boundary work and consequently constitute (Latimer, 1997; 1999; 2013b) both 'good science' and 'bad science'; 'good biogerontology' and 'bad biogerontology'.

Whilst convention holds a broad definition of 'the public', in science and consequently the field of STS, definitions of 'the public'/'publics' and their understanding of and/or their relation to/with science is contested (Miller, 2001; Collins and Evans, 2002)[73]. It is not my intention to engage with debates about what 'the public' is, and for the purposes of this study I hold a fairly broad, dictionary-led, definition of the public. I primarily draw on data yielded from public events (such as *The Public Debate*, *The Older*

[73] There is a wealth of literature surrounding publics and public engagement/participation within STS. Whilst this research has been highly beneficial to the way that the public are invited to engage with advances in S&T, this is not the focus of the current study. There have been no public consultations held with regards to biogerontology (e.g. the 'GM Nation' debate), however, across the data collected in public spaces, questions and comments have been invited.

Person's Conference, The Living Longer Conference, and *The Mainstream Biogerontology Conference*), biogerontologists' academic and media publications, and public data freely available on the Internet. For the purposes of triangulation, I draw on interview data, especially given that interviews, across the data, became spaces for the same kinds of accounts and/or performances that are enacted in the public setting.

Introducing the Public Debate: ADG vs. RF

As I queue patiently in Oxford's cobbled streets for the Public Debate, I recognise, from both media and conference appearances, the two men approaching on the horizon to be Dr Aubrey de Grey (ADG) and Professor Richard Faragher (RF). The eccentric ADG is wearing jeans, a rustic, red and yellow striped woolly hat and flowery tie, which is a stark contrast to RF's traditional and plain suit and tie. In the long queue that spirals around the frosty courtyard, I talk with two Masters students who tell me that they are studying sports science. One of them has been following ADG's media publications for several years and she tells me excitedly that every time that she has *"had a few drinks"* she proselytises to her friends about the supposed potential to slow, and even stop, the ageing process. The other student has heard of ADG, yet whilst she is sceptical, she is also very interested in what he has to say. Neither has heard of RF and both are excited to see ADG. I am not surprised about this because ADG's name often appears in conversations regarding my study that I have with peers, family, and friends because they have seen him on television and/or they have read about him in the news.

The debate is a free public event organised by the University of Oxford in conjunction with the British Society for Research on Ageing (BSRA)[74] and Strategies for Engineered Negligible Senescence (SENS)[75]. RF is the BSRA 'Chair' and ADG is SENS' 'Chief Science Officer'. RF represents the 'mainstream', and ADG represents a challenge to it. I refer to ADG as 'left-of-field'[76]. As ADG and RF linger at the building's entrance, I watch as they shun one another with folded arms and defiant

[74]The BSRA is the largest UK 'Ageing Research' group, and it comprises many biogerontologists across the UK.

[75]'SENS' is a name used by ADG to describe both the 'Research Foundation' and the 'Research Strategy' employed by the foundation. SENS began in the UK but recently relocated to the USA.

[76] 'Radical' – the term used by some authors to describe ADG and SENS (i.e. Binstock et al., 2006; Fishman et al., 2008) - originates from 'root', or 'origins', which makes an assumption about SENS. Thus, I have chosen to use the term 'left-of-field' instead.

stares. I am observing, early in the evening, signs of division. Studies of public claims made by 'anti-ageing scientists' (see Moody, 2002; Binstock, 2004; Binstock et al., 2006a; Vincent et al., 2008, Fishman et al., 2008; Binstock, 2011) describe a division between 'mainstream' and 'radical' 'anti-ageing scientists'. They also report a union in belonging to the AASM (see Mykytyn, 2006c) and this is made visible through a unified *"self-adherence to a [single] set of values and attitudes"* (Vincent et al., 2008: 292). At the start of the Public Debate, based upon what appears as divisive body language and from what I already know at this point about their perspectives, I anticipate that ADG and RF will offer a fragmented set of values and attitudes on stage. Upon entry to the grand lecture hall I find a seat near the front. There are four people on stage: RF, ADG, Dr Lynne Cox[77] and a student representative of the 'Oxford University Society of Biomedical Sciences' (OUSBMS) (this is the group that has organised the event in conjunction with the BRSA and SENS). The crowd waits tentatively for ADG and RF to begin the debate, and whispers are silenced as the host (the OUSBMS representative) welcomes the audience to the event and subsequently reads aloud the event's official 'abstract'. I recognise this abstract from the BRSA's 'Events' webpage:

> *"Scientists have discovered numerous ways to produce significant life extensions in the lifespan of various species – what about humans? ADG contends that senior scientists in the field of ageing have distorted the relationship between ageing and disease and that his research strategies will lead to the rapid development of rejuvenation therapies to combat ageing. RF disputes these contentions and believes ADG is damaging the credibility of the field by conflating his futuristic visions with the practical research strategies of the mainstream. Which of them is right? Are both of them wrong? Regardless, both agree that research on ageing is grossly underfunded and key to a healthy future. Could a cure for ageing be on the horizon?"*
>
> (Student Representative, Event Abstract, Public Debate)

[77] Dr Lynne Cox is a biogerontologist based at The University of Oxford. She is part of the event's 'hosting team' and, at the end of the debate, she gave a presentation entitled 'The Middle Ground'. In this talk, she elaborated upon some of the physical ailments common in older people (e.g. bed sores that don't heal, incontinence, heart diseases, cancer). Dr Cox explained that research is being undertaken to combat these things, and she explained that no matter one's stance (with regards to the debate between ADG and RF), research into ageing should be celebrated.

The OUSBMS representative begins by referring to the discovery of numerous ways, or 'theories of ageing' (Latimer et al., 2011), that have been yielded in the laboratory within in the context of *"extensions in the lifespan"* in animal (models). He asks *"what about humans?*", which purposefully introduces biogerontology's proposal for life-extension in humans. This is alongside constituting a division between human and animal. In using words such as *"rapid"* and *"combat"*, ADG's *"research strategy"* is constituted as both scientific and aggressive, which contrasts with the far less aggressive phrase *"rejuvenation therapies"*. A division is figured between ADG and other *"senior scientists"* in the *"field of ageing"* who have *"distorted the relationship between ageing and disease"*. From numerous academic papers by ADG – predominantly published in SENS' own journal, 'Rejuvenation Research' - I know through my own reading of the field that ADG has publicly accused biogerontology's *"mainstream"* of failing to prove the *"old aphorism"* reported in this event abstract that *"ageing is not a disease"*. This is despite the mainstream's objective to intervene in the supposedly pathological ageing process (see also de Grey, 2005: Online; Warner et al., 2005).

Furthermore, the event's abstract states that RF *"disputes the contentions"* that have been made by ADG and that RF believes ADG is *"damaging the credibility of the field"* by *"conflating his futuristic visions with the practical research strategies of the mainstream"*. What becomes clear at this early stage in the debate is that the credibility of biogerontology is at stake. The division between the *"practical"* mainstream and the *"futuristic"* other, or 'left-of-field', comes into view. This division is described by authors within the context of biogerontology's boundary work and pursuit of credibility (see Moody, 2002; Binstock et al., 2006a; Fishman et al., 2008; Vincent et al., 2008).

A temporal dimension is also introduced as this debate unfolds. There is a difference between present-moment laboratory advancements and what is (or is not) possible to achieve for 'future humanity'. This division is articulated across the literature (see Moreira and Palladino, 2009; Mykytyn, 2010a). Moreover, as part of the event's abstract, the student representative states: *"both agree that research on ageing is grossly underfunded and key to a healthy future"*. This reinforces not only the notion that funding is critical for biogerontologists, but also a temporal division between 'human biomedical futures' and the 'animal laboratory present'.

"We Agree About So Much That I'm Afraid The Font Is Rather Small"

The student representative introduces ADG, and the debate begins. ADG stands up in front of a PowerPoint presentation, receiving an extremely large round of applause. ADG begins by confidently stating: *"We agree about so much that I'm afraid the font is rather small"*. I am disconcerted, not only because debates are traditionally characterised by disagreement, but because this apparent agreement provides a sharp contrast, firstly, to the pair's entrance to the venue, but also to my reading of the frequent back-and-forth debate between ADG and the mainstream. However, finding (the appearance of) 'agreement' supports Mykytyn's (2006c) observation of unity amongst the AASM. After shuffling around with a clicking device, ADG brings up his first slide, which shows (delivered in the form of bullet points) four clear statements. The title is *"we AGREE":*

- *"That intervening the "ageing process" is a morally desirably goal and that failure to recognise this may be widespread but is philosophically fallacious."*

- *"That the ageing process is malleable and thus "medicines for ageing" represent valid research goals."*

- *"That it is already possible to extend the healthy life of many laboratory animals by genetic, pharmacological and dietary means."*

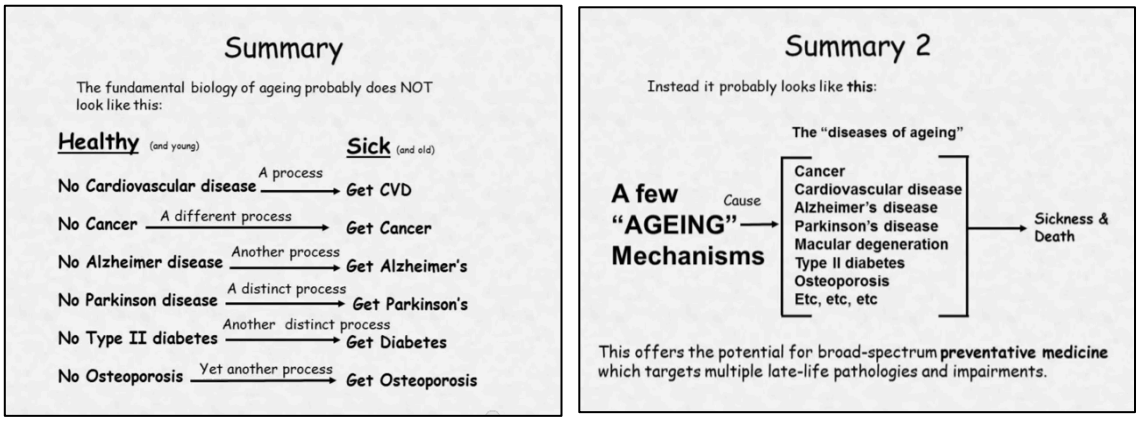
- *"That research into the biology of ageing is therefore vitally necessary and grossly underfunded."*

(Dr de Grey, Public Debate, Presentation Slide)

The four statements – these are likely to have been agreed upon by ADG and RF before the event – describe the pair's *"points of agreement"*. This is in spite of the fact that they have been set up as rival researchers for the occasion. In these very clearly stated points of agreement, the 'big story' about ageing (Latimer, 2014), which appears to transcend smaller stories about ageing here, is told. First, ADG states, on behalf of both, that *"intervening in the ageing process is a morally desirable goal"*, which is an ethics-

based claim. ADG makes the claim in relation to what he calls the morally and philosophically erroneous, traditional Western approach to ageing that does not render intervening in ageing to be an imperative. An assumption is made by ADG and RF that ageing is definitely a process in which intervention is possible. Kaufman et al. (2004) suggest that ethical appropriateness is a key part of the debate surrounding ageing research, and ADG is policing the boundaries between firstly, the 'immoral', 'old' (ageing is not plastic) way of defining ageing and, secondly, the 'moral', 'new' (ageing is plastic) way of defining ageing. This is a distinction that ADG elaborates upon as part of the debate and it is also a division that he makes in academic publications (i.e. de Grey, 2005; 2006).

Figure 1: Slides - RF's Summary of Ageing as a Biological Mechanism[78]



Using the second bullet point, ADG tells the story that *"ageing is malleable"* (plastic), making an alignment with the story that ageing is a biological puzzle (a biological discourse). He subsequently switches to drawing on a medical discourse in referring to *"medicines for ageing"* and makes a switch back to the biological when describing *"valid research goals"*. At a later point in the debate, RF refers back to this second bullet point when he draws on the above pair of slides (see Figure 1). RF describes ageing as *"malleable"* and also as the *"the underlying cause of illness"*. This constitutes a switch back to the medical, yet he also discusses the *"fundamental biology of ageing"*. Multiple switches between the biological and the medical illuminate the complexity of biogerontology's emergence from these two fields/disciplines. In addition, the presentation given by RF at the Public Debate supports and extends the

[78] The presentation slides were made freely available to members of the public on the Internet after the event (OUSMBS, OUSMBS Website: http://users.ox.ac.uk/~ousbms/).

work of Moreira and Palladino (2009), who describe a paradox between how ageing, alongside age-related diseases, is constructed in relation to both *the biological* (ageing as a biological mechanism) and *the chronological* (ageing as lifespan). This is because, they argue (Moreira and Palladino, 2009), biogerontologists construct ageing in relation to a broader set of diseases that are synonymous with chronological ageing, yet the story that ageing is plastic disposes of chronological ageing.

RF points to the first slide (*"Summary"*). He claims: *"the fundamental biology of ageing probably does not look like this"*. The slide represents distinct age-related illnesses (e.g. cancer, Alzheimer's disease, cardiovascular disease) as *"causes of morbidity"* and it also shows these to each be the result of a *"distinct process"*. RF points to the second slide (*"Summary 2"*), and, speaking as if he represents the whole of biogerontology, he claims defiantly that it is *"a few ageing mechanisms"* in the human body that cause *"age-related illness*" and the subsequent associated *"morbidity"* and *"loss of independence"* that accompanies each. It is these physical aspects of ageing that are problematised in government reports (i.e. House of Lords, 2005/6).

In the third bullet point, ADG expands on the second bullet point by claiming: *"it is already possible to extend the healthy life of many laboratory animals"*. Drawing on (what I have termed) the 'laboratory animal present', by way of legitimating the story that ageing is malleable and also an underlying factor in age-related illness, he infers the success of experiments that employ "*genetic, pharmacological, and dietary"* (ADG) interventions. These are experimental interventions in biogerontology laboratories that make use of model organisms. Later in the debate, RF expands on this bullet point, for he draws on the regularly cited 'Rapamycin' and 'Resveratrol' discoveries (see chapter two). This is alongside drawing the audience's attention to studies undertaken by his colleagues. The results of these studies, he states, show the reduction of senescence in Werner's Syndrome[79] (WS) sufferers. This reduction is caused by what RF describes as *"an accelerated accumulation of senescent cells"* that happens when *"senesced cells"*

[79] To elaborate on an earlier footnote, Werner's Syndrome (WS) is a rare autosomal recessive genetic disease. It is a disease where human cells age and become 'senescent' at an increased rate in relation to 'normal' human cells and, consequently, a forty year old with WS can look approximately ninety years old. There is also a premature development of diseases like osteoporosis, bilateral cataracts, diabetes, thymic atrophy. People with WS live to an average age of forty-seven where death is caused primarily by cardiovascular disease and cancer.

are *"deleted"*. This draws on what Vincent (2008), Latimer et al., (2011), and Latimer (2014) refer to as *anti*-ageing language. I understand the reference to senesced WS cells because during preliminary fieldwork that I carried out at Butefield University (see chapter three) I made assays[80] of WS cells treated with a virus to induce (what Dr Tucker referred to as) a *"slower rate of senescence"*. Under the microscope I saw that the 'treated' cells were less textured than ordinary WS cells. Dr Tucker told me that this meant the cells were *"less senesced"*. RF repeats and emphasises these discoveries during presentations at other conferences, such as *The Countryville Ageing Conference* and *The Mainstream Biogerontology Conference*. Such discoveries, as 'facts', appear to be part of what might be thought of as a 'common property' owned by biogerontologists. Another example is a repeated reference to Kenyon et al.'s (1993) discovery that DAF-2 mutant worms live longer than 'normal' worms (see chapter two).

In the fourth bullet point, ADG claims that *"biology of ageing"* research, whilst *"vitally necessary"*, is *"grossly underfunded"*. Alongside aligning biogerontology with biology, ADG makes an appeal here for a greater sum of funding for research. This is emphasised when he expresses his frustration at the inadequacy of current financial provision. This supports the finding of authors (Binstock et al., 2006a; Mykytyn, 2006c; 2010a; Fishman et al., 2008; Vincent, 2008) who note that this fight for legitimation is often entangled in the pursuit of more funding. Furthermore, Fishman et al. (2008) emphasise the role of biogerontologists' dividing between 'credible' claims about ageing and claims that may deter potential funding offers. SENS is mostly funded by private funding bodies/personal donations. Being signed up to the SENS mailing list, I receive regular emails asking for such donations[81]. RF says that he, like other mainstream biogerontologists, carries out *"basic biology research"*[82] (University of Brighton). For the most part, university research is funded by corresponding government/public funding bodies[83]. However, the story that unfolds throughout the debate is that whilst both ADG and RF seek more funding, each sees the other as a

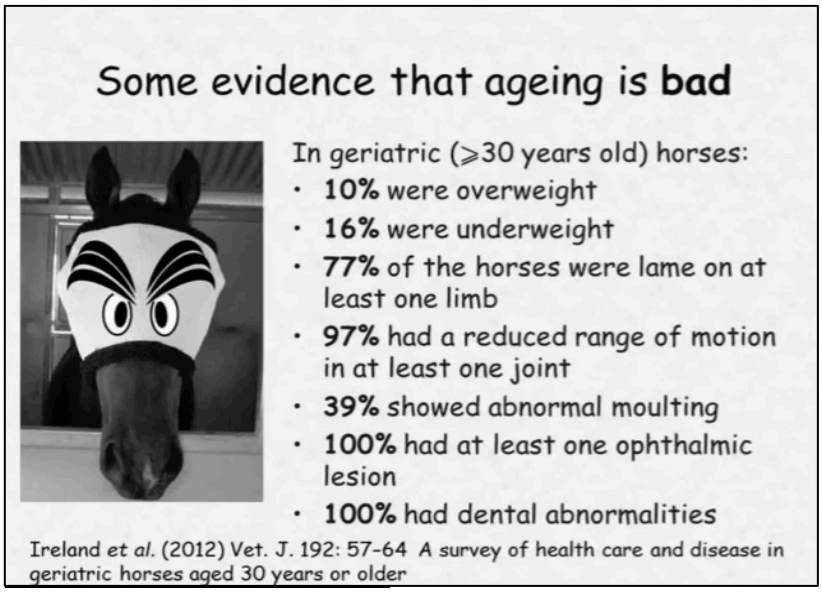
[80] An assay is a procedure used to investigate a 'target entity'. In this case it is in the form of a slide.
[81] SENS' petition for donations is constant so as to maintain research moementum, and, moreover, ADG set up the 'Methuselah Mouse Fund' (which has yielded millions of pounds from donations) as a reward for 'breakthrough' discoveries in the field.
[82] 'Basic biology' refers to biological research carried out as a theoretical basis for biomedical interventions.
[83] Government-based university funding is available for university-based researchers. Also, funding is availble from funding bodies like, for example, 'The Wellcome Trust', and the 'Biotechnology and Biological Sciences Research Council' (BBRSC).

hindrance to funding opportunities. This story was reiterated in several interviews that I conducted. One biogerontologist, however, said that biogerontology is appealing to funding bodies because it is at the *"forefront of scientific pursuit" (*Dr Beer, Pebbleside University).

Public and Private Anti-Ageing Stories

Medical sociologists argue that healthcare practices dispose of the social and medical problems of older people and that this has contributed to the exclusion of older people in society (Latimer, 1997; 1999; Latimer et al., 2011). This is, arguably, not the sole fault of individuals and institutions (Latimer et al., 2011), but also the fault of a neo-liberal society that values youthfulness, autonomy, independency, enterprise, and activity (Featherstone and Hepworth, 2005; see also Latimer et al., 2011; Latimer, 2014; 2015). Authors (Vincent, 2008; Latimer et al., 2011) highlight biogerontology's potential to bring a re-invigorated lens to some of the often ignored, physical and/or mental difficulties of older age (Latimer, 1997; 1999). In the public setting, 'anti-ageing' was circulated as part of biogerontologists' categorising of ageing as 'bad', 'pathological', and (often) as a 'disease'. This supports the findings of Vincent (2008), Latimer et al. (2011), and Latimer (2014). At the Public Debate, RF, who is still 'agreeing' with ADG, clearly figures ageing as *"bad"* (Figure 2).

Figure 2: Slide – 'Evidence' that 'Ageing is Bad"[84]



[84]Another one of the slides made freely available to members of the public on the Internet after the event (OUSMBS, OUSMBS Website: http://users.ox.ac.uk/~ousbms/).

In the above slide (Figure 2), as part of emphasising to the audience that *"ageing is bad"*, RF draws on statistics that have been established based upon a population of *"geriatric horse[s]"*. RF describes the horses as being *"fat"*, *"too thin"*, having a *"gammy leg"*, *"dodgy joints"*, *"problems seeing"* and *"dental abnormalities"*, and showing *"abnormal moulting"*. RF switches to talking about human ageing: "*if we move from one set of animals I care about a lot, to another set of animals that I care about a lot, you'll see the problem*". He claims that the same *"symptoms"* found in the horses are also undesirable *"symptoms"* of ageing found in older people. RF shakes his head and adamantly states: *"this is NOT okay"* (his emphasis). Three key things are accomplished. First, by stating clearly that he thinks *"ageing is bad"*, RF takes a strong position *against* ageing. He does so by drawing on a story about horses, which is interesting because of public reports (see McClelland, 2014) written by animal activist charities (e.g. 'Peta' and 'Racehorse Rescue') about horses; particularly those bred for the purposes of racing that are slaughtered when they are 'no longer fit for purpose'. Second, RF reiterates the story that ageing is malleable and thus an underlying cause of age-related illness. Third, RF switches between talking about animal and human ageing in his use (once more) of animal ageing to support claims about the human.

Mykytyn (2006c) writes that persuasion plays a large part in the AASM's attempt to support and legitimate biogerontology. In addition, scientists are generally known for giving persuasive and rhetorical accounts (Hillgartner, 2000). In public, biogerontologists went to great lengths to persuade the audience of their view. At the SENS conference, a panel of biogerontologists articulated their perspective that those who do not think *"ageing is a bad thing"* and also *"a disease"* are stuck in a *"pro-ageing trance"*. This label figures biogerontologists' view that 'ageing is bad' as ultimately 'correct'. It also figures those who have not adopted this view as being 'misled'. Many biogerontologists are also adamant that ageing is a disease. In an interview, Dr Bloor, who is a biogerontologist studying the genetics of ageing in *C.Elegans* (worms), also criticises the view that ageing is not a disease:

> *"The convention is that ageing is not a disease, it's a sort of natural process, which happens to co-incidentally be associated with some horrible illnesses, so the idea is that you could get rid of the illnesses and just have ageing without the*

> *illnesses, but that's like having TB without the tubercles… You know, leave the tuberculosis "cause that's natural" and get rid of the symptoms!! [Dr Bloor laughs. She is now speaking very passionately] It's incoherent!!"*
> (Dr Bloor, Simmondsfield University, Interview)

Dr Bloor refers to the societal *"convention"* that ageing is a *"natural process"* that "*co-incidentally happens to be associated with some horrible illnesses"*. Thus, she distinguishes between her perspective that ageing is a disease and, what she figures as, the traditional convention that it is not. Dr Bloor states, drawing on metaphor to support her perspective, to "*get rid of the illnesses and just have ageing without the illnesses"* is like having *"tuberculosis without the tubercles"*. Tuberculosis (TB) is historically responsible for many deaths. By drawing on this story about a fatal disease, Dr Bloor implicitly aligns ageing with death. She gives this account on many public occasions. However, drawing on TB is interesting because of debate about whether TB stems from 'nature' or 'nurture'. There has been discussion amongst scientists about whether TB is a result of genetics, or whether it resulted from external conditions – for example, poverty (Davies and Grange, 2001).

Dr Kennedy (Countryville University) tells me that he does not understand *"people who think that ageing is natural"* because he thinks that *"categorically, ageing and death are bad"*. He looks me in the eyes and soberly says: *"I do not want to die"*. During fieldwork that I undertake at his laboratory, Dr Kennedy shows me a PowerPoint display he had previously presented at a conference. He brings to the screen a slide showing two images. The first features of group of people aged (approximately) seventy to eighty years old, and the second features a group of people aged (approximately) twenty to thirty years old. With an extremely disgruntled look upon his face, he stares at the screen, and he points to the two images:

> *Dr Kennedy: [Dr Kennedy points to the image of the older people] "This life is all we have, and we shouldn't live it like that."*
> *Sophie: "Hmmm."*
> *Dr Kennedy: "Imagine if Shangri La, the valley of no ageing, actually existed. If these guys [points to younger people] were 80 and then left the*

> *valley and saw the 80 year olds [points to older people], they would think, 'what on earth has happened to them?' I don't want to be like them! [Dr Kennedy looks very perturbed]"*

Here, Dr Kennedy clearly expresses a desire to avoid what he perceives to be the negative aspects of ageing as he points to the older group and, with disdain, says: *"this life is all we have, and we shouldn't live it like that"*. He refers to the Utopian valley of *"Shangri-La"* (the *"valley of no ageing"*) and he suggests that anybody from Shangri-La who might cast their eyes upon the older people would think: *"what on earth has happened to them? I don't want to be like them!"* As well as drawing on 'Utopia', Dr Kennedy celebrates the more active and less damaged bodies of the younger people in the picture. He is implicitly telling the 'anti-ageing' story. In addition, he projects and celebrates a mythical world of eternal youthfulness. This is a discourse that, Lafontaine (2009) argues, is present in biogerontologists discussions of 'regenerative medicine'. However, mainstream biogerontologists appear hesitant to align with stories about Utopia in more formal publications. Professor David Gems (2015: online) (who studies ageing and genetics) argues that bringing Utopia into the discussion risks *"neglecting a more modest but realisable goal: to develop preventative treatment that partially protects against ageing"*. Gems (2015) asserts in this paper, and elsewhere, (see Gems, 2011) that 'ageing is a disease'. Thus, an outright cure would, he states, be the preferred outcome. The tension between 'imagined futures' and 'material constraints' emerges here. This is not a straightforward tension, for both RF and ADG refer to human biomedical futures despite RF's accusations that SENS is *"futuristic"*.

Human Biomedical Futures: Hope, Youthfulness, and Usefulness

Some authors (Moreira and Palladino, 2009; Mykytyn, 2010a) suggest that key discoveries and texts, as 'tipping points' (Mykytyn, 2010a) in biogerontology's emergence, have played a significant role in the this emergence. Furthermore, they emphasise the importance of a speculative promise of healthy human future (see Binstock et al., 2006a; Mykytyn, 2006c; Lafontaine, 2009; Moreira and Palladino, 2009; Mykytyn, 2010a). To elaborate, certain authors explore the role of social expectations in shaping technologies and they argue that futures are created as part of convincing publics of new S&T (see Guice, 1998; Brown and Michael, 2003; Borup et

al., 2006; Hedgecoe, 2006, 2010). Across the data, biogerontologists publically draw on past and present 'realities' in order to legitimate biogerontology (e.g. Dr Bloor's comparison of ageing to TB). At the Public Debate, both ADG and RF switch between past, present, and future temporalities. Whilst the past becomes the backdrop for the negative aspects of ageing (e.g. 'old' horses' and TB epidemics), it is the 'present' research, they argue, that will positively shape the future. Novas (2006) suggests hope for a better future is strong a currency used in a biomedicine to 'buy' public/government favour. However, hope is situated in experimental laboratory research. Figure 3 depicts a mouse called 'Hope'. I was given 'Hope' at *The Mainstream Biogerontology Conference* by a company (Charles Rivers) that oversees the mass breeding and marketing of laboratory animal models. Hope the mouse is accompanied by the statement (on an attached label): *"Hope. The belief that the future will be better than the past. Hope. The voice after a fall whispering, 'try again'"*. Here, Hope (the mouse) – perhaps as the 'sacrifice' (Birke et al., 2007) - is figured as the means to a better future for humans.

Figure 3: 'Hope' the Mouse

At the Public Debate, RF draws on this story about hope. Meanwhile, he points to the slide depicted in Figure 1 (second slide). This is the slide that figures later life illnesses as subject to an underlying biological cause:

> *"This is an incredibly hopeful slide [points back to 'Summary 2', which is on a large screen behind him] because it offers the potential for preventative medicine, if you will, which would target multiple late life pathologies and impairments. It offers hope, it does not offer tablets."*
> (Professor Faragher, Public Debate, Presentation)

RF refers to the slide as a *"hopeful slide"* as he promotes the story that ageing is malleable as part of the solution for "*late life pathologies"*. RF claims biogerontology offers *"hope"* as opposed to *"tablets"*. This aligns with Novas' (2006) description of hope as 'currency'. A future world is being made here by RF. This is a world where ageing (and associated 'pathologies') is 'prevented'. Borup et al. (2006: 286) suggest development in S&T is driven forward by these "*positive promises and hopes of future capabilities"* (rather than a focus upon the past). With Gruman (2003), Binstock et al. (2006a) suggest biogerontology (as 'Anti-Ageing S&T') is the modern-day pursuit of the 'fountain of youth'. This is within the context of the biomedical model (Moreira and Palladino, 2009) at a time of biomedical dominance (Latimer, 2013b). Moreover, in the twenty-first century, prevention is arguably deemed to be a better option than cure, and regeneration, wellbeing, and enhancement are valued over 'simply' curing disease (Lafontaine, 2009).

Whilst biogerontologists draw on notions of 'cure' and 'prevention', they circulate the importance of health, youthfulness, and usefulness in a society that values productivity (Blaikie, 1999; Featherstone and Hepworth, 2005; Vincent, 2008; Latimer, 2014; Puig de la Bellacasa, 2015). As part of giving a 'TED Talk'[85] (TED Global, 2011), Professor Kenyon, drawing upon her well-known 'DAF-2' discovery, excitedly reports that there is a *"gene for ageing"*. As part of a presentation, Professor Kenyon points towards short videos that she has made of worm-based lifespan experiments (Figure 4). These images have been captured from her own laboratory research. The magnified worms slither around on the screen as she speaks:

[85]'TED Talks' (www.ted.com) are curated by 'TED' (Technology, Entertainment, and Design). Speakers from around the word are invited to speak on a topic for twenty minutes as part of live symposiums. These talks are made available to the public on the Internet.

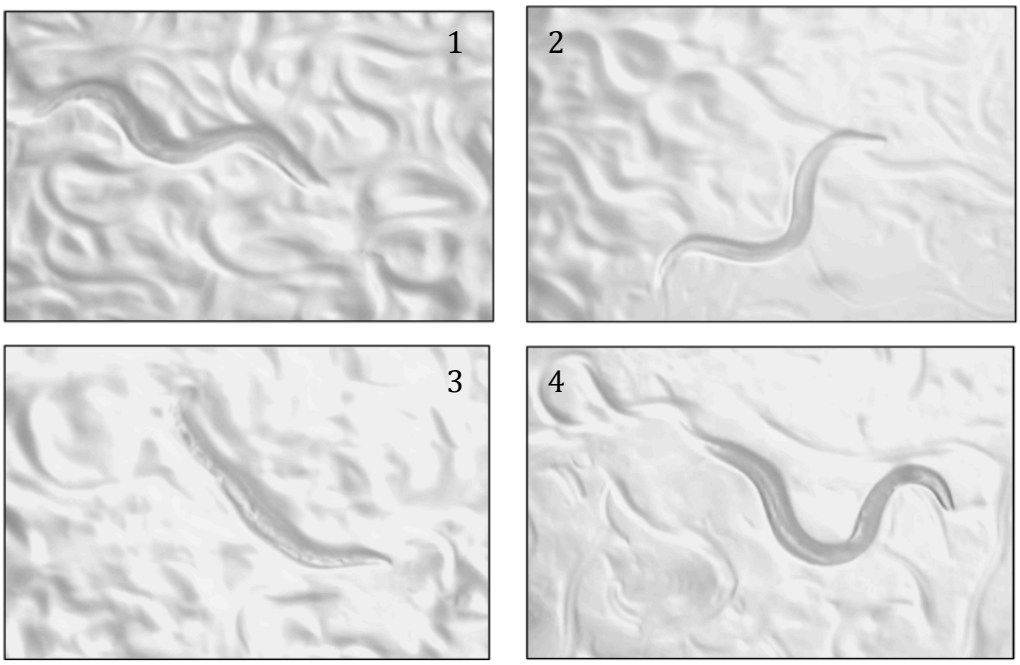
> *"[This is] the normal worm when it's about college student age, a young adult. (Figure 4, Image [1] depicts a worm quickly slithering across the screen). It's quite a cute little fellow.*
>
> *Next you're gonna see the long-lived mutant when it's young (Figure 4, Image [2] depicts a worm also quickly slithering across the screen). So this animal's gonna live twice as long. Is it miserable? [Shakes her head] It's very active, you can't tell the difference really, and they can be completely fertile, and have the same number of progeny as the normal worms do.*
>
> *Now get out your handkerchief, you're going to see in just two weeks, the normal worm's old (Figure 4, Image [3] depicts a stationary worm). You can see the little head moving down at the bottom there, but everything else is just lying there. The animal is clearly in the nursing home, and if you look at the tissues of the animal, they're starting to deteriorate. Even if you haven't seen one of these little C. Elegans… you can probably tell that they're old…*
>
> *Now here (Figure 4, Image [4] depicts a worm quickly slithering across the screen), one gene has been changed out of twenty thousand, look at it, it's the same age, but it's not in the nursing home, it's going ski-ing! So it's really cool, it's ageing more slowly."*
> (Professor Kenyon, TED Talk, TED Global, 2011)

Using these visual representations of worms (as her materials), Professor Kenyon compares two strains of worms: the 'normal' worms and the 'DAF-2 Mutant' worms. She makes a comparison between the two strains of worms at two different ages: *"young"* and *"old"*. Painting an anthropomorphic picture of youthfulness for the audience, Professor Kenyon introduces the *"normal worm"* (Figure 4, Image [1]) as a *"young adult"* (at *"college age"*) and she describes the worm as a *"cute little fellow"*. Both of these descriptors are figurative because she describes the worm as being only a few days old, and 'college' age in the US refers to an adolescent stage. Moreover, worms are hermaphrodites, yet Professor Kenyon describes the worm as a *"fellow"*.

This is ambiguous because, whilst the term 'fellow' can be used to describe a US college student, 'fellow' is also used to describe men.

Figure 4: Slides from Professor Cynthia Kenyon's TED Talk[86]

(Young Normal Worm: Top Left [1], Young Mutant Worm: Top Right [2], Old Normal Worm: Bottom Left [3], Old Mutant Worm: Bottom Right [4])



Next, Professor Kenyon introduces the young 'mutant' worm (Figure 4, Image [2]). She celebrates the mutant worm's 'great' prospects for the future because, she iterates, this worm is going to live *"twice as long"* as the normal worm. Rhetorically speaking, she asks the audience if the worm is miserable, and, as it slithers quickly across the screen in the same way that the young 'normal' worm previously did, she shakes her head. Professor Kenyon gives an account for the worm's *"mutant"* status: "*they can be completely fertile, and have the same number of progeny as the normal worms do"*. As well as projecting an image of happiness onto the young mutant worm (because of its speculative future), Professor Kenyon is drawing attention to this worm's fertility. Here, fertility - a celebrated facet of humanity and womanhood in many cultures across history (Lewin, 2009) - can be thought of (within the context of re*production* that Professor Kenyon describes) in relation usefulness and productivity. Reproduction is a key focus historically in biology (see Grene and Depew, 2004; Rose, 1997) and

[86] These images are taken from the referenced 'TED Talk' (recorded for public viewing), which has been made freely available to the public on the Internet (www.ted.com).

Professor Kenyon is implicitly reassuring the audience that the mutant worm will still be able to re*produce* (my emphasis).

Professor Kenyon proceeds to show a video of the *"old"* normal worm (Figure 4, Image [3]). I know from my time at the MWL - some MWL members draw on Kenyon's DAF-2 discovery as a starting point for their experiments - that this worm is likely to be no older than three weeks old. Professor Kenyon suggests that the audience might reach for their handkerchiefs. This implies that what she is about to describe is 'sad'. As she continues, it emerges that the worm is *"in the nursing home"* due to the physical deterioration of its bodily tissues. She says: *"you can see the little head moving down at the bottom there, but everything else is just lying there"*. The worm is stationary. It is laying there *"in the nursing home"* accomplishing nothing. Thus, the 'normal' worm is treated in this extract as a medical and biological problem in need of putting - out of the way - in the nursing home (see Latimer, 1997; 1999).

Next, Professor Kenyon shows the long-lived mutant worm. Like in the case of the long-lived normal worm (the worm in the nursing home), this long-lived mutant is likely to be no more than approximately three weeks old. As it slithers across the screen as part of the presentation, Professor Kenyon excitedly exclaims: *"it's not in the nursing home, it's going skiing!"*. Here, she celebrates the physical aspects of youthfulness. This is in terms of the physical mobility required for skiing as a leisure pursuit. She describes the difference between the long-lived mutant and long-lived normal worms. She claims that the long-lived mutant is *"ageing more slowly"*. There is an ambiguity in the way that ageing is defined here because the mutant worm is long lived, yet it shows decreased signs of physical ageing. Professor Kenyon draws on the language of CA when describing the 'older' and 'longer-lived' worms, however, she figures these long-lived, older mutant worms as youthful. She also switches between standardised (i.e. CA) and non-standardised (i.e. older, stationary, deterioration), or 'destandardised' (Moreira, 2015), understandings of ageing. Nearing the end of her presentation, Professor Kenyon switches to talking about humans:

> *"It takes two days to age as much as the normal worm ages in one day, and when I tell people about this they tend to think of maybe an 80 or 90 year old*

> *who looks really good for being 90 or 80, but it's really more like this, suppose you're a 30 year old guy, and you're a bachelor and you're dating people, and you meet someone that you really like, you get to know her and you're in a restaurant and you say, 'well how old are you?', and she says, 'I'm 60'. That's what it's like."*
> (Professor Kenyon, TED Talk, TED Global, 2011)

Professor Kenyon suggests that a common assumption is that slower biological ageing would mean an eighty or ninety year old would *"look really good"* for their age. However, she claims that what it is *"actually like"* is a sixty year old looking about thirty. In this example, there is an emphasis upon the aesthetic aspect of ageing. To further illustrate her point, Professor Kenyon asks the audience to imagine a thirty-year-old bachelor on a date. This is a very Western story (much like skiing and going to college). She creates a youthful, romantic scenario that is more appealing than the 'nursing home'. This enacts a disposal of older people (like the racehorses), and the qualities that they possess, in favour of younger people and a youthful, 'productive' lifestyle (Featherstone and Hepworth, 2005). Vincent (2008), Latimer et al. (2011), and Latimer (2014; 2015) highlight that biogerontologists' language in these types of public settings is critical because it shapes society's discourse/s. Furthermore, the data shows that Professor Kenyon's language circulates the discourse of anti-ageing/ageism that these authors warn against. Elsewhere, Latimer (2015) argues that these types of values uphold a neo-liberal agenda that disempowers older people. In addition, Latimer (2014) examines the language used in biogerontologists' public presentations. She highlights anti-ageing rhetoric and a simplistic, 'glib' delivery of this rhetoric (e.g. referring to hermaphrodite worms as 'he' or 'she'). This 'glib', and often banal, tone was present across public biogerontology.

Playing God?: Ethics, Audience Participation, and Switching Concerns

Several authors (Binstock et al., 2006a; Mykytyn, 2006c; Fishman et al., 2008; Mykytyn, 2010a) claim that the ethical plays a key part in biogerontologists' public accounts. I have previously referred to ADG's and RF's claim that biogerontology is *"morally desirable"* and this is a story present across multiple publications, conference presentations, and media appearances. In a 'Channel 4' documentary ('Do You Want to

Live Forever?', 2007), ADG reiterates the importance of defeating ageing in order to alleviate suffering. Elsewhere, Gems (2011; 2015), with ADG, argues that any perceived ethical issues that are used to critique biogerontology can be thought of as 'vampires'. Gems (2015: online) argues: *"we must draw aside the rosy veil of tradition and face ageing for what it is, and in all its horror: the greatest disease of them all"*. In the Channel 4 documentary, ADG draws on this same discourse of horror when asked about what his response would be to someone who is concerned about the potential for global overpopulation in light of life extension:

> *"It's an important question… ultimately it's a matter of choice… do we want to continue our youthful lives as the people who are already alive, or do we want to have a turnover of people dying, and of course, not just dying, but dying rather horribly - because ageing, let's face it, isn't very much fun – and being replaced by people who are being born."*
> (Dr de Grey, 'Do You Want to Live Forever?', Channel 4 Documentary, 2007)

ADG says suggests a *"choice"* about whether to die or not, yet he is in favour of avoiding *"dying rather horribly"* in favour of the preservation of youth. The documentary frames ADG as the 'spearhead' of the quest to 'save humanity' from these horrors; a position that parallels one of the key stories that Mykytyn (2006c) found when she spoke with 'anti-ageing' practitioners. Questions like the one described above however, arise in direct response to the imagined futures that biogerontologists themselves project. Elsewhere in the documentary ADG proposes a hypothetical solution, where any person who wishes to have a child must promise to die. A statement such as this, communicated through the medium of a television programme, fails to leave space for public/s to challenge it. Elsewhere however, public engagement events carve out limited space for audience members to respond. Whilst dialogue between biogerontologists and the public arguably follows an asymmetric 'top down' model (Miller, 2001), the designated 'question times' (often between ten and twenty minutes long) at conferences/public events provide space for audience members to comment. Here, audience members and/or delegates ask biogerontologists 'big questions'. These are questions that emerge in response to biogerontologists' challenge to taken-for-granted understandings of ageing.

At the Public Debate between ADG and RF, the short question and answer time of about twenty minutes gives rise to a plethora of raised hands. Audience questions cover the feasibility of 'curing ageing' in relation to what RF and ADG have explained about ageing being malleable, pathological, and a site for prevention, intervention and/or cure. In particular, there was much interest from the audience regarding ADG's assertion that, theoretically, it is possible to restore humans in the same way that one might *"restore a vintage car"*. This was received as controversial amongst those who were familiar with what is known as the 'Hayflick Limit' (Hayflick, 1994), which is a theory that poses an unavoidable limit to life-extension. This is as opposed to the limitless life extension that ADG forwards. Part of ADG's theory involves an anti-cancer programme that he calls 'WILT'[87]. Here, an audience member derisively describes WILT as being *"unrealistic"*, and the crowd murmurs in response. RF vigorously nods his head in agreement with this murmur, and he interjects. RF likens WILT's feasibility to that of *"seeing the Lochness Monster"*. Everybody laughs. ADG says, sarcastically, that whilst it may *"sound unrealistic [at this point], so do most science ideas before they happen"*.

Turner (2009) suggests it is the socio-cultural implications of extending life that are of key importance in addressing the future of life extending S&T. Common audience questions echo the nature of the issues raised by Turner (2009). For example, Turner (2009) asks: 'What will be the implications for relationships between people who are physically 'young' looking, but chronologically 'old', and how would radical life-extension impact marriage, families, religion, and work?' (my paraphrasing). A number of biogerontologist responses to this kind of questioning/critique downplay the possibility that biogerontology's core aims will be fruitful enough to allow for such widespread social change to occur. In public, mainstream biogerontologists were quick to iterate that biogerontology might only improve healthy lifespan through decelerated ageing to the point where fifty healthy years are added to current lifespan. Thus, they argue, there should be little concern that their research is problematic. Biogerontologists disposed of concerns in light of ethics-based arguments. For example, it was claimed

[87] 'WILT' is part of the 'seven deadly things', which I unpack later in the current chapter. WILT stands for Whole-Body Interdiction of Lengthening of Telomeres. It is based on the premise that telomeres, which maintain a chromosome at its proper length in the cell replication process (like the protective bit at the end of a shoe-lace), deplete over time (Wall, 2010). ADG points out in his explication of the theory that cancer rapidly renews the telomeres to support its rapid growth. WILT involves removing from the body genes that facilitate this renewing of telomeres. Thus, WILT is invasive and needs to be carried out every ten years so that the body can still continue to function (www.fightingageing.org).

that despite potential changes to the social order, these changes are not good reasons to not pursue the core goals of biogerontology. This argument is presented by biogerontologists on account of the immorality of allowing suffering to occur at the hand of ageing.

Such responses are given at the Public Debate by biogerontologists. As the debate unfolds, RF asserts that one need not worry about living until the age of one thousand because that idea is *"science fiction"*. However, ADG makes an ethical appeal several times. There is significant ambiguity here however, as some mainstream biogerontologists, such as Gems (2011; 2015), and also RF, have offered both of these responses. At times this is as part of a single instance of account-giving. Across the data, biogerontologists make similar switches between their perspectives in their accounts. This is often complex, as biogerontologists draw - often going back and forth - from multiple discourses as part of seeking legitimacy. One such occasion unfolds at the *The Living Longer Conference*. An audience member doubts ADG's approach to ageing because of potential implications for the sustainability of the planet. In a talk he gives that evening, ADG asserts that there are *"no limits to longevity"* (ADG). Consequently, a perturbed audience member asks ADG (drawing on a 'Malthusian argument'[88]) about SENS in relation to the earth's resources:

> *Audience Member: "In terms of a growing population, do you see the side effects of longer life as compatible with the sustainability of the planet or do you see it as irrelevant?"*
>
> *ADG: "I do think that its very important that we should maintain the global population at a stable level that is sustainable, but of course the level that is sustainable will change over time as technology is developed that allows more humans to be packed in with an unchanged quality of life… even if we make the pessimistic assumption that there is a fixed number of people that can exist on the planet and technology doesn't change that number, we still have the choice between a high death rate*

[88] Thomas Robert Malthus wrote an essay 1798 claiming that the number of resources required to sustain a population increased in direct proportion to the number of people of the population. This has become known as the 'Malthusian Argument'.

> *or a high birth rate. At the moment we have a high death rate, and two thirds of those deaths are from ageing, and in the western world, about ninety per cent of deaths are due to ageing, so it's clearly humanity's worst problem. If we develop therapies that can fix that problem then its certainly the case that in the very long term there will be the need to bring the birth rate down to something comparable to the new reduced death rate to avoid continued global population increase."*

In response to the audience member's question about the compatibility of SENS' *"side effects"* with the *"sustainability of the planet"*, ADG says that it is important to "*maintain the global population at a stable level that is sustainable"*. He continues by drawing on a future imaginary; a future where S&T advancements facilitate "*more humans to be packed in with an unchanged quality of life"*. Drawing on the same notion of choice that he articulates in the Channel 4 documentary, ADG also proposes a 'solution'. This is to engineer a decrease in the birth rate so as to match the lowered death rate that might be a side effect of fixing ageing as *"humanity's worst problem"*. Whilst the audience member is clearly concerned for the whole earth, ADG returns to a focus upon humanity and human ageing. In an earlier statement made during this conference presentation, ADG likens SENS to the 'Good Samaritan' (see chapter seven). This Biblical parable draws on the compassion of the Samaritan, and by likening himself to the Samaritan, ADG implies that he is compassionately 'saving' humanity. Despite this 'concern' (Puig de la Bellacasa, 2011; Latimer and Puig de la Bellacasa, 2013) for humanity, ADG goes on to express less concern for humanity (and in particular for *future* humanity) in the following statement:

> *"One thing that I have to point out is that above this question is the issue of people who haven't been born yet, people who haven't been conceived yet. Now surely we can say that everybody that has been born has equal human rights, but when it comes to children that have not been conceived, it's pretty obvious that we have voted with our feet that they don't matter very much. When someone challenges me on this, my typical answer is to ask three questions. I say "how many children have you got?" and they'll say like "one" and I'll say "how many children could you have had by now if you had put your mind to*

> *it?", and this answer is of course larger. The third question I ask is "how dare you deprive all those hypothetical people of life?" So we're already doing exactly that already, it's clear that from a moral perspective we have come to the decision that future un-conceived people don't matter much."*
> (Dr de Grey, Living Longer Conference, Presentation)

Here, ADG ascribes a lower value to people yet to be born in relation to people already living on the earth, or the 'living now'. In this account, ADG takes the perspective that children that have not yet been conceived (*"hypothetical children")* do not matter very much because *"we've"* (he speaks for society) chosen to have a smaller number of children that *we* could have, a point which he explicates through the use of rhetorical questions concerning how many children particular people *could* have had during a reproductive lifetime. He shares his *"three questions"* with the audience, making a direct alignment between one's choice to use contraception and one's choice to not save space on the planet for future generations of humanity. By making himself a representative of society through his persistent use of the word *"we",* ADG confirms the view that "*we have come to the decision that future un-conceived people don't matter much"*. This account contradicts previous statements that he has made about having compassion for humanity, as he attempts to (what he refers to as) 'save' it through his research programme, SENS. When examined in light of these contradictory accounts, ADG's compassion for humanity seems conditional.

ADG faces here what Parfit (1984) (who studied 'transbemanism'[89]) termed the 'repugnant conclusion', a particular kind of moral dilemma that occurs where two opposing and equally undesirable options present themselves: 1) a situation in which there are smaller number of very happy people, and 2) a situation where a larger number of people exist in just about tolerable conditions. Parfit (1984) suggests taking a more context specific approach in order to avoid such a situation. This is an approach that differs significantly from what Parfit (1984) calls the 'non identity' approach that ADG has taken here. ADG's approach switches the focus from talk of future generations to talk of care, or concern, for humanity in the here and now. ADG seems to take an

[89]Transbemanism is an approach/movement that seeks (theoretically speaking) to upload consciousness to a computer in order to preserve it for re-downloading in a future era. 'Transbemans' would, thus, become immortal because the body would no longer be 'biological'.

extreme view, which is why he has been referred to as 'radical' by some authors (e.g. Binstock et al., 2006a; Fishman et al., 2008). Because ADG's accounts do not always align with one another, it might be suggested that he is doing work to justify SENS and his perspective here, rather than carefully considering questions that he is asked. At *The Older Person's Conference,* Dr Tucker makes similar assertions to ADG. I was initially more disconcerted by Dr Tucker's claims because I had categorised Dr Tucker, who is not in the public eye, as more conservative in his approach compared with many other biogerontologists:

> *Dr Tucker: "What are your concerns about the field?"*
> *Sophie: "I have an interest in the ecological implications of the field."*
> *[Dr Tucker laughs dismissively]*
> *Sophie: "What about the availability of resources?"*
> *Dr Tucker: "Data shows that the population is stabilising, and anyway, sterilisation would always be an option if there was an issue."*
> *Sophie: "What about the right to have children?"*
> *Dr Tucker: "Since when has it been a right to have children?"*
> *Sophie: "What about the enjoyment of having children?"*
> *[Dr Tucker laughs dismissively again]*
> *Dr Tucker: "When has pleasure ever come into it?"*

I express my concern for the planet[90], and Dr Tucker (similarly to ADG) accounts for a *"stabilising"* birth rate, drawing on generalised and anonymous *"data"*. Dr Tucker brashly asserts: *"sterilisation…would always be an option if there was a [population] issue"*. I struggle to suppress my annoyance. I challenge his perspective, yet he denies a *"right to have children"*. I challenge him again, and I become increasingly frustrated as he tells me that *"enjoyment"* does not come into this story. I cannot tell whether he is being facetious or flippant as he gives this account, which offers the same story that ADG professes to the public about controlling conception. This approach, that forwards an almost 'God-like' (Evans, 2002) approach to 'choosing' about life and death, subverts biology's focus on reproduction (Grene and Depew, 2004). It also contradicts an evolutionary approach in biogerontology that favours the 'passing on' of DNA

[90] This encounter occurred early on in my study. Since gaining more experience as a researcher, I have learned that it is best to maintain neutrality as part of interaction.

(Kirkwood, 1999). Dr Tucker works in a small laboratory, and he is not known for making polemic statements like the one he makes at *The Older Person's Conference*. I find out after this encounter that he has several children. I can only suggest that Dr Tucker is trying to make a point.

The way that biogerontologists appear to be pulled in extreme positions might be attributed to the pursuit for credibility and also to the way that particular arguments appear to be an established aspect of the public field. Evans asserts:

> *"The professionals who debate this topic are not so free. They are operating with a very constrained list of universal, commensurable ends that have become institutionalised by the dominant profession in the debate."*
> (Evans, 2002: 11)

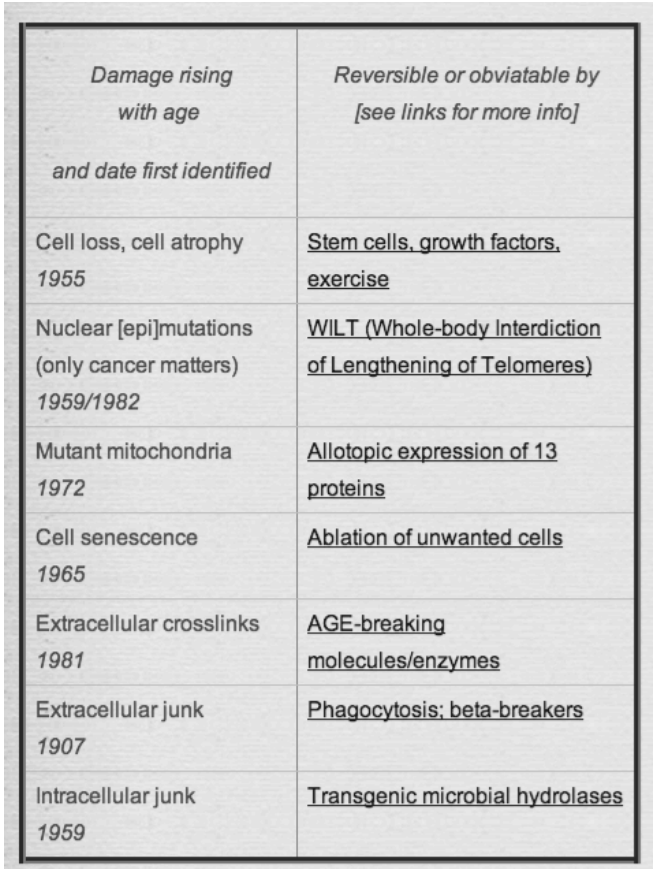
Alongside the banal and contradictory way that biogerontologists answer questions from the public (disposing of these 'big questions'), the data supports Evans' (2002) suggestion that deep and meaningful – or 'slow' (Stengers, 2013) - debate about sciences *ends*; the type of debate once encouraged by theologians and philosophers, has been replaced by the kind of 'rational argumentation' about sciences' *means* that, Evans (2002) highlights, is employed by the modern Bioethics tradition.

SENS' 'Seven Deadly Things': Threatening Life and/or Science

The Public Debate began with agreement between RF and ADG. There is a growing sense of discord, and great anticipation however, as ADG takes the microphone from RF to explain what he perceives are their 'points of disagreement'. ADG explains to the audience that within his research programme, SENS - which is based on a theory of his own formulation - figures seven types of reversible, cumulative damage. ADG calls these the *"seven deadly things"*. As he proceeds through the list I recognise each of these 'things' from the Channel 4 documentary that he appeared in. A written table, which is also used to present these 'seven deadly things' (Figure 5), appears in an online journal called the 'Rational Argumentator'. The table refers to: 1) each type of damage, 2) when each type was discovered, and 3) how each of these could potentially, according to SENS, be stopped/reversed. In the table, each of the seven types of damage

supposedly caused by the *"complications"* of *"metabolism"* (ADG) (issues that SENS plans to address separately as the *causes* of ageing) are shown: 1)*"Cell Loss/Cell Atrophy"*, 2)*"Nuclear (Epi)Mutations"*, 3)*"Mutant Mitochondria"*, 4)*"Cell Senescence"*, 5)*"Extracellular Crosslinks"*, 6)*"Extracellular Junk"*, and 7)*"Intracellular Junk"*. SENS claims that each of these damage-types needs to be *"combatted"* (ADG) in order to repair the physical damage in human bodies. Whilst ADG does not unpack such issues in detail at the Public Debate, I have been able to read about these discussions elsewhere. Accordingly, I have drawn here on an interview held between Weiner (2010: 15) and ADG to aid me in the task of describing and explicating 'the seven deadly things' in detail in the next paragraph. The appearance of the chart, as well as the 'closed' and/or settled nature of each of the seven 'things', is important to bear in mind when examining why RF does not agree with SENS.

Figure 5: "The Seven Deadly Things"[91]



Damage rising with age and date first identified	*Reversible or obviatable by [see links for more info]*
Cell loss, cell atrophy *1955*	Stem cells, growth factors, exercise
Nuclear [epi]mutations (only cancer matters) *1959/1982*	WILT (Whole-body Interdiction of Lengthening of Telomeres)
Mutant mitochondria *1972*	Allotopic expression of 13 proteins
Cell senescence *1965*	Ablation of unwanted cells
Extracellular crosslinks *1981*	AGE-breaking molecules/enzymes
Extracellular junk *1907*	Phagocytosis; beta-breakers
Intracellular junk *1959*	Transgenic microbial hydrolases

[91]Online article – made freely available here: http://rationalargumentator.com/issue24/indefinitelife2.html

The first deadly thing - *"cell loss"* - describes the notion that as we get older, our cells die and release toxins, a process which in turn leads to an overall decline in function. Proposed treatment methods include broad categories of activity such as exercise, alongside more complex stem cell replacement treatments intended to boost the immune system. The second deadly thing is described as *"mutations"* in the nucleus of genes, which causes what we commonly understand to be cancer. The proposed treatment for this 'thing' is *"Whole Body Interdiction of Lengthening of Telomeres"* (WILT), a process/treatment which entails removing the enzyme 'telomerase' from every cell in the affected body. Telomerase is the substance that replenishes the end of telomeres in cells as they replicate. Telomerase depletes over time, and gradual depletion is what ADG claims causes the physical signs of ageing. The third deadly thing is described as *"mutant mitochondria"*. These mutant forms that are to be targeted, ADG claims, consist in corruptions to the mitochondrial DNA as objects essential to the process of providing each cell with energy. Such mutations, ADG claims, can cause serious diseases in major organs. ADG proposes that a cell's mitochondrial DNA might be instead transferred to its nucleus, away from where all the *"hot"* energy is created. The fourth deadly thing is *"cell senescence"*, which ADG claims is a process by which cells become less active as a person gets older, and, he claims, this can be fixed by the *"ablation"* of these cells. The fifth deadly thing is *"extracellular crosslinks"*, objects which - chemically speaking – are classified as sugars, and which are thought to act as 'links' between cells, stiffening collagen in the skin and giving the appearance of wrinkles. ADG poses that these crosslinks constitute one of the most basic types of damage, and he asserts that these particular sugars can be 'broken' down by dissolving them – without damaging the cells – with a highly specialised solvent. The sixth deadly thing is *"extracellular junk"*, which is excess material that accumulates on the outside of cells in the body, causing things like heart disease and strokes. This is to be addressed, ADG contends, by encouraging the development of a more efficient immune system. The seventh (and final) deadly thing is *"intracellular junk"*, which is the junk that accumulates inside cells. This is, according to ADG, to be treated by getting each cell's *"junk disposal system"* to run more efficiently, which in turn, he argues, would lead to a decrease in many degenerative, brain-based illnesses.

Allowing ADG to both operationalise 'anti-ageing' language (Vincent, 2008; Latimer et al., 2011) (i.e. 'deadly', 'junk', 'dispose', 'senescence', 'ablation') and to simultaneously reinforce a particular story about 'usefulness' by talking about the body primarily in terms of efficiency, the 'seven deadly things' appear as particularly interesting discursive objects here because even though ADG talks about them as if they are certain, I know that many of these defined 'things' are greatly contested. I know for example from my time at Butefield University, where I studied WS cells with Dr Tucker and Professor Cadbury, that the theory of *"Cell Senescence"* is still unsettled. Furthermore, ADG explains to Weiner (2010: 155):

> *"With less that than ten million dollars and within five years, or certainly ten years, I could make mice that did not have any mitochondrial DNA… if we did that and nothing else, it could be that they'd live just a bit longer. But I don't care. It's a candidate mechanism, so let's fix it… if there's only seven things to fix, then we damn well should."*
> (Dr de Grey, Interview with Weiner, 2010)

Here, drawing on the example of *"mutant mitochondria",* ADG claims that he will be able to successfully implement his ideas once enough money has been raised. Even though he, for the most part, speaks with certainty about the 'seven deadly things', elsewhere in this interview he refers to *"WILT"* as the *"weak link"* (ADG). This, he suggests, is because WILT will be the most difficult 'idea' to implement, with the treatment involving the introduction of new stem cells into the body every ten years. WILT represents a particularly invasive and expensive course of action. It is this 'thing' that is directly questioned by an audience member at the Public Debate. ADG admits in the interview that WILT would take *"substantial justification"*. It becomes clear at the Public Debate that it is the decided, or 'closed', nature of these seven ideas, or 'things', that is of most concern to mainstream biogerontologists, who place great value upon the traditional scientific method and the exercise of 'good science'.

Public Concerns: Good Science vs. Bad Science

Whilst SENS is an independent research body (rather than a university/government research body), 'mainstream' biogerontology research is undertaken predominantly at

universities and related academic institutions (see chapter two). Mainstream biogerontologists (like RF) argue that ADG's approach to studying the mechanisms of ageing is 'closed'. RF argues that, instead, the 'norms' of science facilitate an 'open' approach. Merton[92] (1942) describes the four 'norms' of science: 'universalism', 'communism', 'disinterestedness', and 'organised scepticism'. ADG has not yielded a significant set of 'results', but rather he has articulated an overarching 'theory' of ageing ('Seven Deadly Things'). Furthermore, ADG circulates a strong value system and given that he publishes his written publications in his own journal rather than the mainstream academic journals (e.g. Cell, Nature), arguably, he does not partake in biogerontology's 'organised scepticism'. Within the context of the empirical aspect of scientific method, Popper (1963) argues that scientific hypotheses require testing, followed by scientists deciding, based upon experiment, whether to 'accept' or 'refute' a given hypothesis. SENS' approach appears not to adhere to this way of 'doing' science because ADG gives the impression that he has already accepted his hypothesis before carrying out the relevant research. Following ADG's description of SENS' research programme, RF, who circulates what he believes to be the core values of science, takes the microphone and firmly reminds ADG (and the audience) that *"science is a progress report, nothing more"*. I can see that RF is getting angry at what he is hearing from ADG. RF accuses ADG of being an *"overenthusiastic futurist"*. RF proceeds to give an account for his unfavourable perspective of SENS:

> *"Okay, a question, and one that those of us who are used to trying to interface between science funding and lab based stuff will understand as this. Do you do SENS or do you do a fundamental ageing research programme? I speak as somebody who did a PhD at the bench, which Aubrey did not, I speak as somebody who runs a research group, which Aubrey has not done, and I speak as somebody who was responsible for co-directing thirty-five projects in the UK, for an ageing research programme that I ultimately had to report to government. I don't know WHO [his emphasis] Aubrey reports to, God alone I suspect. The real problem goes like this. SENS and ageing research programmes both make suggestions for avenues of research. Which one is best?*

[92] 'Classic' STS – 'the first wave' (Collins and Evans, 2002) – is valuable in analysing the characterisics of science because it is pre-critical as part of a clear description of the foundations of science/method. This grouping of literature has helped to constitute a solid understanding of science (e.g. Popper's notion of 'falsification').

> *SENS is closed. You know, it's not good to say, 'my views haven't changed' [said in a mocking, cavalier voice] since 1982. It assumes that the primary causes of ageing are known, and that the job now is just to fill in the gaps by something half way between scientific research and acts of worship; between where we are and where we need to be. Ageing research programmes and scientific research programmes in general are open, they treat our knowledge of biology as provisional and incomplete, because that's what science is, and it is the better and more practical option… SENS assumes it already has the answers. I do not think that that is the case. For me to prove Aubrey wrong about SENS, I only have to be lucky once. For Aubrey to prove me wrong about SENS, Aubrey has to be lucky all the time. All of his predictions have to be right."*
>
> (Professor Faragher, Public Debate, Presentation)

In this extract, RF constitutes two research categories: 1) SENS, and 2) a *"fundamental ageing research programme"* (RF). The second category refers to RF's own approach, which (apparently) involves progressively testing hypotheses in the laboratory setting. Across the data, ADG does not refer in his public accounts to any particular laboratory experiment that have been carried out as part of SENS. RF articulates (on several public occasions) his own research exploring 'cellular ageing' (similarly to Dr Tucker and Professor Cadbury).

Furthermore, in the extract, RF highlights to the audience that he *"did a PhD at the bench"*, that he *"runs a research group"*, and that he is *"somebody who is responsible for co-directing 35 projects in the UK for an ageing research programme"*. In doing so, he performs the identity of a 'proper' and 'prestigious' scientist. RF is sure to remind the audience of the 'fact' that ADG has done none of the things he describes in this account, and he emphasises at a later point in the presentation that ADG's disciplinary 'background' is computer science and not biology. This 'degradation ceremony' (Garfinkel, 1956) downgrades ADG to a lower status and it also affirms the perspective that mainstream biogerontology is credible. Furthermore, RF asserts (speaking for all of science): "*ageing research programmes and scientific research programmes in general are open…provisional and incomplete…because that's what science is"*. RF argues that

if SENS - being a closed and complete theory - is proved wrong, then the whole of SENS would be rendered invalid. This is not, he argues, 'good science'. Throughout this lengthy account, RF thus figures mainstream biogerontology as 'good science' and in turn he figures SENS as 'non-science', as 'impurity' - what Douglas (1966) describes as 'dirt' and as 'bad science'.

RF's criticisms of ADG attack ADG's *"futuristic visions"* (RF) - I cannot help but think about ADG's claim about the first person to live until they are one thousand already being sixty - for RF argues these these 'visions' are not grounded in laboratory setting, nor empirical data. At a later point in the Public Debate, RF draws a parallel between ADG's claims of 'no limits' to lifespan to *"drawings in ancient caves of transport devices"* (RF). However, RF is not averse to incorporating science fiction stories into his arguments. At *The Ageing Research Conference*, in a particularly enthusiastic attempt to persuade the audience of biogerontology's proposed 'healthy future', RF opens with an extract from a science fiction novel in order to illustrate his point.

ADG 'fights back' at the Public Debate, arguing that the 'mainstream' (he stares at RF at this point) are vague and/or conservative in their estimations of, and public statements about, what biogerontology is likely to achieve. ADG appears notably concerned that these conservative claims will deter potential funding bodies looking for a 'cure' for ageing (rather than merely adding an extra few years to the end of human lifespan). The debate exemplifies authors' contentions that legitimacy is a central focus in biogerontology. Moreover, Fishman et al. (2008) assert that legitimacy is the key driving force behind boundary work in biogerontology and the AASM (Mykytyn, 2006c). Rather than policing the borders in order to distance science and medicine from 'quackery' (Fishman et al. 2008) (which includes unregulated 'pills and potions'), the data shows that 'purification' of biogerontology (in terms of 'good' and 'bad' science) itself is a key enactment. There is ambiguity here because both RF and ADG claim to represent biogerontology. ADG, who is said to play in public the role of the *"persecuted avant garde"* (Vincent, 2008: 332), is widely critiqued by the 'mainstream' in published academic journals. Approximately thirty self-proclaimed 'mainstream' biogerontologists published a letter in a prestigious journal stating a desire not to be

associated with ADG or SENS (see Warner et al., 2005). Dr Bloor, during an interview, clearly distances her research from ADG and SENS, calling SENS *"poor science"* (Dr Bloor). This is a story that I hear many times over. Thus accounts of 'good science' - and subsequently 'good biogerontology' – emerge as the primary 'matter of concern' (Puig de la Bellacasa, 2011) in this public sphere. By the end of the Public Debate, RF and ADG are both seething. The student representative requests a show of hands to determine which biogerontologist 'wins'. A handful of people raise their hand for ADG. The remaining hands rise for RF, and he smiles triumphantly. He has persuaded the crowd. The mainstream - or to draw on ADG's term, the *"top brass biogerontologists"* - have won.

Summary

In this chapter, which was organised around the Public Debate between ADG and RF, I examined 'Public Biogerontology'. Following Binstock et al. (2006a), Fishman et al., (2008), and Mykytyn (2006c), I show that, alongside figuring ageing as *"malleable"*, biogerontologists – who spoke as if they have created a new 'paradigm' (Kuhn, 1962) – used the public setting as a platform upon which to build credibility and/or legitimation as part of this 'mainstream'/'left-of-field' debate. Where biogerontologists refer to the field's key findings, the substance of the debate is value-laden, with biogerontologists asserting strong opinions and performing biogerontological identities. Furthermore, following Vincent (2008), Latimer et al., (2011), and Latimer (2014), I demonstrated that 'anti-ageing' language and/or rhetoric was used by biogerontologists (drawn on as part of gaining credibility). In addition to categorising ageing as 'bad', biogerontologists circulated a value for both 'youthfulness' and 'usefulness' in society (Latimer et al., 2011) - particularly as part of 'human biomedical futures'.

In this public setting, biogerontologists engaged with future world-making practices as part of attempts to enrol the public. The paradox between (what I refer to as) the 'laboratory present' and 'human biomedical futures' emerged. Alongside switching between these temporalities, biogerontologists also made switches between different definitions of ageing (e.g. the biological, the chronological) and between varying ethical 'concerns' (Puig de la Bellacasa, 2011). Biogerontologists referred to a 'moral imperative' to pursue biogerontological goals. Furthermore, (what I refer to as) the 'ethics story' was integral to biogerontologists' public accounts, as biogerontologists

aimed to persuade audiences of the benefits of slowing and/or stopping ageing. However, the public setting emerged as a space for biogerontologists' switching 'ethical' concerns, as ADG expresses concern for all of humanity, but also a distinct lack of concern for future humanity yet to be born. Whilst audience members asked (what I refer to as) 'big questions' about ageing and life on earth, these questions were disposed of by these contradictory and banal accounts.

As the Public Debate progressed, the nature of 'science' itself emerged as central to what was being debated by ADG and RF. RF downgraded ADG's 'closed' approach to science; thus 'downgrading' the left-of-field to 'bad science' in relation to the mainstream's (the victors of this Public Debate) 'good science'. I reiterate that the purity of science emerged as the primary 'matter of concern' (Puig de la Bellacasa, 2011). Whilst care is verbally expressed in the public setting (for example, ADG's 'compassion' for humanity), there is an absence of care as 'practice' (see chapter one). Furthermore, data yielded from this public setting notably lacks the 'fleshiness' (Latimer and Puig de la Bellacasa, 2013) of the 'laboratory present' that I proceed to explore in the next chapter.

Chapter Five

'Simply Genetics': A Tale of Two Laboratories

Introduction

After exploring Public Biogerontology in the previous chapter, I now explore the day-to-day life of the biogerontology laboratory. I begin by offering a rich description of the socio-spatial layout of two laboratories at which I spent time as a participant observer: Metrotown University and Countryville University. By way of examining the accomplishment of biogerontology, I explore day-to-day laboratory routines, alongside biogerontologists' classificatory systems, which includes the laboratories' division/s of labour. I also illuminate the relations between biogerontologists and their materials, which includes animal model organisms. The chapter captures biogerontologists' 'world of genetics', including the way that ageing is 'geneticised' in this space as researchers prepare for and conduct 'lifespan experiments'. These lifespan – and other – experiments are discussed in more detail in chapter six, however, much of the current chapter serves as an introduction to the mundane 'doings' of the experimental environment. I draw from ethnographic material collected at both universities. After initially describing each laboratory separately, I mainly draw from data collected from each as a unified dataset. I maintain awareness that the two local sub-sites are not disconnected from 'global' biogerontology (see chapters one and three), as these local contexts are deeply embedded in the global context, constituting the global and also being constituted by it. The two laboratories are very ordinary *"basic biology"* laboratories, to use RF's term (see chapter four), where members study ageing and genetics using model organisms (flies and worms). The chapter captures the mundane routines of the laboratory, alongside exploring biogerontologists' cares/concerns, which builds upon the previous chapter (chapter four). In addition, the analysis that follows provides a descriptive and analytical foundation for the analytical chapters that follow it (chapters six and seven).

Metrotown University's Biogerontology Laboratory

The MHAI is on the third floor of Metrotown University's biology building. To access the institute, I traverse heavyweight security barriers at the entrance to the building on the ground floor. Ariel (PD researcher) collects me from the entrance. Carrying a note containing Professor Hurst's (MWL laboratory head) approval for my visit, I successfully petition the centre manager for a keycard that allows me free access to the building. Every day, I take a lift up to the third floor of the building and, using my temporary visitors' keycard, which I am told must be kept very safe and returned at the end of my stay, I enter the MHAI through its large glass doors. Upon entry to the building, I first encounter the common room, which has an attached kitchen. Ariel tells me enthusiastically that the common room is a place for both formal meetings at which scientists present their work, and informal gatherings at which all members socialise. To the right of the common room, there is a long, open-plan laboratory comprising eight side-by-side bays. Each bay is about four metres long and two metres wide. I am based mainly at the MWL, known as the 'worms lab', and the MWL researchers work in the second and third bay. The remaining six bays house researchers from the 'Metrotown Fruit-Fly Laboratory' (MFL) and the 'Metrotown Yeast Laboratory' (MYL). Some bays are used for storing specialist equipment shared between all three laboratories. To the left of the common room, there is an enclosed laboratory space used by the MFL. Each laboratory is run separately. Whilst I am based at the MWL, I also spend time at the MFL. However, I only describe the MWL in depth.

Offices run the length of the laboratory space, and these are separated from the bays by a two-metre corridor, which I use daily to either access the offices of MWL researchers (on the left), or the bays occupied by MWL researchers (on the right). There are four offices that are occupied by lecturers (one lecturer per office room), and there are two offices occupied by PD researchers (between two and four PD researchers in each room). The PhD and Masters students share a larger office, which is situated by the common room. Professor Hurst is the head of the MWL and also a Professor of Biogerontology. When he is not lecturing, he works in his office (deskside) planning experiments, putting funding applications together, meeting students/researchers, and marking papers – amongst other things. Aside from Professor Hurst, who does not work at the bench (benchside), each MWL researcher has both an office space and a bench

space assigned to them. Whilst the laboratory space is open and shared with researchers from the MFL and the MYL, the office spaces are enclosed and act as a border between lecturers and those working at the bench. Because of the open plan layout, where three laboratories work in one open laboratory space, laboratory names (i.e. MWL, MFL, MYL) refer to groups of researchers rather than a physical space, which I found confusing to begin with.

Each individual bay in the laboratory space has a high bench running around it, in a 'U' shape. There are shelves above each bench housing a mixture of items (e.g. boxes, trays, vials, bottles, pipettes, syringes, bungs, gloves, plates and racks). Many of the boxes are grouped according to colour (including blues, reds, yellows). There are many different things in each box – some contain papers, some contain equipment, and some contain a mixture of both. As I gaze at the shelves, which are overflowing with these boxes, Hannah (MWL laboratory technician) assures me that they are in order. She explains to me that she is in charge of keeping the laboratory tidy and that she groups boxes according to colour for aesthetic purposes. There are labels on the boxes that say things such as *"surgical blade removers", "transit box", "microscope and injections – Joanne", "5ml Tips", "magnetic stir plate", "vacuum pump bungs",* and *"dolphin stocks*". Whilst some are empty, most of the vials and bottles - which are labeled with the names of a chemical and researcher (e.g. *"HCI – KATE"*)[93] - have clear liquid in. At the end of each U-shaped bay is a window running the length of the laboratory space, which is on the right as one looks down the length of the laboratory from the common room. On the wall next to these windows are magnified images of worms on A4 sheets of paper. There is another layer of shelves - slightly higher than the other shelves in the room - that runs the length of the bay above the window. They are stacked with brown boxes with barcode stickers on them.

I am told that I can use one of the seats at the MWL's bench - a seat next to the corridor - as my own space. This is Kate's (PD Researcher) seat, but she assures me that because she is writing a paper, she has no need to sit at the bench at the moment, but will instead be in her office space that she shares with Ariel. There is a sink at the end of the bay next to my bench space. Opposite my bench space, there are unused, broken fridges.

[93] HCI is the chemical abbreviation for Hydrochloric Acid.

Jackson (PD researcher) rolls his eyes when I mention the fridges and tells me they are *"clogging up the lab"*. There are many different places for waste disposal. I see many different types of bins and sinks. Some bins and sinks are isolated for the disposal of waste from specific chemicals, and these are very clearly labeled using black and white A4 signs. For example, Eva (PhD student) tells me that all waste from experiments involving use of the drug 'RU486'[94], a potentially harmful substance, is separated from other waste so that the drug does not leak into the water supply or pollute other materials. Some researchers have their own bins where they put waste from their experiments, which can include used equipment such as slides, vials, bungs, and also general chemical waste. Worms, attached to these materials, go in bins after use. There are various filing cabinets, drawer units, boxes, bins, and buckets under the benches. There is a controlled temperature centrifuge[95] - set to 22c, 2.5m and 12.8RPM - next to me, and there is also a bench of computers opposite the bays near the offices. Kate takes me to see a large cupboard next to the MFL's closed laboratory space, which contains 'stocks' of worms kept at many different temperatures. Professor Hurst shows me a storage freezer near the MWL bay that worms are kept in. He says that some remain from laboratories that he worked in in the 1970s.

Professor Hurst is the head of the MWL and, as well as overseeing the experiments conducted benchside, he supervises all students and PD researchers. There are five PD researchers, two PhD students, one MRes student, one international graduate student, and one laboratory technician. The PD researchers, funded individually by different funding bodies, are all at different stages. Whilst Professor Hurst does not work benchside, he often stops to say hello to researchers at the bench or to engage in casual conversation – for example, a general conversation about *"how it's going"*, or the fact that *"Emily from Longtown University is taking a long time to get back to us about that paper"* - as he walks down the corridor to, or from, his office. Occasionally, he leaves his office to speak to researchers. If Professor Hurst's inquiry requires more than a short conversation (see above examples), researchers are invited to join Professor Hurst in his office or in the common room to talk. Professor Hurst arranges to meet with new researchers once a week. Once researchers have 'found their feet', Professor Hurst meets with them every few weeks. Once a week, all members of the MWL attend a

[94] RU486 is is a compound in the drug given to women during 'termination procedures'.
[95] A centrifuge is a piece of equipment used to separate two substances that have different densities.

laboratory meeting where one person presents. I am told by Kate that the *"lab meeting is the most important time of the week"*.

Countryville University's Biogerontology Laboratory

The CFL is based on the second floor of Countryville University's 'Life Sciences' building, or the CEC. Unlike at Metrotown University, there is no barrier to entering the CEC, or any of the buildings at Countryville University for that matter. As I walk through the CEC for the first time, accompanied by Dr Kennedy (CFL co-head) I pass multiple dinosaur and animal skeletons on display in large Perspex containers. After climbing two flights of stairs and passing through a set of double doors, I approach a shiny, white, clinical, yet immaculate corridor. The corridor, which is so quiet that one could hear a pin drop, contrasts with the shabby brown and grey shades that cover the rest of the CEC building, acting as a background to the slightly messy arrangements of animal artifacts presented in chipped plastic cabinets. Dr Kennedy notions towards a small paper sign on a door that reads *"Drosophila Lab"*. This laboratory - the physical site of the CFL - is situated half way up the corridor. Upon entering the room, which is much smaller than the laboratory at Metrotown, I am hit by a thick smell, which I soon learn is the smell of fruit flies and fruit fly food. The smell seems to me to be a little fishy, a little gamey, and a little malty – something which Dr Kennedy apologises for on entering this laboratory space. Whilst at the MWL, the worms – kept in small petri dishes - can barely be seen with the naked eye, I am struck by how 'present' the fruit flies feel. There are flies - dead and alive - everywhere. There are flies in the air, flies squashed into the benches, flies in vials, flies in bottles, and flies in large glass jars. In contrast to the public setting, I am now in the midst of the 'fleshiness' of the laboratory. Dr Kennedy tells me that behind the closed doors of the laboratory's walk-in incubators (several, which are on the left as I come in), there are thousands more fruit flies. Some of these fruit flies are what are known as 'stocks' and some are, as Dr Kennedy describes, *"mid experiment"*. Whilst laughing, Dr Kennedy exclaims: *"it's a fruit fly massacre in here"*. There are two PhD students in the room, who are also laughing at this point.

I also notice that the laboratory space is chaotic, and that there are more 'things' than spare shelve space. Bottles, vials, jars, trays, test tubes, pipettes - to name but a few -

are sprawled across benches, racks, and shelves with no apparent order. Students are at the bench working. Dr Kennedy tells me that the CFL is a relaxed laboratory, and that I should *"make myself at home"*. The laboratory space is a rectangular shape and approximately eight metres long and four metres wide. A bench runs around the perimeter of the room, and the CFL researchers sit at different spaces across the bench to work. There are no allocated spaces, but researchers usually gravitate towards one of the microscopes. I am told that a Carbon Dioxide (CO_2) source runs around the room, and I see that there are little taps for CO_2 dispensation that are visible every metre along the bench. James (PhD Student) tells me that the CO_2 is used to gas, or *"knock out"*, flies when researchers want to study them under the microscope. He says that when the gas knocks out the flies, they become still and docile. The interior of the laboratory, much like the laboratory space at Metrotown, is mostly grey and white. The floor, window frames, blinds, door, desks, walls, incubators, and ceiling are different shades of grey. Blue chairs add a more colourful hue to the room. I notice panels of lighting, an air vent on the ceiling, and a fire alarm. There are two walk-in incubators which are, as James tells me, for stocks. There are two external incubators set to different temperatures. These are for flies currently being used in experiments. There is a *"biohazard danger"* sticker on one of the external incubators, despite, as I discover during my time at the CFL, a legalistic approach to health and safety whereby researchers follow the rules, often begrudgingly, as part of a duty to the laboratory.

As well as a bench, there is a small desk where researchers in the laboratory space can use a computer and printer. Next to the printer, there is a jar of dead flies, alongside two trays of Dr Starr's (CFL co-head of laboratory) bottles of un-hatched fruit flies. There are trays of bottles full of flies on most surfaces. In each bottle, there are masses of brown abandoned pupae stuck to the sides of the bottles. There are many big jars full of dead fruit flies. I can tell that the flies are dead because they are all stationary and stuck together in a big brown, gooey mass of food residue. I am told that these jars are the *"fly morgues"* (James). I see several more clusters of older looking microscopes in different corners of the room. There are plug sockets all around the bench and space, which researchers use to plug their laptops into. There are items like jars, gloves, boxes, and tubes in a muddle on the windowsill. Running down the length of the laboratory are shelving units, which house boxes. On the lower shelves, there are empty cardboard

boxes and cardboard boxes that contain unused equipment like unused bungs. The upper shelves house trays of what Dr Starr tells me are *"batches"* of flies, and these are in bottles and vials. Written on trays and boxes are batch numbers, alongside researchers' names. There is a sink at the far end of the room, and to its left are more shelves that house conical flasks, vials, pipettes, and petri dishes. I am struck by how many 'things' – including flies – are being crammed into this small space.

Dr Starr explains to me that incubators are *"very, very important"*. This is because, she says, they store fruit flies at controlled temperatures. There are two walk-in incubators on the left as you walk through the door to the laboratory space. I am told that one incubator is set to 17°C and the other to 25°C. Each incubator is about two metres long and one metre wide. There are also two standalone incubators - each the size of an average household fridge. I am told that these detached incubators are kept at 27°C and 28°C. All incubators contain many shelves of trays full of vials, and also bottles that are full of fruit flies. Each tray contains a batch of flies, with each being used for an experiment. Like at the MWL, different incubators are used to store flies at certain experimental stages. The 17°C incubator is for storing the flies when they are not being used for an experiment (referred to by researchers as *"stocks"*). In contrast, according to James, the 25°C incubator is for *"getting them ready"* for an experiment and the 27°C and 28°C incubators are for storing the flies whilst they are being used in an experiment.

Dr Kennedy and Dr Starr are the co-heads of the CFL. There are three PhD students and two research Masters (MRes) students based at the CFL. Dr Kennedy supervises one MRes student and one PhD student, James, who is assigned the task looking after me during my stay. Dr Starr supervises one MRes student and two PhD students. Dr Starr explains to me that whilst she is really keen to take on a PD researcher, there is no money for a PD research role at the moment. The students are in the laboratory every day, but they sometimes leave to attend the shared PhD student office located on a different floor of the CEC. There is one laboratory technician who washes and organises equipment for all of the laboratories on the corridor, and she visits the CFL once or twice a day to collect dirty flasks and vials. Dr Kennedy and Dr Starr work in their offices located in a different building to the laboratory space. I spend time in their

offices watching them carry out what Dr Starr calls *"day-to-day"* tasks. These tasks include marking undergraduate papers, administrative work, and paperwork relating to the laboratory experiments. As heads of laboratory, Dr Kennedy explains that they are required to do things like *"plan and oversee experiments, order stocks, and supervise students"*. Dr Kennedy does not spend time much time in the laboratory other than sporadically checking that research is going accordance to plan. Dr Starr, when she has time, spends time in the laboratory carrying out experiments alongside students that she supervises. I see her in the laboratory, studying flies and checking stocks, several times during my time there. Dr Kennedy says that it is a *"rite of passage"* to do what he calls *"lab work"* but he says that he would rather not do it any more and that he prefers working in the office.

Metrotown University vs. Countryville University

At both the MWL and the CFL, researchers study genetics in animal models, which is as part of a 'genetics' based approach to ageing – the approach taken by Professor Kenyon, with her 'DAF-2' finding (see chapter two). There are, however, stark differences between the two laboratories, and also between the universities in which they are situated. Metrotown University is situated in a large UK city and many of the university's buildings are grand and boast impressive, detailed architecture. Inside Metrotown University buildings, I marvel at high ceilings and interiors that, whilst clean, are old and often intricate. Countryville University is situated in a small, quaint UK city, and the university's buildings are modern and 'slick' looking. Inside the brightly lit Countryville University buildings are many glass walls, alongside ample modern 'flat-pack' furniture – mostly in bright lime green and red colours - that comprises designated study zones and lounge areas. Metrotown University has an historical feel to it, and the interior of the main university building is very expensive looking, with lots of antique furniture and paintings scattered throughout the main buildings.

Whilst both universities are high in the UK university league tables, Countryville University has a good reputation for its high teaching standards, and Metrotown is renowned for its internationally acclaimed high standard of research. Dr Kennedy tells me that even though high quality teaching is useful for recruiting undergraduate

students to a university, he says *"high quality research is valued more in the academy"*. He adds that as a lecturer at Countryville University, he is expected to be *"subject to the whims"* of undergraduate students in order to maintain the teaching standard and this, he complains, gets in the way of carrying out research. I am told that Metrotown University – the outwardly more 'prestigious' institution - has more money than Countryville University, and also that it attracts more funding because of its reputation for high quality research. I see this difference reflected in the differences between the two laboratories and their resources (i.e. equipment, number of researchers, time allocated for research).

Dr Kennedy discloses to me that he is only at Countryville University because - after several fellowships that went badly due to his failure to find, what he calls, *"good results"* - it was the only place where he could get a permanent position. Whilst the MWL is situated within an institute (the MHAI) that focuses upon ageing, the CFL is based in the more general setting of the Countryville University's biology department, and ageing research is a fairly new focus in this department. Despite being known as biogerontologists within the biogerontology community, Dr Kennedy and Dr Starr are not known as biogerontologists *per se* at Countryville University. At the MWL, there is a sense, especially amongst Professor Hurst and the PD researchers, that they are definitively doing 'biogerontology'. At the CFL, whilst Dr Kennedy does refer to himself as a biogerontologist, most researchers in the laboratory describe what they are doing as *"fly genetics"*, with a *"particular interest in ageing"* (James).

As well as a significant difference in size between the two laboratories, there are several key differences in the day-to-day running of each space in terms of conduct and ethos. At the MWL, Professor Hurst has a laidback approach to laboratory coats, with most not wearing them, and he does not mind what time people arrive or leave the laboratory as long as they carry out excellent research. Professor Hurst does express this commitment to excellence, and also a strong drive to advance research at, what he calls, *"these new frontiers of ageing research"*. Researchers at the MWL are sure to be seen at the key biogerontology conferences, and I regularly hear them discuss the prestigious journals in which they are trying to publish. Researchers at the MWL tell me that they regularly spend time at the laboratory at the weekends in order to, as Gonzalez says,

"get their work done, whatever it takes". PD researchers have come from all over the world to study at the renowned laboratory.

At the CFL, there is a slower and less ambitious approach to research, and most of the PhD students at the CFL tell me that they do not want to stay in academia after they have finished writing their theses. Professor Hurst has more contact with researchers at the MWL throughout the day compared with Dr Kennedy and Dr Starr at the CFL. This is because at the CFL, the heads' offices are in a separate building to the laboratory space. There is no formal laboratory meeting at the CFL; however, at the MWL, the 'Lab Meeting', as Kate (MWL PD researcher) tells me, is the main event of the week and researchers from other universities often travel to join the meeting.

At this weekly lab meeting held at that MWL, Professor Hurst, through thorough questioning and debate, ensures that researchers' work is of a high standard. It appears that most of these key differences between the MWL and CFL are symptomatic of the corresponding differences between the two institutions. At the MWL, members give the impression that 'first-class' research is being carried out. At the CFL, I sense an inferiority complex on the occasions when other more prestigious laboratories - like the MWL and MFL - are discussed, and there seems to be a resigned, implicit admittance that the CFL's research is 'second-class'. Dr Kennedy tells me that a renowned biogerontologist that he used to work with has recently *"got a paper in Cell"* (a prestigious journal). Dr Kennedy shrugs his shoulders and tells me *"no-one from our lab will get anything published in Cell"*. At both laboratories, there was a sense of camaraderie, with a particular focus on celebrating – researchers report that celebrations are often held at Professor Hurst's house - when researchers got a paper published or complete their PhD thesis.

Division/s of Labour: Heads, Hands, and Hierarchies

Laboratory labour can be divided into four categories: 1) Heads, 2) PD researchers, 3) PhD students/graduate students[96], and 4) Technicians. These are classified in a laboratory hierarchy (ordered 1-4). The heads are in charge of the laboratory. They plan

[96] Whilst PhD students are also (technically speaking) graduate students, the term graduate student is used to describe students carrying out non-PhD postgraduate research.

and supervise research projects, alongside overseeing recruitment, the budget, and resource allocation. It is generally acknowledged that the heads are in charge and have the 'final word'. A PD researcher tells me that in one laboratory that when he tried to *"do his own thing"* he got into trouble with his 'head' and narrowly avoided disciplinary action, meaning he is now more complicit. There is an informal hierarchy amongst PD researchers – who report only to the heads - based upon the length of time at a post. Kate is the PD researcher that has been at the MWL the longest and, thus, she is treated sometimes as if second-in-command to Professor Hurst, as other researchers in the laboratory look up to her and ask her for advice.

The PhD students have more authority and autonomy than the graduate students, particularly as their research posts are longer, whereas graduate posts are no longer than a year. Laboratory technicians (assistants) - described as the *"most important people in the laboratory"* by the PD researchers - report to all of the researchers. Laboratory assistants at the MHAI assist PD researchers in practical aspects of experiments, especially whilst PD researchers are busy writing academic papers. Hannah, the MWL's technician, is very much part of the MWL, and she is married to one of the PD researchers. At the CFL, however, the assistant is not part of the laboratory, but assists several other laboratories in the building. Researchers at the CFL say 'hello' as she comes to *"do the rounds"* (James) by collecting used, dirty equipment, and subsequently returning clean equipment.

The heads refer to, what Dr Kennedy calls, an *"apprenticeship system"* when explaining that the younger a researcher is in his/her career, the more practical and *"hands-on"* their work is, as the early career researchers have to do the *"boring and mundane tasks at the bench"* (James). These are, in Dr Starr's words, *"monotony"*. For the most part - aside from Dr Starr's occasional involvement - it is the PD researchers, students, and the laboratory assistants that carry out practical experimental tasks at both the MWL and the CFL. As well as each having what is called a *"lab role"* (Hannah) assigned (e.g. checking stocks, keeping chemicals in order, checking equipment works), PD researchers are given the task of teaching new graduate students how to use all of the equipment *"properly"* once they graduate from undergraduate courses. Drawing from Pallí (2004), I make a distinction between the laboratory's 'head' and the

laboratory's 'hands'. Generally, the heads spend most of their time 'deskside' carrying out practical tasks, whereas the hands spend most of their time 'benchside' doing paperwork and holding meetings. For Pallí (2004), PD researchers played more of a mediating role between the head and the hands, yet, aside from the time spent writing papers, I found the PD researchers to be very much the 'hands'. Papers are the currency of the laboratories, as results are made public. *"You must publish",* Ariel tells me, *"otherwise you will not be able to progress"*. Passing the degree is the priority for all of the students. These goals and academic requirements are part of the laboratories' social requirements and/or membership. Talking of publishing and paper writing takes up a large portion of researchers' conversations at the laboratory setting.

All 'hands' share the same research space, and, generally speaking, the PD researchers can be distinguished because they look a little older[97]. I often hear the hands give each other advice. As well as an asymmetrical flow of power, I notice that there is an asymmetrical flow of advice-giving, with members who have been there longer giving advice to members who have not been there as long. The relation between the head and the hands is captured in a meeting held between Professor Hurst and Orla (MWL graduate student). The meeting is held so that Professor Hurst can check that Orla is being rigourous in her research and is, in Professor Hurst's words, *"doing okay"*. The following extract is taken from this meeting:

> *Professor Hurst: "How many worms did you start with and how many are left?"*
> *Orla: "I started with twelve and there are five left."*
> *Professor Hurst: "That's a small amount, but it makes a good pilot study."*
> *[Orla smiles and nods]*
> *Professor Hurst: "Oh yeah, did you blind the trials?"*
> *Orla: "Yes."*
> *[Professor Hurst makes 'A-Ok' sign with his thumb and forefinger and Orla smiles]*

[97] By this I mean the average CA. Whilst the average age of PhD and graduate students was early to mid twenties, PD researchers were mostly in their thirties/forties. The laboratory technicians varied in age.

Professor Hurst asks Orla how many worms she has used for her experiment. When she says that she has used twelve worms in the experiment, Professor Hurst refers to this study as a *"good pilot study"* because it is small in size. Orla is happy because, whilst her study has been downgraded to a pilot study, Professor Hurst approves of the work that she has done. Professor Hurst asks Orla if she has *"blinded the trials"*. This is where information that could possibly cause experimental bias is hidden. Orla says that she has and, subsequently, Professor Hurst gives the 'A-Okay' sign as a symbol of his approval. Orla is seen as doing 'good science'. She has given an account to Professor Hurst but Professor Hurst has not given an account to Orla, reflecting the asymmetry between the head and the hands.

Furthermore, sharing knowledge between the laboratory community members is valued. The 'Lab Meeting' is, reiterates Professor Hurst, *"one of the most important occasions of the week"*. *"If you really want to see what goes on inside the laboratory",* he says enthusiastically, *"it is important that you are with us for a lab meeting"*. In a lab meeting, Jackson (PD researcher) is giving a presentation about a new experimental technique for what he calls *"Measuring oxidative stress"*. As part of this technique, he attaches a blue fluorescence to dead and dying worms so that he can study them in more detail under the microscope. He explains that this new technique that he is working on means that it is less time-consuming to attach the fluorescence to the worms than the older techniques. To begin with, Jackson explains a little about his experiment using line graph data. Professor Hurst interrupts:

> *Professor Hurst: "Why does that graph not have labels for the coloured lines that represent the flies?"*
> *Jackson: "The purpose of the graph was to show the diverse range of outcomes."*
> *Professor Hurst: "Okay."*
> *[Jackson goes through a few slides and shows the results in a type of triangular chart]*
> *Jackson: "I'm experimenting with this type of chart, I think it looks good…"*
> *[Professor Hurst interrupts Jackson]*

Professor Hurst: "The fifteen degree result contradicts my paper from 1998."
Jackson: "No, this is for oxidative stress."
Professor Hurst: "Ah okay then, that makes sense."
[Jackson looks back to the graph]
Professor Hurst: "Are you sure the fifteen degree ones haven't just been out on the bench because the results are surprising."
Jackson: "No, that's not the case, but yes the results are surprising."
[Jackson continues with the presentation]

To begin with, Professor Hurst asks Jackson to give an account for why the line graph did not have labels, and Jackson appeases Professor Hurst in claiming that the purpose of showing the graph was, in fact, to show the diversity of the range of outcomes. It is not long before Professor Hurst interrupts and evokes another account. Professor Hurst problematises an apparent contradiction between, first, Jackson's result and, second, a result from one of his own papers that was written over ten years ago, and Jackson gives another account – repairing the moral order - for this contradiction in his reply that is the graph is actually showing *"oxidative stress"*. There is third interruption as Professor Hurst questions his conduct with regards to the *"fifteen degree"* results. Jackson assures him that this is *"not the case"*, but acknowledges the *"surprising"* results. However, Jackson leaves the question unresolved this time.

This extract makes visible the culture of practicing 'good science' that exists in the laboratory. It is interesting that Jackson (PD researcher), in his account-giving, has more negotiating power than Orla (graduate student) has in hers. This is exemplified by the way that Jackson is happy to leave the question about the 'fifteen degree' results not fully resolved, and also the way that he corrects Professor Hurst.

Routines and Repetitions: Picking, Tipping, and Pushing

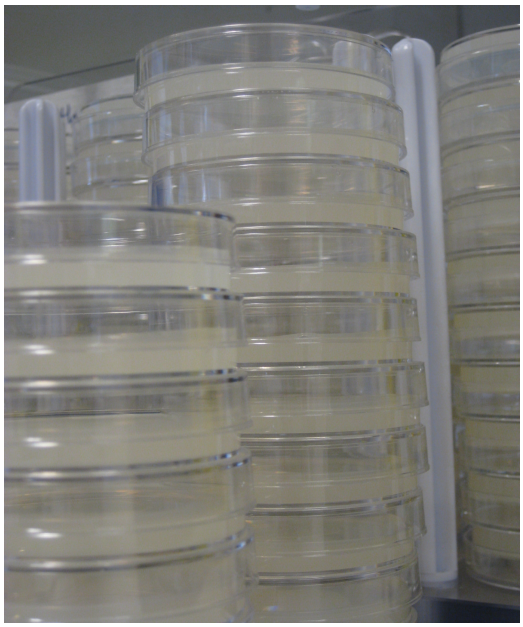
Dr Starr describes the laboratory routine as *"monotony"*. I find a very slow and outwardly unexciting routine, which is carried out by the hands. One of the main daily tasks at the CFL is 'picking'. It involves using a 'fly pick' (see Figure 6), which is a small metal rod approximately fifteen centimetres in length to transfer, under the

magnification of a microscope, a worm from one plate to another. Hannah tells me that different researchers bend the nibs into different shapes as part of different 'picking techniques'. Kate says she *"prefers to round the nib off at the end to provide a little circular platform to lift the worm up with in a gentle way*". Others prefer a sharper end and use more of a digging action. Before a worm is picked, researchers place the nib of the pick under a Bunsen burner flame so as to sterilise the nib.

Hannah (MWL laboratory technician) says that the pick nib is made out of platinum because platinum cools down quickly after the flame. *"This way"*, Hannah says, *"the worm is not hurt"*. Hannah tells Eva, Orla, and I that in some laboratories, researchers use eyelashes to pick because, she says, *"eyelashes are softer and cause even less harm to the worm"*. Eva and Orla, who are picking at the bench, are very surprised. Orla the graduate student says, *"Wow! That'd be SO hard"* (her emphasis). Often picking is done as preparation for an experiment, as researchers pick what they call the *"best worms"*. Hannah says that it is important that the worms used as part of an experiment are at the same stage in the life cycle. I watch as she studies worms from different plates under the microscope and, subsequently, picks worms from each plate that are at the right stage. She puts each of the carefully selected worms in one plate (approximately fifty per plate). I ask Hannah if picking is done only as preparation for an experiment. Hannah says that sometimes worms are *"also picked for further analysis… often under the microscope or in the plate reader"*.

There is only one plate reader, and I often hear researchers negotiate access with one another. I unsuccessfully attempt to pick some worms from what Hannah called a *"redundant batch"*. I could not even focus the microscope properly, and Eva reassures me that picking is definitely something you *"have to practice"*. Hannah then assures me that it is a *"difficult job - I had to spend months at a summer school to learn how to work using worms"*. An ambiguity between harm to the worms, and harm to 'good science' comes into view (see chapter seven) during my interaction with Hannah, Eva, and Orla.

Figure 6: A 'Pick' (left) and 'Plates' (right)

'Fly tipping' (see Figure 7) describes the process of transferring flies from one container to another. During lifespan experiments - as opposed to when flies are stored as stocks in flasks and are 'tipped' less frequently - flies are tipped from one vial to another every Monday, Wednesday and Friday in the morning, and this is done so that the flies have fresh food. Vials are around four or five inches in length, and the bottom one or two inches of the vial contains a solid, light brown, waxy looking substance which is the flies' food. Each vial is stuffed with either cotton wool or a bung to stop the flies from getting out. 'Tippers' take the old vial in one hand (usually the left) and tap it down on the table quickly, several times. Xavier (CFL PhD student) says that this is known as the *"machine gun method"*. Next, tippers take the new vial in the right hand and place the openings of the two vials together, with the new vial opening pointing downwards so that the flies, who tend to be flying on an upwards trajectory, fly into the new vial. The cotton wool or bung is then quickly placed in the opening of the new vial before any flies are able to escape. I notice that there is a distinct knack to doing it quickly. Each fly-based experiment that is running at any given time has anywhere between twenty and two hundred vials that require tipping three times a week. During my time at the CFL, I clumsily tip a batch of flies, which are also 'redundant' because they were used in an experiment that went wrong. I find tipping much easier than picking. I also noticed the physical, fleshy presence of the flies, in relation than the tiny worms that can only be seen under the microscope.

Figure 7: Racks of flies waiting to be tipped (Left) and Bottles of flies (Right)

Handling fruit flies under the microscope is known as 'pushing'. Pushing involves taking out the bung at the top of a vial or flask and shooting CO_2 into the vial using a gun so that the flies in it will be *"knocked out"* (James) which he explains as meaning to *"put to sleep"*. The flies are knocked out so scientists can take the docile, stationary flies out of the vial to examine them under the microscope. The flies are taken out with a paintbrush and pushed onto gauze positioned under the microscope. CO_2 blows through the gauze in order to keep the flies docile. Scientists at the CFL and MFL complain that their eyes sometimes get really tired whilst pushing because the CO_2 blows into their face. James says that in the first year of his PhD research, he carried out microscope work with contact lenses but now always wears glasses when he pushes flies so that his eyes do not get tired.

Ordering Benchside Tasks

The staff hierarchy accomplishes a division between benchside and deskside tasks. The heads tell me that deskside time is mainly split between administration, teaching, organising, and overseeing. The general consensus amongst the heads is that organising experiments and papers is the priority. Moreover, the hands classify their benchside tasks, such as picking, tipping and pushing, as they organise their time. One morning, during 'tipping', I talk with Dylan (MFL PhD student):

Sophie: "Are you tipping today?

Dylan: "No! I'm doing dissection today [said in an excited tone]"

Sophie: "Dissection of flies?"
Dylan: "Fly brains."
Sophie: "Wow! How do you do that?"
Dylan: "With a lot of practice."
Sophie: "I bet."
Dylan: "If you do it properly, you do it right down the middle and if you do it PROPERLY [his emphasis] you keep the brain in tact." [As he relays his expertise, I find his tone to be confident]

I ask Dylan if he is going to be tipping. Trying to appear savvy, I make this assumption because it is Wednesday morning. Dylan says that, in fact, he is *"doing dissection"*, which refers to the task of slicing the brains *"down the middle"* and then studying the brain under the microscope. Dylan says that if you are doing it *"properly"* (said with emphasis), you slice down the middle of the fly brain, whilst *"keep[ing] the brain in tact"*. This language uses violent imagery, yet there is also care for 'good science' present in the way that he describes this 'practical labour' (Puig de la Bellacasa, 2011; Latimer and Puig de la Bellacasa, 2013). Whilst 'dissection' is a particular benchside task, Dylan's excited and confident tone implies that – compared with a menial task like tipping - dissection is a less ordinary task, and, also, that it is a more exciting task. Next, I speak with Esme (MFL laboratory technician) whilst she tips flies. She also figures tipping as an inferior task:

Sophie: "What are you doing now?"
Esme: "Today is a tipping day, we tip Monday, Wednesday, and Friday because of the life cycle of the flies."
Sophie: "How long does it take?"
Esme: "It will take about an hour." [Sighs]
Sophie: "Right, what will you do next?"
Esme: [With more enthusiasm] "I will go and take an hour for lunch and THEN [her emphasis] I will go and do some molecular biology."
Sophie: "I've tried fly tipping, and I tried picking worms and I found picking much harder, not that I'm not saying fly research is easier!"
[We laugh]

Esme: "Yes picking is much harder because tipping is really easy."

Esme tells me that because it's a *"tipping day"*, researchers are *"tipping"* - around the flies' lifecycle - for the morning. She is getting tipping 'done' before she goes on to do other tasks, as tipping is essential for healthy flies and thus essential for experiments. In contrast to Dylan's description of the expertise required for 'doing dissection', Esme describes tipping as "*really easy"*. Tipping is figured as banal but essential. Esme says, unenthusiastically, that tipping will take her an hour, yet when I ask Esme what she will do next, her countenance changes, and she tells me that she will *"go and do some molecular biology"* in the afternoon. She did not explain what she meant by this, but I could tell that she was looking forward to 'doing' it very much. This supports Grene's (1987) description of the way that 'the molecular' is valued and/or prized in biology, and that studying whole organisms (e.g. zoology, ecology) is not. However, Esme, despite being a technician who spends most of her time 'changing the nappies' (Latimer and Puig de la Bellacasa, 2013), gets to 'do' the molecular biology, which subverts Grene's ordering. This can be likened to when members of the highest Indian caste, the Brahmins, carry out the 'lower' work of shoveling excrement in Douglas' (1970) study. In addition, Emerson and Pollner (1975: 243) argue that 'dirty work' designations act to *"reaffirm performance criteria"* in institutional practice, and at the MWL, PD researchers are still expected to carry out this work, despite their higher 'rank'.

'Imaging' is also figured as an exciting task by researchers, particularly researchers working with worms. Whilst the fleshiness of the fruit flies is physically tangible in the laboratory, researchers require imaging technology in order to 'see' the worms. At the MWL, the work carried out in the microscopy room is deemed less 'mundane' than the other tasks. This is because the moving images are *"extremely interesting to look at"* (Amelie, PD researcher). When I am taken to the microscopy room, it is on the premise that I will be shown, Amelie says, *"something that is interesting compared to picking"*. Amelie takes me to the microscopy room. There are six iMac computers that are attached to microscopes. The room is protected using a numerical code and I could not have accessed it without going in with Amelie, who had reserved a session. I am shown *"the Zeiss"*, which Amelie has reserved and says (making a typification) it gives the *"best quality magnification"* and, subsequently, she says it is *"the most expensive"*.

The computers have magnification software installed, and using this software, the image of magnified worms taken from the microscope becomes visible on the computer screen. I see lots of settings on the microscope, and Amelie looks through the lens of the microscope, smiles, and says that it has been *"left with a really good set up"* by the previous user. She says that she is happy about this because she likes it when laboratory members uphold an excellent standard, and, also, because there is less for her to do.

Amelie opens up the 'image capture and analysis' software and says *"we can now see the wild-type worms on the screen"*. She explains that the worms are *"wild"* because they have not been manipulated. They do not seem very wild to me because they are in a controlled laboratory setting. I am disconcerted and I look at the screen again. The background is black and pixelated and, in the foreground, there are the images of worms. The worms are visible in the form of white, with a pale blue tint, glowing fluorescent - like Jackson, Amelie has attached fluorescence for magnification purposes - contoured shapes. Worms are put on small glass slides with a bacteria jelly on them (their food) so that they can be viewed under the microscope and also have a surface to slither in/on. The imaging software has a powerful zoom lens that means that each worm on the screen is approximately thirty centimetres long and five centimetres wide.

Amelie adds oil to the slides that are being magnified because, she says, it leads to *"an increase in the clarity of the image"*, which means, she explains, *"a better experiment"*. This is especially important given that the software measures the images. The microscopy room routine is very controlled and seemingly prosaic. Yet, just after Amelie shows me glowing shapes on the screen which show *"increased signs of brain ageing in the worm"* (see chapter six), she makes a switch momentarily to a world of aesthetics, as she is captivated by the image – which is a 'point of crossing' (Latimer, 2013a; 2013b) – and says *"these are VERY pretty"* (her emphasis). The moment is disrupted as Amelie, returning to her routine, stands up wipes the oil from the Zeiss so that it is left at an 'excellent' standard for the next user.

The Geneticisation of Ageing: Death, Sex, Babies, and Food

Reproduction is a key focus for biology (Grene and Depew, 2004). Picking, tipping, and pushing - amongst other tasks - are carried out as part of a set of overarching tasks, such

as breeding, maintaining, and manipulating the animal models. James tells me *"a lot of what we do is simply fly genetics"*. Dr Starr also tells me *"basically its genetics"* and Professor Hurst says his laboratory is researching *"genetics where ageing is the phenotype"*. Through these statements, assumptions about ageing are made (i.e. that it is a 'phenotype') and 'simply fly genetics' refers, in fact, to a whole 'world of genetics' (see Latimer, 2013b) being made in the laboratories. Geneticists study the characteristics inherited from genes. Genes are small parts of what biologists call Deoxyribose Nucleic Acid (DNA), which is, according to scientists, the unique - apart from in the case of identical twins - blueprint of an organism (Rose, 1997; Atkinson et al., 2009). Biologists have represented DNA as two intertwined strands, commonly known as the double helix, and these strands carry an organism's genetic code. Each gene is said to code for a specific protein by specifying a particular order for the form of amino acids (Riddley, 1999; Grene and Depew, 2004). Long strands of ravelled DNA constitute what are known as chromosomes, which come in pairs - usually one chromosome from the male sex organs and one chromosome from the female sex organs - and these are what 'pass on' particular traits and facilitate the replication of the characteristics of both parents (Rose, 1997).

James tells me that fruit flies have four pairs of chromosomes. Kate tells me that the worms are hermaphrodites, which means that each worm has both male and female sex organs, and, therefore, that all of the chromosomes - eight in total - come from within a worm. Speaking more generally, for each gene, James tells me, each organism possesses a pair of 'alleles' - one on each chromosome - and this pair creates a *"trait"* (James). In the laboratory setting, organisms are continuously bred in order to provide a consistent stock of animals to be used for experimental purposes. The controlled breeding of the laboratory facilitates the creation and maintenance of what researchers generally call the *"wild-type"* and the *"mutant"* strains of worms and flies.

Often, organisms are subject to intervention and/or manipulation at this genetic level, as researchers test the effects of particular chemicals on the worm/fly genes. James says that sometimes he removes or adds particular genes in flies, and sometimes he 'gives' the flies chemicals that will cause the over or under *"expression"* (James) of a targeted gene. A *"strain"* is the term used by researchers to describe groups of flies and worms

that share the same genetics. The *"wild-type"*, James tells me, is an un-manipulated strain, taken originally from the 'wild' but rebred in the laboratory. I have already referred to my disconcertment that organisms that are bred in controlled conditions, and also kept in vials, flasks, and plates, are referred to as 'wild'. These worms and flies do not seem particularly wild, and this descriptor challenges conventional understandings of what is 'natural' and what is not. In experiments, researchers compare mutant strains with the wild-type. At the CFL, on occasion, the wild-type is known by its official name, *"Dahomey"* (based upon its geographical origin). At the MWL, the wild-type is often referred to as *"N2"*. Researchers speak of *"crossing"*, or crossbreeding, the wild-type with other strain. Researchers at the CFL maintain their strains by making sure that each strain is isolated using separate vials/flasks. This is so that organisms will not, as Thea tells me, *"mate"* with different strains.

James explains that placing two fly strains together in the same flask creates a new fly strain. He places approximately twenty wild-type flies together with twenty flies that carry *"the gene of interest"* (James). The gene of interest is, he tells me, a particular gene that has been isolated for experimental purposes. James says that it is commonplace for researchers to breed flies with a gene that expresses a particular trait with flies that carry the gene of interest. This is so that the flies with the gene of interest can be visibly identified. I learn that the wild-type flies 'naturally' have white eyes, and James tells me that he wants to create a mutant strain with white eyes, which he calls the *"pale eye trait"*. He tells me that to do so, he will cross the wild-type strain with a strain that carries the 'gene of interest'. He tells me that at the CFL, they cyclically carry out *"backcrossing"* and *"outcrossing"* (James).

As well as *"keeping an eye"* on animals' lifecycles, outcrossing and backcrossing, he says, are some of the most time-consuming benchside tasks alongside *"the eugenics"* (James). At both the CFL and MWL, these tasks require researchers to work around organisms' lifecycles (see later in the chapter) in order to select the correct animals so that each experiment is rigourous. James is outcrossing a batch of flies which, he says, means *"inter-strain reproduction"*. James tells me that he is doing this so that he has the *"healthiest set"*. This is because, he says, "*outcrossing increases [the] genetic diversity"* of each strain, which *"creates a larger gene pool"* and which, in turn,

decreases *"inbreeding"* (James). 'Borrowed' by society from 'biology' (Vincent, 2008), 'inbreeding' is also used in often stigmatising descriptions of social communities where biologically 'related' members reproduce within those communities (Hedrick, 1985). Inbred populations draw from a smaller pool of genes, and, therefore, they are, according to scientists (Ralls et al., 1988), producing more of what James calls *"recessive traits"*. Thus, he explains, there is more chance of a harmful recessive mutation being passed down and expressed when two recessive alleles become paired.

James explains to me what he means by alleles by drawing on an example based upon the red and white eyes traits. For each gene there are dominant and recessive alleles that comprise genes, which, in turn, code for traits. He explains that the allele for red eyes is dominant (A) and the allele for white eyes is recessive (a). Parent flies, each possessing two alleles, will possess any combination of these alleles and pass two of them down to offspring. A double dominant (AA), would lead to the red eyes trait being expressed and only the red eye trait carried by offspring. A double recessive (aa) would lead to white eyes trait being expressed and only the white eyes trait carried by offspring. Where there is one dominant and one recessive (Aa), the dominant allele, in this example of the red eyes trait, is expressed, whilst the offspring would still carry the recessive allele for the white eyes trait.

James explains that some recessive mutations can be harmful, and they can go undetected if they are paired with a dominant allele - even if they are expressed when a pair of flies has two recessive alleles. He explains that this is more likely to occur if the genetic diversity is not managed, which is why he outcrosses flies. Flies that have a higher genetic diversity, he continues, will also be healthier because, over time, there will be an increased ability in a population to defend against disease. This is, he says, because there will be a higher ratio of flies with a higher level of immunity. James says that in the last few months, he has *"done three rounds"* (which he tells me means *"three generations"*), and also that "*each time [a round of outcrossing is completed], their eyes get paler as more of the recessive alleles that carry the white eyes trait are expressed within the fly batch"*. He explains that he has recently created a new strain of flies where the *"curly wings trait"*(James) has been linked to the gene of interest. He takes a gassed fly from the gauze and places it on the table for me to see. *"Have a look*

at that! The curly wings are visible with the naked eye", he exclaims. I recognised this trait straight away. The other makers are *"tubby"* (large body), *"singed hair"* (short hair*), "pale eyes",* and *"red eyes"* (James).

Organisms that are genetically impure, unhealthy, unusable, already used, and/or no longer needed, are disposed of immediately because there are not *"useful"* (James). CFL researchers often talk about throwing away what they call *"redundant batches of flies"* and I watch researchers empty the vials containing dead flies into *"the fly morgue"*. Thea (CFL PhD student) explains that organisms become redundant when *"an experiment goes wrong, or an error has been made in breeding or preparing the flies for experiment"*. At the CFL, eggs, larvae, and pupae that line the vials and flasks are also thrown away because they, Thea tells me, *"clog up"* the vials and pollute the food. I watch as flies are gassed before they are put into the fly morgue. At the MWL, plates and slides of worms are either thrown into appropriate bins or they are *"washed out"* in the sink (Thea). There is no apparent check for whether worms are dead or alive when thrown/washed. They are treated as if they are inanimate. Similarly, plates of redundant worms are thrown into the bin.

Regularly feeding the organisms is integral because, as Xavier tells me, fresh food keeps them at optimum health. I watch Hannah as she feeds worms the E-Coli bacteria, which she has dissolved into a clear, water-based jelly. The jelly is inserted using a pipette into each plate. Hannah also refers to *"chunking",* and I learn that this is the process of transferring worms contained in square chunks of E-Coli bacteria food solution. It looks like a thin, clear layer of solid, jelly-like liquid at the bottom of each plate. I observe worms' food being changed every time worms are picked and moved to a new plate. Making fly food is more complicated and it involves visiting what is referred to as the *"kitchen"* - known formally as the *"Drosophila Media Preparation Room"*.

I observe that food is made up of a combination of agar jelly, yeast, and sucrose. James tells me that the amounts of these components are altered because food is often an experimental variable. The kitchen is not unlike a regular household kitchen with many appliances including a dishwasher, a sink, and a microwave. There are lots of boxes and

containers filled with different ingredients. To make food, James firstly picks up a large bag of brewer's yeast. He takes a large scoop over to the scales to measure a small amount. James coughs as the fine yeast powder is dispersed into the air and goes into his lungs. He mixes the yeast with the sucrose and agar jelly and puts it in the microwave for *"several four-minute bursts"* (James). The room smells to me like malted hot drinks, which is probably the smell of the yeast. James tells me that other researchers in the laboratory use the hob instead of the microwave and also that everybody has a slightly different method for making the flies' food. The food, which is in the form of warm brown liquid, is poured into fresh vials. The vials will be used for the following morning's fly tipping. Even though it is an integral part of experiment, it feels to me like a strange break from the controlled laboratory routines.

Biogerontologists and their Instruments

Biogerontologists' materials become their 'extensions' (Strathern, 1991; Munro, 2001; Latimer, 2008) in that they attach to and detach from these as part of their day-to-day routines of 'good science' – for example, vials, food, plates, animals, and so on. Materials are used, which is followed by disposal. As well as using and disposing of animals, researchers also use and dispose of equipment as and when is needed. This enacts a pragmatic or instrumental[98] relation between researchers and their materials. Typical comments between researchers include things like: *"I'm using the Vortex machine as I need to mix these two liquids evenly",* or *"are you done with the plate reader? I need to use it for this experiment"*. Used equipment gets put back into its place afterwards so as not to clutter the laboratory. Some equipment - for example, the glass slides used to view animals under the microscope, and cotton wool bungs for the top of vials - is disposable after a single use. 'Vessels' such as plates (also known as petri dishes), vials, and bottles are washed by technicians in the autoclave after use. These materials, as 'instruments' of good science and/or good biogerontology, become part of the enactment of biogerontology in the laboratory setting.

The flies and the worms are also biogerontologists' materials, and I have described the ways that researchers handle them - as 'docile' instruments - benchside. Latimer

[98] I use this word to describe a 'using' relation, rather than thinking about instrumentalism in terms of a more broad 'utilitarian'-type philosophy.

(2013a) differentiates between the animate and the inanimate, and she argues it is not merely a case of distinguishing between these - for example, in the laboratory, the worm as animate and the microscope as inanimate - but that it is a matter of a 'complex dwelling'. I argue that the laboratory's animal models become 'animate-inanimates' of sorts because they are living and animate yet, as part of the 'mass', they are no longer separate and unique organisms. Researchers value worms and flies because they are experimentally efficient. Professor Hurst tells me that worms are better because they are small so you can freeze them down. Also, he says, they have short lifespans, which means they are good for conducting large numbers of lifespan experiments (see Milne, 2015). Lifecycles order, or 'punctualise' (see Latimer, 2013a) the scientists. Dr Starr talks about the importance of timings:

> *"You plan ahead when you're going to do things, so it's a very regimented thing for the two and a half months that the flies are alive, when you work with whole animals, you have to grow things, and they have set times that they take to grow [them] and you have to know when to collect things. You have to plan, there's a lot of planning of timing really."*
> (Dr Starr, CFL Co-Head, Interview)

Organism lifecycles are integral to the ordering of the laboratory and subsequent experiments. Researchers talk enthusiastically about lifecycles. They show me different developmental stages under the microscope. James explains that there are three stages in the development of a fruit fly before they become adult flies: 1) egg, 2) lava (larvae – plural), and 3) pupa (pupae – plural). Furthermore, I am informed that the 'normal' length of the lifecycle is ten days. On day one, after conception, the organism is what is known as a *"first instar larva"*. On day two, this becomes the *"second instar larva"* (James), and this is followed, on days three and four, by the *"third instar larva"* (James). For just over half of day five, it is then, what is known as, a *"pre-pupa"* (James). The organism is then, James asserts, a *"pupa"* until day ten. At day ten, he says, the fly *"encloses"*, and subsequently an adult fly hatches.

Thea says that the flies are very sensitive to temperature. She says that the lifecycle takes seven to ten days in the highest temperature incubator and 'two plus' weeks in the

lower temperature incubators. I can barely see the fly eggs with my eye because they are half a millimetre long. Under a microscope, I see that eggs are yellow and oval. James says that at the end of the third instar larva stage, the larva finds somewhere on the side of the vial or bottle to pupate (to turn into a pupa). I see that a pupa is a small chrysalis with a hard translucent shell. Pupae, soon to enclose (hatch into a young fly), cover the walls of the bottle that James shows me. Thea explains that she can see how close flies are to enclosing because, she says, the *"darker it is, the closer it is"*. She invites me to look, and I see various shades of dark shapes of flies-to-be through the translucent pupa.

Gonzalez (MWL PD researcher) explains that the lifecycle of worms - following the *"embryonic stage"* - is made up of four larval stages and these are known as 'L1', 'L2', 'L3', and 'L4'. I learn that there is a *"moult"* (Gonzalez) at the end of each of these stages. At the end of the L2 stage, at higher incubator temperatures, worms take *"one to three days"* (Gonzalez) to complete the lifecycle and at lower incubator temperatures this becomes, he tells me, *"three to five days"*. Whilst I observe the worm larva through the microscope, I cannot differentiate between worms at the different larval stages. I observe Gonzalez picking for an experiment. He is engrossed with what he is doing:

> *Sophie: "What are you doing?"*
> *Gonzalez: "I'm picking worms for a lifespan experiment, I need to separate adults from their offspring and then once they're at a certain stage, a very identifiable one, they can be put on the plate for the lifespan experiment."*
> *Sophie: "Right."*
> *Gonzalez: "It's important that they are all at the same stage. They lay six eggs every hour. If you know that they're all at the same stage, then you can know how many progeny there will be at a certain time, for example, at Tuesday at 10 o'clock, I know that there will be X amount of offspring."*

I ask Gonzalez about this experiment again at the end of the week:

> *Gonzalez: "I haven't started it yet, I'm still preparing for it. I'm still picking for it."*
> *Sophie: "Oh wow!"*
> *Gonzalez: "I want all of the worms in all the different strains to be synchronised so that they are at the same stage when I start the experiment on Sunday."*
> *Sophie: "Will you come in on Sunday to start it?"*
> *Gonzalez: "Yes and then I'll start counting from Sunday."*

Gonzalez is *"separating adults from their offspring"* because he wants to use the offspring for a lifespan experiment. In order to use these offspring, he says, they need to be "*at a certain stage, a very identifiable one"* so that *"they can be put on the plate for the lifespan experiment"*. Gonzalez describes that adult worms lay six eggs every hour and, subsequently, he explains that if he has isolated a group of worms all at the same stage and put them together on one plate, he can then predict how many new *"progeny"* there will be at any given time. This was at the start of the week. When I ask Gonzalez at the end of the week how the lifespan experiment is going, he says that he was still preparing for it. He explains he wants "*all of the worms in all the different strains to be synchronised"*. This is so that they are all at the same stage for starting the experiment on Sunday. Gonzalez's commitment to his experiment and/or 'good science' is shown, alongside a 'demanding relation' (Latimer, 2013a) between Gonzalez and his worms.

Animals, Excellence, and Membership

Animals were instrumental to the way that both heads and hands constituted their identities. I regularly heard researchers refer to themselves as a *"worms person"* or a *"fly person"*. Researchers use these categories to describe researchers at other laboratories – for example: *"Oh those guys over at X laboratory, they're fly people"*. These categories are not exclusive to the field of biogerontology, yet they are categories in the non-public setting that are used to describe biogerontologists' identities. This was accompanied by a sense of pride in working in, what were referred to as, the worm/fly *"traditions"* (Professor Hurst). During one afternoon at the bench, Professor Hurst enters the laboratory and sits by Kate and I. We discuss the history of *"C. Elegans research"* (Professor Hurst):

> *Professor Hurst: "In some labs there is a certain level of snobbery for labs or scientists who aren't up to scratch, for example, if they weren't classically trained in C. Elegans. Dr Lowe did great work, but he wasn't an excellent scientist and the guys that I worked with at previous jobs always used to make comments about him."*
> *Sophie: "What does it mean to be classically trained in C. Elegans?"*
> *Professor Hurst: "Work from C. Elegans all came from a guy: Dr Topps. I worked with him at postdoc level. He started off with the research and then realised that it was an excellent model to work with."*
> *Sophie: "Oh right."*
> *Professor Hurst: "A lot of ageing research is really very bad. They apply some chemicals to worms and get some results, but they don't really know enough about genetics."*

Professor Hurst tells me that there is *"snobbery"* in his community – implying that there is not snobbery in his laboratory – if laboratories and/or scientists *"aren't up to scratch…if they weren't trained classically in C. Elegans"*. He refers to Dr Lowe – who apparently did *"great work"* – and he says that some colleagues make comments about Dr Lowe's poor science. Intrigued, I ask Professor Hurst what it means to be classically trained in *C. Elegans*. He tells me: *"work from C. Elegans all came from a guy: Dr Topps"*. He boasts about working with Dr Topps, who he describes as a pioneer in research with C. Elegans (worms). In doing so, Professor Hurst constitutes his work as excellent, or 'first class', like that of Dr Topps (and not as 'second class', like Dr Lowe's work). Professor Hurst warns that there is a lot of *"bad"* research ageing research where researchers have not been classically trained, but merely *"apply some chemicals to worms and get some results"*. A PD researcher, Ariel, tells me that in a highly competitive field, she was recently recruited - by Professor Hurst to the MWL - because she had had a prior research post at Dr Topps' laboratory.

Animals were described as instrumental to biogerontologists' membership and career progression. Most researchers had stayed within the same animal model tradition. Often, researchers reported that their choice of animal model was based upon an

excellent laboratory that they wished to work in. Dr Kennedy tells me how he came to work with flies:

> *"When I went to third year of undergraduate I did a research project and it was a fly project and then for my MRes equivalent I chose a project based on my supervisor, not so much based on the project. I was interested in the project but it was the supervisor more. He was just clearly you know, clearly excellent, and the other one which was more lab based, which is what I mean is more molecular lab based and the molecular stuff never grabbed me. I always felt it was fiddly and you're dealing with things that you can't see and something could go wrong that could be any one of six things, but flies you know, it was a bit more macro, and this supervisor was just excellent and I did that project and then did a PhD in his lab as well and that was it. I was kind of hooked, and so what you do is you build up expertise, both expertise and a comfort zone."*
> (Dr Kennedy, CFL Co-Head, Interview)

Dr Kennedy describes beginning his research career working with flies in this third year of an undergraduate degree, which was followed by an MRes equivalent also working with flies. He describes how his choice was based on an *"excellent"* supervisor, alongside his preference for a 'fly project' over a 'molecular project'. This was, he argues, because he likes the tangible, fleshy, *"macro"* nature of the flies compared with the *"fiddle"* involved in studying molecules. This contrasts with the more traditional classificatory system present areas of biology (see Grene, 1987), which was described earlier in this chapter. Dr Kennedy says that he became *"hooked"* on flies and that to progress, you must build up both *"expertise and a comfort zone"* when working with a particular animal model. He tells me later that whilst this expertise opened up opportunities to work in various laboratories, the specialisation can be a hindrance if a researcher wishes to switch to working with another animal model.

These accounts show the importance of the animal (models) to a researcher's career, and also membership to science, biogerontology, and a particular 'animal model' tradition. Furthermore, researchers emphasise the importance of the 'fleshy' contact with organisms, which is distinctly more prevalent as part of benchside labour.

Researchers showed me online databases ('WormBase' and 'FlyBase'), which were spaces for members of the 'worm' and 'fly' communities to share organism profiling (e.g. 'Strain A' has 'Measurement X') and experimental information (e.g. 'I applied 'Chemical Y' and this was the outcome'). Whilst the worms and flies are briefly mentioned in the public setting, in the laboratory setting – or, what I have termed, the 'animal laboratory present' – there is a greater emphasis placed upon them.

Summary

In this chapter I described the world/s made by biogerontologists (as 'basic biology' laboratories) at two biogerontology laboratories. By providing a rich description of the socio-spatial layout of the Metrotown and Countryville laboratories, I showed that biogerontologists' day-to-day routines were particularly ordinary - or *"mundane"* as Dr Starr suggested - which contrasts with the public 'heroics' (Featherstone, 1992) that were performed in the public setting. I showed how 'good science', like in the public setting, was valued by researchers at both institutions, particularly at Metrotown University as a 'first-class' institution in relation to Countryville University's seemingly humble 'second-class' status. I showed that the classifications made in this setting were a continual accomplishment, which was shown on occasions like 'Lab Meetings' and 'Progress Reviews', alongside celebrations of researchers' publications and other successes. By making visible the ordering/s 'made' by researchers, I exemplified the accomplishment of 'good science' as excellence, which extends the work of Latimer (1997; 1999; 2013b), who observes the same kinds of orderings medical settings as part of observing 'first class' and 'second class' medicine. I showed that the accomplishment of 'good science' – as the ethical - was a practical enactment of care, but through showing that this enactment is synonymous with biogerontologists' public *concern* for good science, I extend Latimer and Puig de la Bellacasa's (2013) interrogation of 'the ethical' in biogerontology.

As part of explicating researchers' care for 'good science', I described the social ordering of the biogerontology laboratory. First, I unpicked the 'division of labour' - and/or 'the labour of division' (Latimer, 1998) - within the context of the laboratory's staff hierarchies. Drawing on Pallí (2004), I described a key distinction between the 'head' and the 'hands', and I extended this distinction by making visible researchers'

labour of dividing between the heads' 'deskside' work and the hands' 'benchside' work. I also illuminated asymmetrical flows of accountability between the different types of researchers in the laboratory spaces, which, as part of an apprenticeship system, reinforces the notion that there is much value placed upon 'good science' in this setting. Furthermore, I described the way that researchers classify different benchside tasks for their level of 'importance' and/or interest. For example, basic tasks like 'picking' - or what Latimer and Puig de la Bellacasa (2013) describe as 'changing the nappies' - whilst important, were also less desirable than tasks like 'dissection' or 'molecular biology'.

I described repetitive tasks like 'picking', 'tipping', 'gassing', and 'pushing', which are foundational to the accomplishment of the mundane laboratory routines at Metrotown and Countryville. These tasks are undertaken as part of 'lifespan' – and other - experiments that 'make use' of animal and non-animal materials as part of studying multiple aspects of ageing as a mechanism. In this current chapter, I described (with a focus on fly/worm reproduction and death, and also the pursuit of 'purity') the making of a 'world of genetics' in the laboratory space, with the animal (models), as instruments – and perhaps as 'cyborgs' (Haraway, 1991) - being made to stand for genes in addition to being made to stand for humans. This is as ageing - as what Professor Hurst calls a *"phenotype"* - becomes subject to a process of geneticisation in this setting. Ageing as being determined by an organisms' genes is, in turn, one of the meanings of ageing and life that are are 'made to mean' in this setting. In the current chapter, I made reference to researchers' description of selective breeding practices, as 'eugenics', and I continue with this trope at a later point in the thesis (see chapter seven). Moreover, I have shown that the animals, as models and/or instruments, are integral to the accomplishment of researchers' - as 'worm' or 'fly' people – identities also and membership to the particular life sciences' traditions in which they are entangled/situated. Such identification contrasts with clear biogerontology-based identities that are circulated in the public setting (see chapter four).

In the current chapter, I explored researchers' physical proximity to animal and non-animal materials at the bench, which I observed as being part of 'good science' and its relation/s of instrumentality and usefulness accomplished at the bench by the hands.

Whilst 'good science' was a continual accomplishment - in relation to attempts to control the liveliness of the animals (as other life) - moments of ambiguity (e.g. Amelie's 'pretty worms' and Hannah's avoidance of 'harming' worms during picking) were introduced, particularly in relation to thinking about what exactly is being harmed. I elaborate upon such ambiguities and complexities at a later point in the thesis (chapter seven). However, in the next chapter, I extend focus to ageing in relation to laboratory control and standardisation, and also the 'quantification' of ageing, and I build upon the detailed descriptions of the laboratory – and its experiments - that were offered in the current chapter.

Chapter Six

Making it Fit: The Quantification of Ageing

Introduction

In the current chapter, I elaborate upon the description of biogerontologists' mundane laboratory routines, or what can be thought of as biogerontologists' *"everyday engagements of care"* (Latimer and Puig de la Bellacasa, 2013: 153), captured in the previous chapter. This is by way of describing some of the laboratory experiments – these experiments were also referred to by biogerontologists in the public setting (see chapter four) – and, in doing so, examining three enactments of ageing that take place in the laboratory: 'lifespan', 'healthspan', and 'neurofunction'. I draw on these enactments of ageing as a locus for the discussion of the quantification (Porter, 1995), standardisation (Moreira, 2015), and/or simplification (Star, 1983) of ageing. I was initially disconcerted when ageing was scarcely mentioned in the laboratory setting. At Metrotown, I was observing at an institute dedicated to 'ageing'; Metrotown Healthy *Ageing* Institute (my emphasis) (the Metrotown laboratory space was laden with biros and lab coats embossed with this word: ageing), and my initial invite to Countryville was premised upon my coming to observe researchers as they study 'ageing' in flies.

Ageing (as a category) did not seem to be present in day-to-day laboratory experiments. Collins (2008) distinguishes between actors' and analysts' categories. I had, because of biogerontologists' consistent use of ageing as a category in the public setting, developed ageing as, what Collins refers to as, *"a category of [my] own – to do the work of explanation"* (Collins, 2008: 1). Despite this initial disconcertment, I describe in this chapter how ageing was an absent-presence, as biogerontologists constituted ageing – as part of the continual accomplishment of 'good science' - as quantified. Quantification is the 'trustworthy' currency of science (Porter, 1995), and in what follows, I show that biogerontologists make their data fit this way of seeing and/or doing. Furthermore, in the chapter, as well as focusing (drawing primarily upon data taken from the MWL and the CFL) on the accomplishment of three different experiments/ways of measuring 'ageing' in the biogerontology laboratory, I extend my focus to the way that the three

enactments of ageing described are represented. I also draw from other modes of data for the purposes of triangulation.

Public Biogerontology and the Ambiguous Category of Ageing

To recap (see chapter three), the first time 'ageing' was mentioned in the laboratory setting was when Amelie (MWL PD researcher) became curious about why I (the *"anthropologist"*) was sitting at the bench scribbling into a reporter's notebook. To recap, Amelie stopped picking for a moment to ask me what in the world I was doing *there* studying *them*. *"Oh!!! You're interested in AGEING!?"* was her response when the penny dropped that I was there to study *them* because they were studying *ageing*. In a previous chapter (see chapter four) I showed that biogerontologists (like RF and ADG) agreed in public that ageing was a biological mechanism, and also that intervening was a moral imperative. This was echoed in public perceptions of biogerontology, and my field diary reports my receiving of many emails (mostly from peers and colleagues) informing me that they had watched or read about the 'scientists' that they perceived me to be studying; the scientists who are 'curing ageing'. Before I entered the laboratory space, I had taken for granted the category of 'ageing'. This is especially because stories about ageing were circulated in interviews:

> *"The possibilities for biogerontology [are huge], well the realistic ones, at the moment in terms of intervening in ageing and what that would do for ageing related health and the possibilities of sort of transforming medicine and having a whole new medicine in the future which is based on the prevention of ageing, and, you know, it would never be complete prevention, but it would be a kind of reduction of ageing."*
> (Dr Bloor, Simmondsfield University, Interview)

Dr Bloor uses the category 'ageing' four times in the above extract and she continues to use it throughout the interview. First, she describes *"intervening in ageing"* in relation to the targeting of *"ageing related health"* and subsequently *"transforming medicine"*. In doing so, Dr Bloor (as a representative of the biogerontology community) circulates the 'big story' about ageing (Latimer, 2014) (see chapter four) in relation to healthy human biomedical futures and the *"reduction of ageing"* as a desirable medical goal for

humanity (see also Binstock et al., 2006; Mykytyn, 2006c; 2010; Fishman et al., 2008; Vincent, 2008; Latimer et al., 2011). Whilst biogerontologists had drawn on quantifiable definitions of ageing in the public setting – for example, I have already described Professor Kenyon's reference to the 'lifespan' of *C.Elegans* in a public presentation - I felt justified in my initial expectation that I would find 'ageing' as an explicit category in the laboratory setting. However, I proceeded to ask myself the questions: why *would* 'age' (an ambiguous, immeasurable, and, arguably, non-standard category) be present in a science laboratory setting, and also what categories *are* present in this setting? Dr Day (Head of Lemworth University's biogerontology department) draws on the categories 'lifespan' and 'ageing' during an interview:

> *"We've already increased lifespan by 50% in the last fifty years or something like that, so we've already markedly increased lifespan in the past century, so do we increase it 50% more? 20% more? What is too much? Ultimately what I think biogerontologists are doing, we are trying to eliminate not just ageing, but all age related diseases. If we could do that, we would cure ageing, well all age related diseases and all degenerative aspects of ageing."*
> (Dr Day, Lemworth University, Interview)

Dr Day draws on the category *"lifespan"*, which refers to chronological age (CA). Here CA is both a measurable *length* of life and a 'biomarker' for ageing (Moreira, 2015) contrasting with popular, qualitative notions of the 'lifecourse' (see Featherstone and Hepworth, 1989; Blaikie, 1999; Bothelo, 2014). Dr Day begins by talking about the past and present (*"We've already increased lifespan by 50% in the last 50 years")* in relation to approximated statistics about the general increase in human lifespan that has happened in the absence of targeted intervention against ageing. He then (speaking for the biogerontology community) makes a switch to projecting his ideas into the future. This is alongside a making a switch to speaking about ageing rather than lifespan (*"We are trying to eliminate all age-related diseases…and all degenerative aspects of ageing. If we were to do that we would cure ageing")*. He is drawing on biogerontology in relation to a biomedical discourse (Moreira and Palladino, 2009), which is emblematic of biogerontologists' accounts that are given outside of the laboratory setting (see chapter four).

I have described (see chapter five) how biogerontologists, as part of what I have referred to as the 'laboratory present', examine multiple strains of worms and flies as part of the day-to-day rhythm of the laboratory, which includes lifespan experiments. I also showed that biogerontologists value the health and/or purity of model organisms, which was mostly as part of the accomplishment of 'good science'. Furthermore, in the public setting, ADG emphasises: *"what we're on about is extension of healthy lifespan*" (Public Debate), which I find out later is often shortened by biogerontologists to *"healthspan"*. RF (also at the Public Debate) asserts: *"there are more than a few straws in the wind here that show that we are not lengthening life, we are lengthening life through the improvement of health. We are improving healthspan"*. In addition, Dr Kennedy says to me during an interview: *"it's all about healthspan… you have to say healthspan and not lifespan these days"*. I have already shown that potentially stigmatising diseases, like cancer (see Sontag, 2001), become part of biogerontologists' rhetoric as they describe (what they refer to as) the *"unhealthy"* effects of ageing (see Binstock 2006a; 2006b; Mykytyn, 2006c; 2008; 2010a).

At *The Public Sector Ageing Conference*, Professor Kirkwood gives a presentation that emphasises, drawing on both CA and biomarkers for ageing alongside a biomedical discourse, increased physical and mental degenerative effects of ageing in, what he refers to in his presentation as, the *"eighty five plus"* (see also Collerton et al., 2014). He explains that both physical and mental function generally declines to a greater extent after this chronological 'limit'. Milne (2015) suggests that further to a more traditional focus on physical decline, mental function (including dementias such as Alzheimer's disease and Parkinson's) is at the forefront of discussions surrounding healthspan and the study of ageing. During an interview, Dr Starr explains to me that she is interested in (what can be thought of as) 'neurofunction' in relation to flies' behaviour:

> *"I work on the effects of ageing function controlled by the brain in a sense, so I look at behavioural measures at least in flies. I'm finding that the lifespan extending manipulations that we do, like changing insulin signaling, either has no effect on some of these behaviours that I'm looking at, has no effect on the normal decline of them, or it makes the decline worse, faster, and so these animals can be long lived but have faster behavioural locomotive decline for*

> *example…you can actually separate, at least in a fly, lifespan and behavioural ageing."*
> (Dr Starr, CFL Co-Head, Interview)

Dr Starr refers to *"ageing function controlled by the brain"* as she describes *"look[ing] at behavioural measures… in flies"*. Here, in explaining a perspective of ageing as both brain function and *"locomotive"* function (determined by the brain), she refers to behaviour exhibited by the flies she studies. Their behaviour is thus figured as an output of the flies' cognition. This is, she explains, in relation to the *"decline"* in flies' behavioural function that takes place later in their lifespan. Dr Starr does however make a distinction between function and lifespan when she says: *"animals can be long lived but have faster behavioural locomotive decline"*. She circulates a discourse of function and she thus reiterates a functional/productive perspective of ageing. This can be thought of in relation to the story about usefulness that was circulated in the public setting; the story that is criticised by multiple authors (e.g. Vincent, 2008; Latimer et al., 2011) in relation to biogerontology and/or 'anti-ageing science and medicine' and its ageist claims (Mykytyn, 2006c; 2010a).

Enactment One: Ageing as Lifespan

Like many ethnographers of science, I find in the laboratory setting a very slow and outwardly unexciting routine. Dr Starr tells me that this routine is *"monotony"*. The routine comprises benchside tasks (see chapter five) undertaken by the hands (Pallí, 2004) such as picking, pushing, tipping, feeding, breeding, and maintaining. These are carried out as part of preparation for, what are commonly referred to as, *"lifespan experiments"*. Lifespan experiments are designed to measure the length of organisms' life. Researchers at the CFL and the MWL carry out these lifespan experiments, which are one of the predominant undertakings of the laboratory setting. This is alongside examining the underlying cause of variations in lifespan that are found during these experiments. The average lifespan of a 'wild-type' fly is between five and seven weeks, which, described in the previous chapter (chapter five), is dependent upon the temperature at which the flies are kept. Similarly, the average lifespan of a worm is three to four weeks. James (CFL PhD student) explains to me that lifespan experiments typically entail two kinds of intervention. The first method of intervention that I observe

is the administration of a chemical compound (often referred to as a drug) to a particular organism (for example the harmful substance *"RU468"*). Differing chemical compounds applied to the organisms, James says, either reduce, increase, or *"knock out"* genes that are targeted because they might regulate ageing. I notice that he refers to *"knocking out"* genes in the same way that he refers to *"knocking out"* flies. This language reinforces a story of forcefully getting rid of something when it is not useful/optimum. This implicitly aligns with the anti-ageing and pro-usefulness discourses – captured by Vincent (2008), Mykytyn (2008), Lafontaine (2009), and Latimer et al. (2011) – that I described in a previous chapter (see chapter four).

James describes the second method of 'intervening' as the manipulation of the organisms through breeding new mutant strains in order to create *"long-lived mutants"* (James) (e.g. DAF-2 and GLP-4 mutant worms). Whilst Davies (2013) suggests mutant model organisms encourage heterogeneous modes of 'thinking' and 'doing' science, I observed that standardised mutant worms and flies were part of a predominantly controlled laboratory routines and also part of the ongoing practical accomplishment of 'good science'. However, there is some degree of the 'unknown' as the drugs that are administered to organisms are selected based upon *"previous successes and educated guesses"* (James).

As I have described (chapter five), it is organisms' lifespans and lifecycles that become a source of unpredictability/uncontrollability, which aligns with Milne's (2015) finding that lifespan and/or ageing experiments subvert notions of 'ideal' science because of the longer waiting time required as an organism/cell 'ages'; ageing is 'slow' (Puig de la Bellacasa, 2015). Heidegger describes the way that modern technologies 'enframe' (1977) people *"beholden to the calls of metaphysics and technology"* (Latimer and Munro, 2009: 330). This can also be thought in terms of 'punctualisation' (see Latimer, 2013a), as researchers' time and space is ordered by the liveliness of the animals (see chapter five). Latimer (2013a) describes this relation in terms of 'being-with'. This is in the sense that the relation is mutual, yet it is premised upon instrumentality rather than affect. I have described that Gonzalez (MWL PD researcher) makes plans to work at the MWL at the weekend because he requires the batch of worms that he was picking to be at the same stage (L4) for a lifespan experiment (see also chapter five). Furthermore,

Hannah (MWL technician), rolling her eyes, tells me: "*being in at the weekend is not ideal, but often you find yourself planning your life around the worm's lifecycle"*. Whilst Puig de la Bellacasa (2011) describes 'ethical doings' as working with the rhythms of nature, here, biogerontologists are forced to work around these rhythms are part of 'good science'.

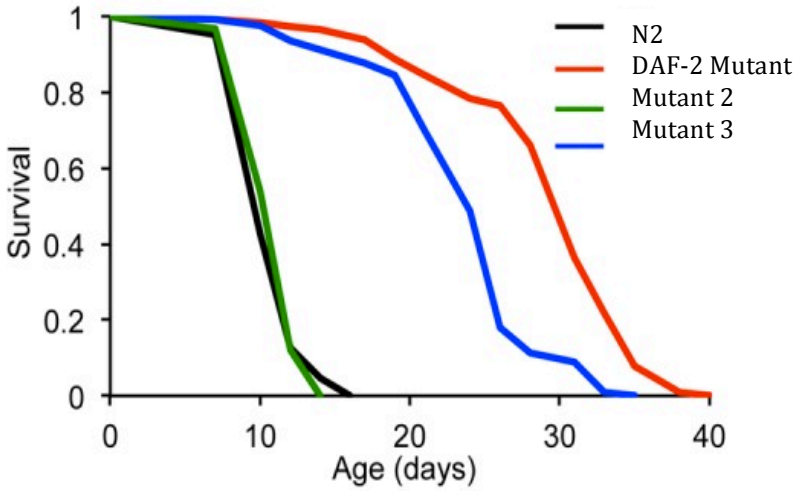
Early one morning, I find James with a tray of about fifty flies. He explains to me that he is conducting a lifespan experiment. I see that each vial contains approximately twenty flies. He counts the number of dead and alive flies in each vial and then he gasses the flies with the CO_2 gun. He then applies a clear liquid, administered with a pipette, to the alive, gassed flies that remain in each fresh vial. He explains that the flies are part of an experiment that he has set up in order to *"measure the lifespan of flies"* (James). He says that the flies have been administered a solution, the clear liquid, made up of ethanol and RU468 (also referred to as Mifepristone). RU468 is, he explains for the second time: *"the abortion drug that is administered to women undergoing early stage termination procedures"*. RU468, in theory, causes *"the controlled expression of the gene of interest"* (James). James has identified this particular gene of interest (though he does not refer to it using a unique name, like DAF-2) as potentially having an effect upon lifespan. James says that there are three *"batches"* of flies that are part of this experiment that he is conducting: 1) a group of flies being administered a high dose of RU468 that has been dissolved in ethanol, 2) a group of flies being administered a low dose of RU468 that has been dissolved in ethanol, and 3) a control group being administered ethanol only. James applies the solution to the top of the flies' food in each vial. Upholding 'good science', he says that he is very careful to measure an identical amount of the solution each time it is applied so that the experiment is *"rigourous and easily replicated"* (James).

James adds this solution every time that he tips his flies. I watch him count the number of flies that are dead and the number of flies that are alive in each vial. He does this in order to measure lifespan. He says that he does this every day whilst an experiment is running. The total number of organisms that are counted dead and alive each day is entered first into a spreadsheet and then into a computer. James explains that at the end of the experiment when all of the flies have died, he will instruct specialist data analysis

software to calculate the average lifespan of each of the three groups of flies. James tells me that after this, he will instruct the software to analyse these data-sets to see if the result is *"significant"* (James). He explains: *"only occasionally you get a significant result"*. He also asserts that when there is a significant result that it is *"relatively exciting"* (James). These exciting 'results' become the focus for further experimental inquiry. In this particular moment, James appears 'moved' by good science; by this 'Wow! Moment' (Latimer and Puig de la Bellacasa, 2013).

At the MWL, lifespan experiments follow the same experimental model. However, researchers use worms instead. Whilst the dead/alive flies can be seen with the naked eye, magnification is required in order to observe the same in worms. Under a microscope, researchers at the MWL observe 'plates' of worms that are part of lifespan experiments. Kate (MWL PD researcher) tells me that she counts worms that are still alive (still *"slithering across the plate"*) in order to measure lifespan. She explains that these measurements are represented in graphs. She points towards a line graph (Figure 8) that she has created (also using specialist software) to represent 'results' she has obtained from several recent lifespan experiments that she has carried out.

Figure 8: Line Graph to Represent Kate's Lifespan Experiment[99]



Sophie: "[The result of the lifespan experiment] goes onto the graphs...?"

Kate: "Yeah if you make one mutation sometimes they're a bit shorter

[99] For the purposes of the informant's anonymity, I have removed the names of two of the three mutant strains of worms so that the experiment/graph cannot be identified using academic publications.

> *lived, and if you do something else sometimes a bit longer lived. You can look at comparisons, you know."*
> *Sophie: "Right."*
> *Kate: "See this black line, that's a wild-type worm, so you've got the percentage surviving on the side, and this is the age of them when they died. So as they die, look at the black line, that's the lifespan of a wild-type worm. And then if you make various mutations, some of them are shorter lived and some of them are longer."*
> *Sophie: "And so, you know, people talk about significant results, so what do those graphs show, is there a significant result, are you putting that in your paper?"*
> *Kate: "Yeah so you do statistics on these, statistical software to use on this, and I can tell from that, that there is a statistically significant difference between that black line and that red line. And I will report that somewhere in the paper."*

Kate shows me a graph that represents *"comparisons"* between the varying 'lifespan' of different strains of worms figured in the diagram, which can be thought of as an 'inscription device' (Latour and Woolgar, 1986). Interestingly, lifespan is represented on the X-Axis using the category of *"age"* (this is measured chronologically in 'days'). The *"percentage [of worms] surviving"* is shown on the Y-Axis. There are three differing strains of mutant worm represented. This is alongside *"N2"* (the 'wild-type' worm). Kate begins to talk about lifespan as she interprets the graph. She tells me that the black line represents the wild-type worm. Kate says: "*some of [the strains] are shorter lived and some of them are longer lived"*. She also says that she can *"tell from that, that there is a statistically significant difference between that black line and that red line"*. Here, she refers to a visual (seeing with the naked eye) difference between the red and black lines on the graph. The red line represents the DAF-2 mutant. Kate tells me that the next thing that she will do is use *"statistical software"* in order to analyse the data. Like James, Kate tells me that a statistically significant result is valuable. It is a 'success' for 'basic biology' and the pursuit to 'solve' ageing (Moreira and Palladino, 2009). Smiling, Kate tells me she will "*report [the statistically significant difference] somewhere in the [academic] paper"*.

Enactment Two: Ageing as Healthspan

I have referred to what biogerontologists call healthy lifespan, or *"healthspan"*. Dr Kennedy (CFL head) tells me that this category is emerging in the field because of growing concern that an increased lifespan will render organisms more susceptible to ill health in these 'extra' years. Moreira and Palladino (2009) show the co-constitutive relation between the 'medical' and the 'biological' in biogerontology and they also describe the paradoxical relation between 'chronological' and 'biological' definitions of ageing (see chapter two). This is within the context of biogerontologists' differing definitions of ageing. 'Healthspan', exemplifying this paradox, draws together notions of health as a biomarker of ageing (measured non-chronologically) with the chronological and/or standardised measure of 'lifespan' (Moreira, 2015). During Orla's (MWL graduate student) 'Progress Review' meeting with her 'head', Professor Hurst, I observe - following Lewis et al. (2012) who observe model organisms 'diagnosed' with 'Rett Syndrome' on account of the symptoms, 'paw grasping' and 'biting' - the diagnosis of what Orla and Professor Hurst call *"GLP-4 mutant worms"*. These worms, the pair claim, have had their 'germline' removed in at attempt to decrease the instance of tumours in this mutant. This is because large amounts of tumours have been found to be a 'side effect' of the GLP-4 mutation in the worms.

Orla explains to Professor Hurst and I that she has been studying a set of images of the worms in the microscopy room. She explains that she has been checking for *"abnormalities"* (Orla). Orla has captured still images of the magnified worms. She claims that in the experiment that she has been carrying out, two batches of the GLP-4 mutant worm were compared over twelve days, with each batch kept at a different temperature (20°C and 25°C). The *"germline"*, which is a set of cells that house genetic material to be passed on to the worms' *"progeny"* (Orla), has been removed from this batch of worms because of the increased incidence of tumours found in this strain at the MWL. Orla inserts her USB stick into the computer and she brings to the screen the still images of the worms that she has captured. Professor Hurst examines the images. On the large computer screen I see an image of what looks like a worm. Upon the grey background, I see a composition of grey shapes, lines, and areas of shading that are arranged into a 'worm shape'. Orla and Professor Hurst stare intensely at the first set of

images on the screen, which are images of the GLP-4 mutant worms kept at 20°C. The two researchers converse as part of the 'Progress Review' meeting:

> *Orla: "The images of the worms were taken over the course of 12 days. These photos [the first of 2 sets] show the worms at 20 degrees."*
> *[Professor Hurst flicks through the photos and smiles]*
> *Professor Hurst: "There don't appear to be any tumours here."*
> *[He looks at one image]*
> *Professor Hurst: "I think that this is fat [points to an image of the worm which appears to have a an unusual substance that has taken up a lot of the inside of the worm] and I think that these bits are yolk [he points to what look like holes in the fat] as they have nowhere to go because of the removal of the germline."*
> *Orla: "Mmmm." [smiles and nods in agreement]*

Professor Hurst examines images of the first *"batch"* of worms Orla shows him. He then diagnoses the worms: *"there don't appear to be any tumours here"*. I observe many small and differently shaped translucent masses intertwining and overlapping with the many (seemingly) identifiable body parts visible in the image. Professor Hurst, after looking pensively at the screen, diagnoses these masses as *"fat"* and *"yolk"*. Orla nods and mumbles in agreement. Later in the interaction, Professor Hurst identifies the different parts of the worm's body: *"look, we can see the vulva here and the gonads, although they are sitting a little differently to normal. There's the spermatheca [he draws a diagram of the spermatheca for Orla]. Here's the intestine, there are clearly no tumours"*. Professor Hurst, who describes the worms' body parts, has reduced them to these constituent parts. Such a reduction is consistent with biogerontologists' publicly circulated statement that ageing is a mechanistic process that can and should be intervened in (see chapter four).

Following the diagnosis of *"no tumours"* and what is figured as, instead, less harmful *"fat"* and *"yolk"*, Professor Hurst and Orla are visibly pleased with this provisional 'result'. When they examine the images taken from the second batch of worms, which have been kept at 25°C, there is a similar result in that, again, yolk and fat are present.

Furthermore, there is an absence of tumours. Professor Hurst says that the fat that is present in the worms that were kept at the higher temperature (25°C) is more widespread than in the worms that were kept at the lower temperature (20°C). He says that the yolk in the second batch is coming from the worm's vulva. In contrast, he says that this is not the case in the first batch of worms. In the first batch, the source of the yolk is not clear. The visual difference between the two sets of images is such that I have no trouble in differentiating between the two. Professor Hurst tells Orla that the body parts are more identifiable in the second batch. Next, he speculates that because of the extra 5°C, the second batch of worms is likely to have *"grown more quickly"* (Professor Hurst).

As they both revisit the images, I can see that Professor Hurst and Orla (despite the unexpected presence of yolk and fat) remain pleased because there are no tumours. The tumours have become a biomarker for the worms' health. However, the worms at this stage are not standardised because they cannot be quantified. Whilst both sets of GLP-4 mutant worms (germline and no germline) have both been diagnosed with 'abnormalities' (*"tumours"* in the case of the 'normal' GLP-4 mutant strain and *"fat"* and "*yolk"* in the case of the GLP-4 mutant strain with no germline), the worms with no germline are explicitly figured as healthy and they are implicitly figured as an example of healthier ageing. Either way, 'health' is celebrated in this instance. This aligns with biogerontologists' value of 'healthspan' in public, which is circulated at the Public Debate (see chapter four) (see also Binstock et al., 2006a; Mykytyn, 2006c). This interaction between Professor Hurst and Orla enacts 'healthspan' because the health of the longer-lived mutant worms (the GLP-4 mutants strain) is measured in these images that Orla has generated as part of her research project.

Alongside figuring an entanglement between medicine and science in this enactment of diagnosis, Professor Hurst and Orla circulate a complex understanding of the categories 'normal' and 'abnormal'. Whilst fat and yolk are celebrated, the fat and yolk, alongside the tumours (synonymous with cancer), are implicitly framed as abnormal in relation to the biologically 'normal' wild-type worm. However, the presence of fat and yolk, as abnormalities (yet the 'lesser of two evils'), becomes more desirable than the presence of tumours in this experiment. Furthermore, in relation to biomedical and

biogerontological discourse constituting cancer as a severe pathology (e.g. de Grey, 2005; Gems, 2015), the tumours are figured as abnormal and the fat and yolk are figured as normal. As part of biogerontology as biomedicine (Moreira and Palladino, 2009), the GLP-4 mutant worms that have tumours - figured as 'somatic pathologies' (Rosai and Ackerman, 1979) - are 'unhealthy'. Whilst these worms have had a long 'lifespan', the same could not be said for the worms' 'healthspan'.

The image that Orla shows in her meeting with Professor Hurst becomes a 'point of crossing' (Latimer, 2013a; 2013b) of sorts between discourses associated with both 'biology' and 'medicine', which, authors describe, is characteristic of biogerontology (i.e. Moreira and Palladino, 2009). To begin with, Professor Hurst and Orla discuss the worms within the context of biological/scientific method, yet a switch to the biomedical is made when the diagnosis takes place. As they discuss Orla's experimental model and a potential difficulty with Orla's experiment, they make switch back to discussing biology:

> *Professor Hurst: "How many worms did you start with and how many are left?"*
> *Orla: "I started with 12 and there are 5 left [alive]."*
> *Professor Hurst: "That's a small amount, but it makes a good pilot study. It's a good experiment, with good results, the only problem is that it's a little hard to measure what is going on because the fat is making it so hard to see anything. Whilst the results confirm a paper by Dr Moorland, no-one has gone near it so far because it's hard to make sense of it in a quantifiable way."*
> *[Professor Hurst looks at an image. He looks bewildered.]*
> *Professor Hurst: "That just looks like chaos!"*

Orla tells Professor Hurst that there are five worms left 'alive' out of the twelve worms that she has used for this experiment. Whilst this measurement appears typical of lifespan experiments, the number of dead and/or alive worms is not the focus of Orla's research. Professor Hurst replies with a positive response: *"that's a small amount, but it makes a good pilot study. It's a good experiment, with good results"* (see chapter five

for a discussion of this interaction in relation to accountability). By *"good results"*, Professor Hurst refers to visual results yielded by Orla's experiment. Referring to Orla's experiment as 'good', even though it is 'only' a pilot study, is part of the MWL's ongoing accomplishment of 'good science'. However, Professor Hurst delivers some (relatively speaking) problematic news to Orla: *"the only problem is that it's a little hard to measure what is going on because the fat is making it so hard to see anything"*. It is this inability to 'tame' aspects of organisms (as part of standing for 'biology') that leads to the constitution of the 'life' sciences as inferior to more 'controllable' and less 'variable' scientific fields like chemistry and physics (Grene, 1984). However, Davies (2013) subverts this when she argues in favour of the kind of heterogeneity and (thus) unpredictability (of mutant organisms in the laboratory) that Professor Hurst and Orla uncover in the described interaction.

This (potentially) unstandardisable and thus unquantifiable result in the GLP-4 mutant strain of worms poses a challenge to laboratory members' accomplishment of 'good science'. It also poses a challenge to chronological understandings of ageing in spite of how the story that ageing is malleable figures chronological ageing in relation to the 'later life' illness (i.e. tumours/cancer) that Moreira and Palladino (2009) describe. Professor Hurst continues: "*whilst the results confirm a paper by Dr Moorland, no-one has gone near it so far because it's hard to make sense of it in a quantifiable way"*. Here, he warns Orla that despite this good 'visual result', it will be hard for her to produce a *"quantifiable"* result. Thus, he reinforces quantifiability as a core value of scientific experiment (Porter, 1995). Professor Hurst frowns as he revisits the images of the worms on the screen, which are covered in 'ambiguous' masses of fat and yolk: *"that just looks like chaos"* (Professor Hurst). Moreover, science's findings, Porter (1995) highlights, are required to be measurable in a way that can be quantified so that findings are translated universally and trusted by those outside a given field. Unfortunately for Orla, it is unlikely that her results will fit these requirements this time. In an interview, Ariel (PD researcher) reinforces the notion that non-quantifiable results are not at all helpful to scientists because they do not lead to publications. She says: *"without publications, it is hard to progress as a scientist"*. Whilst Orla produces a 'good result' for 'healthspan', without a quantifiable result, it is unlikely that she will

yield the required 'publishable' result. Her experiment simply cannot be made to 'fit' (Munro, 2013b) with the broader aims, objectives, and agendas of science (Star, 1983).

Enactment Three: Ageing as Neurofunction

I referred earlier in this chapter to cognitive and somatic function. This was within the context of Dr Starr's definition of ageing constituted in relation to mobility experiments carried out at the CFL. Cognitive function, or *"neurofunction"* (Amelie, MWL PD researcher), is explored in two key ways: 1) observing visual representations of an organism's brain and/or (neuro) 'activity' that takes place in the brain and 2) the observation of an organism's behavior/s (for example, 'mobility') as an indicator/marker of activity in the brain. At the CFL, I observe the hands, under Dr Starr's careful supervision, carrying out *"mobility experiments"* (Dr Starr). Xavier (CFL PhD student) excitedly shows me a mobility experiment that he is currently working on. As part of this experiment, flies are inserted into an apparatus comprising two test tubes. As part of this apparatus, one tube is covered up with a cloth and one tube is exposed to a light. Xavier uses a pipette to apply quinine to the inside of the tube exposed the light. He says that he is *"testing the flies' memory"* (Xavier) in order to see if the flies will remember the tube (out of the two tubes exposed to the light) that has quinine applied to it. He explains that if the flies remember which tube the quinine is in, they will (in theory) avoid the tube. This *"remembering"* (Xavier) by the flies, and their subsequent somatic movement (figured as an output of brain activity), is used by the benchside researchers as a 'biomarker' for brain activity. Xavier says that he is observing the flies and also counting how many from each strain (of the several strains) that he is using are found in each tube. Whilst he is *"trialing"* (Xavier) the experiment for its efficacy (rather than carrying out a lifespan experiment), he explains that in the future he will use the same experimental model to measure the mobility of different batches of flies that are at differing chronological ages.

Xavier explains to me that whilst he is not measuring brain activity *per se*, he can begin to formulate hypotheses relating to brain activity based upon the in-depth knowledge and understanding of the flies' brains that he has learned during his PhD study. I cannot help but think of 'mobile' and 'active' flies within the context of older people that belong to the celebrated active, useful, and consuming 'third age' (see Higgs and Rees-

Jones, 2009; Latimer, 2015). Furthermore, at *The Countryville Ageing Symposium*, there was a formal discussion held between representatives from multiple fields (e.g. scientists, sociologists, public sector). During this 'roundtable' discussion, a priority was placed upon discussing the pursuit of an increase in the 'activity' and 'mobility' of older people in society. This echoed Professor Kirkwood's address at the *The Public Sector Ageing Conference*. As part of this address, Professor Kirkwood described the 'untapped' wealth of productivity and usefulness of members of society who are age eighty-five and above.

Returning to the CFL, Xavier informs me that studying behaviour cannot be used to quantifiably measure processes that occur *inside* the brain. Biogerontologists at the MWL examine worms' brains using high quality magnification and imaging. I have already described my time with Amelie (PD researcher) in the MHAI's microscopy room (chapter five). In the microscopy room, Amelie explores images of worms for the effect that a protein, which she refers to as *"PK"*, has upon the worms' brain function. However, she first takes me to her office to teach me *"the basics"* (Amelie). She says abruptly: *"I first want to show you something to help you understand a little better"* (Amelie). Amelie lets me know that it is important for me to have some *"grounding in biology"* so that I can make sense of the images that she will show me in the microscopy room. I remind her that I am no biologist and, with a smile, she begins to draw a diagram for my benefit. Amelie draws several shapes and lines on the back of one of her documents and tells me: *"this is what happens when cells replicate"*. I find it difficult to understand what she is saying because of the combination of her foreign accent and her 'science-speak'. I see (what appears to me as) a chaotic scribble on the page; one that I cannot interpret. *"You understand?"*, she asks. I am not sure that I do, but I nod, and she leads me to the microscopy room.

Amelie asks me: *"You have heard of DAF-2, right?"* Confidently, I tell her *"Yes"*. I am pleased that I understand at least one thing that she is explaining to me amongst the flurry of diagrams and genetics-based language. I have definitely heard of DAF-2 because the DAF-2 mutant strain is famous for its long lifespan (Kenyon et al., 1993) (see chapter four). Amelie elaborates: *"when DAF-2 is expressed, it's transcribed to DAF-16 and this is where we've been seeing long lived mutants who have been living*

over double the length of days". On her computer, she shows me a graph with the lifespan of the wild-type (N2) worm. This is alongside several other strains. The graph is not dissimilar to the one that Kate shows me (see Figure 8). I see that the black line representing the DAF-2 mutant is used to represent a lifespan double the length of the wild-type worms' lifespan. The graph also represents the lifespan of numerous other mutant strains. Amelie tells me that these other strains (non-DAF mutant) only have a slightly longer lifespan in relation to the wild-type, which is *"not significant"* (Amelie). This data that Amelie has collected supports Professor Kenyon's results pertaining to the DAF-2 mutant worm. Amelie is drawing on this widely known and often drawn on (in biogerontology) finding. In doing so, she accomplishes membership to the global biogerontology community.

Amelie explains to me that as part of her current PD research she is attempting to isolate certain proteins present in the DAF-2 mutant in order to see which ones are related to the increase in lifespan. Reducing the worm to its genetic components, she explains: *"there's a protein, PK on the graph, that seems to be significant in the DAF-2 mutant… I've attached a green fluorescence to the protein so that we'll be able to see the protein under the microscope"* (Amelie). I smile and nod. This time I understand more of what she is attempting to explain to me. Amelie explains that today she will be comparing the expression of the PK protein in two types of worms: 1) the wild-type, and 2) the DAF-2 mutant worm. First, she shows me the wild-type worm. On the screen, I observe a dark background with a glowing worm-shaped outline. The outline comprises multiple glowing lines and shapes. Amelie examines the DAF-2 mutant worms using specialised imaging software connected to the 'The Zeiss' (the best microscope). As Amelie examines the images of the DAF-2 mutant worm, she tells me that she is focusing on the 'fluorescent shapes':

> *Amelie: "It's a really good image." [She presses the computer mouse to capture several images using the software]*
> *Sophie: "I'm not sure I can see the difference."*
> *Amelie: [Points to the 'brain'] "See, the strings of light are a little brighter in the brain area of the DAF-2 mutant compared to the wild-type."*

Sophie: "Right."
Amelie: "This could mean that there is increased neurofunction."

Amelie points to a cluster of strings of white fluorescent light around what I knew (because of other times spent in the microscopy room) to be a representation of the worm's brain. In doing so, she figures these *"strings of light*" on the screen as brain activity. These might be thought of as 'artful' scientific images (Coopmans, 2014). Amelie makes reference to the image of the wild-type worm that she had previously shown me on the screen, and I recognise the same kinds of 'strings of light' around the brain area that had been present in Amelie's image of the wild-type worm. Whilst I cannot tell the difference between the two images, Amelie seems considerably more pleased with this second image (my lack of recognition is perhaps because I cannot recall the representation of the wild-type to my mind's eye in enough detail and also because I do not have expertise in this area). Amelie suggests that there is *"increased neurofunction"* in the DAF-2 mutant worm compared with the wild-type. After she examines the image, she explains to me that increased neurofunction is potentially related to the extended lifespan in the DAF-2 mutant. She says that this, in turn, is *"linked to the PK protein"* (Amelie). I ask Amelie what she will do next. She says she will investigate this initial result further:

Sophie: "Right, okay. What will you do next?"
Amelie: "I'll have to quantify the data, which can be done using the software, as it can take measurements on the screen."
Sophie: "Right."
Amelie: "You can either do a visual analysis or a molecular analysis."
Sophie: "Okay."
Amelie: "It's good to do as many as possible, so that you can corroborate."
Sophie: "Okay."
[Amelie looks back to the image and studies it further]
Amelie: "Sometimes you get a big visual difference when you look at the image and then no significant difference in the experiment, and sometimes it's the other way round."

Sophie: "Interesting."
Amelie: "It can be tedious and frustrating to work out why."
[Amelie looks into my eyes in a seemingly sincere manner]
Amelie: "Sometimes you just don't know. You won't ever know."

Until this point, Amelie has only referred to a visual result (examination with her own eyesight). I discussed earlier in the chapter that, as part of the accomplishment of 'good science', a quantifiable result is preferred over an unstandardised visual result in this laboratory setting. Amelie states: *"I'll have to quantify the data…which can be done using the software, as it can take measurements on the screen"*. She discusses the two types of analysis that she can do next: *"you can either do a software-based visual analysis or a molecular analysis"*. She explains that next, as part of her schedule, the images of the worms will be subjected to a software-based analysis. This is whereby the two sets of images will be precisely measured, quantified, and standardised. Furthermore, Amelie refers to carrying out a molecular analysis. This will involve, she describes (in a later interaction), making visual representations of the molecular structure of each worm, and that this will make visible *"significant proteins"* (Amelie). She does not explicitly state a preference for one type of analysis over the other but she claims: *"it's good to do as many [types of analysis] as possible, so that you can corroborate"* (Amelie). Aligning multiple results in this way – as part of 'corroboration' - is also part of the accomplishment of 'good science'.

After studying the image again, Amelie tells me with a perplexed look: *"sometimes you get a big visual difference and no significant difference in the experiment, and sometimes it's the other way round"*. Here, she refers to observing a difference with the naked eye compared with a quantified difference that would be universally interpretable across the biogerontology/biology/scientific community (Porter, 1995). Contrasting her adherence to routine, rigour, and good science, Amelie refers implicitly to the moments of 'chaos' and/or the 'unknown'. Meanwhile, she tells me about the occasional disparity between first, a visual result and, second, a result calculated using software and/or molecular analyses: *"It can be tedious and frustrating to work out why"* (Amelie). Next, Amelie turns from the computer screen, she sighs, looks into my eyes and says: *"sometimes you just don't know…you won't ever know"*. In this moment, she makes a

switch from a world of (scientific) simplification, control, standardisation (Star, 1983; Davies, 2013), and 'visual knowing' (de Rijcke and Beaulieu, 2014) - aspects that are characteristic of the empirical tradition (Shapin, 1994; 1997) – and she momentarily embraces the 'mystery' of the unknowable (Shapin, 2007). Whilst the 'visual result' of this encounter might lead to a 'good' result, she refers (*"you just don't know*") to instances where results are not compatible 'good science'. Results that do not fit - like in the instance of 's unpublishable result - are disposed of.

Summary

In the current chapter, drawing on multiple modes of data (i.e. the laboratory setting, interviews, and conference data) and also building upon key findings of previous analytical chapters (chapters four and five), I have made visible three enactments of ageing that were made visible in the 'laboratory present': 'lifespan', 'healthspan', and 'neurofunction'. These multiple enactments of ageing exist simultaneously as part of the day-to-day practice of biogerontology, and also biogerontologists' understanding/s of ageing. At the start of the chapter, an overview of biogerontologists' public accounts was given in order to illuminate their switching/s between notions of (animal) 'lifespan' and (human) 'ageing'. Whilst biogerontologists (heads) referred primarily to 'ageing' in the public setting, I described that in the laboratory setting, ageing was an absent-presence in the accounts and enactments of benchside researchers (hands). This finding adds considerable depth to biogerontology-specific STS literature that only refers in passing to 'ageing' research in the laboratory (i.e. Binstock et al., 2006; Fishman et al., 2008). Furthermore, it extends the work of Vincent (2008) - who examines experimental language used by biogerontologists in public and in interviews (see chapter two) - by unpacking the meanings assembled by researchers at the bench.

The current chapter showed that 'ageing' was implicit in the three experimental enactments described, however, as a category and/or 'term of art', ageing was not referred to specifically and/or directly by biogerontologists as part of the day-to-day laboratory practice and account-giving. Furthermore, the findings made visible biogerontologists' requirement for yielding quantifiable results, which, Porter (1995) argues, are considered 'trustworthy' and, therefore, become a requirement for researchers' publications. Quantified, and also simplified, results were valued especially

for the purposes of publishing high quality academic papers. This finding draws upon the research of Star (1983) and extends her work to the field of biogerontology. Alongside researchers' care for 'good science', which was reported at length in the previous chapter (chapter five) in relation to rigour and excellence, the requirement in biogerontology - as part of the discipline of science - to publish papers was shown, through accounts and practice, to be highly standardised and controlled as part of strict experimental conditions in the laboratory setting.

The current chapter showed that whilst the flies and worms, as biogerontologists' 'instruments' (see also chapter five), were used as part of controlled experiments (e.g. lifespan and mobility experiments, diagnosis, and imaging), there were moments (e.g. Orla's images of 'fat' and 'yolk' and Amelie's 'unknowable' glowing worms) where results yielded would/might not be standardisable. Inevitably, these moments presented a considerable challenge to researchers' endeavour/s to practice 'good science'. I described that for the most part, researchers at Metrotown and Countryville were able to simplify their complex data-sets using graphs, charts, and figures, which became diagrams of 'ageing' and 'inscription devices' (Latour, 1987). However, I showed that in particular moments of the 'unknowable', biogerontologists repaired the (moral) order by disposing of these 'mysterious' results. However, through such disposals, researchers primarily made the animal (models) 'fit' with the institutional agenda of science and biogerontology's wider research agenda, which extends Munro's (2013b) suggestion - that we dispose of that which does not 'fit' with our world-making – to the biogerontology laboratory.

Whilst the quantification of ageing in the laboratory setting has been described, I also highlighted that some of the ways that ageing is being made to mean in the laboratory space are not (necessarily) synonymous with CA (e.g. 'neurofunction' and 'healthspan'). Moreover, the three ways ageing was figured – 'lifespan', 'healthspan', and 'neurofunction' - circulate three differing stories about ageing and older people because the model organisms (flies and worms) are being made to stand for, or 'transposed' (Friese, 2013) to, humans by the researchers at the bench. This also extends Friese's work to the biogerontology laboratory setting. As such, alongside a story about the 'restandardisation' of ageing and life, which builds upon the work of

Moreira (2015) because it makes visible an added layer of complexity to notions of the 'standardisation' of ageing, three smaller overlapping stories about ageing and life are circulated: 1) living a long life is desirable, 2) living a long and healthy life is desirable, and 3) living a long life full of function and vitality (both mentally and physically) is valuable. In addition, I have also demonstrated, following Moreira and Palladino's (2009) claims regarding the public setting, that biogerontology is a complex entanglement of biology *and* biomedicine. Furthermore, I have also demonstrated that that these three stories about ageing and life - taken together with the broader story about the standardisation and (arguably problematic) mechanisation of ageing and life - challenge any notion of a simplistic understanding of ageing as one 'simple' mechanism (see chapter four), as forwarded by biogerontologists. Whilst I have in the current chapter described biogerontologists' figuring of ageing and life as (mostly) standardisable, in the following (and final) analytical chapter, I explore complex and ambiguous practices of care that fracture from this way of seeing.

Chapter Seven

Ambiguous and Complex Practices of Care

Introduction

I have described the continual accomplishment of 'good science' as both a matter of *concern* (public) and/or a matter of *care* (laboratory setting) (Puig de la Bellacasa, 2011) in the three previous analytical chapters. Furthermore, matters of care can be *"dealt with through 'ethical doings'"* (Puig de la Bellacasa, 2010: 160). These are 'day-to-day' practices that embody an affectual relation of care to other life/lives - to recap, these practices are exemplified by permaculture and/or such a relation to the 'land' (Puig de la Bellacasa, 2010; 2015). Whilst I have shown 'good science' to be a 'practical' matter of care in the laboratory, this is not all that researchers care for. I have already introduced several ambiguous moments of care present in the 'laboratory present' (chapters five and six) that highlight care for other life/lives. In the current chapter, in highlighting the multiplicity of care in biogerontology, I expand upon these. This, in turn, highlights the complexity of the field of biogerontology. Consequently, I explore the moments of ambiguities as moments of 'ethical doings' (Puig de la Bellacasa, 2010).

At the start of the current chapter, I return to a critique of the 'authenticity' (Heidegger, 1962; 1977) of biogerontologists' public accounts. Whilst a concern for 'good science' is implicitly prioritised (see chapter four) in this setting, I reiterate that these kinds of public accounts are predominantly ethics-based *accounts* (perhaps as 'ethical *sayings*'), for biogerontologists draw on E/ethics (Latimer and Puig de la Bellacasa, 2013) as the central currency of their discussion/debate. Furthermore, I examine both 'Ethics' and 'the ethical' (Latimer and Puig de la Bellacasa, 2013) (see chapter one) present mundane laboratory practices. As the chapter unfolds, I draw out moments of ambiguity with regards to whether it is 'good science' or 'science for good' (or both) that biogerontologists care for. In describing 'being alongside', Latimer (2013a) (see chapter one) highlights the importance of a motile approach to worlds of care (see chapters one and two). Consequently, I examine momentary 'ethical doings' (Puig de la Bellacasa,

2010) in a setting where members predominantly (see chapters four, through to seven) – as part of an instrumental relation to animal (models) – care for efficient and rigourous science over and above other life/lives. This is as part of constituting a mechanistic understanding of ageing as 'plastic' (Latimer, 2014). To close, I suggest that moments of non-instrumentality are towards a 're-enchantment' of the laboratory setting; towards a 'recovery of techné' (Feenberg, 2004) (see chapter one), as, benchside, biogerontologists encounter other life; breaking from the broader institutional agendas within which they are entangled (Latimer, 2008). In this chapter, I draw on data taken from the laboratory setting, conferences, and online publications.

In/Authentic Public Heroics: The Quest to Save Humanity

I have already examined biogerontologists' public, 'heroic' (Featherstone, 1992) accounts forwarding a concern for humanity (see chapter five). To recap, biogerontologists - in academic papers, interviews, and public presentations - spoke of a 'united' pursuit to defeat the 'dragon' of ageing (Bostrom, 2005) (as a pathological biology mechanism) with a 'silver bullet'-type intervention (Gems, 2011). Bostrom (2005) (a prominent Ethicist with an interest in promoting the AASM) believes the 'defeat' of the dragon is necessary in order to recreate a world where death no longer destroys life. To support his claim, he tells a story about a mythical village held captive by a fire-breathing dragon that is eventually slayed. Until its death, the dragon was thought by the village to be 'part of the way things are'. In these public accounts, it is humans who are figured as being the benefactor of advancements, as biogerontologists 'slay' the dragon.

In an interview, Professor Hurst (MWL head) refers to biogerontology as partially *"utopian"* in his discussion of the field's ameliorative possibilities. He also describes biogerontology as *"whole new medicine"*, which opens up space for a new way of thinking about human ageing. Across the data (see chapter four) this (mostly public) discourse is applied to *people* in relation to the salvation of the *human* race. In this earlier chapter, I challenged the authenticity of these kinds of public, and often contradictory, accounts. I made reference to ADG's use of the parable of the Good Samaritan as he gives an ethical account, which I now unpick. The following excerpt is taken from a statement made by ADG at *The Living Longer Conference*. Here, ADG

reinforces a concern for humanity. He draws on (what he refers to as) *"Holy Scripture"*, and I am disconcerted because I know from other talks that he has given that he does not adhere to a religious/spiritual belief system. It appears as if he is using this parable in order to persuade the audience:

> *"It would, in my view, be a sin not to be working to defeat ageing. Why's that? Very simple! Ageing causes suffering, and Holy Scripture of all types is really rather unequivocal on this point, that suffering is something that we ought to be working to minimise, we only need look to the parable of the good Samaritan as the most conspicuous example of this. We are not supposed to be walking by on the other side and letting suffering continue when we might be in a position to do something about it. We need to be today's good Samaritan protecting humanity of the future, and perhaps the relatively near future, from the development of the suffering that countless generations have had to endure as a result of simply being born a long time ago."* [ADG speaks a dispassionate tone] (Dr de Grey, Living Longer Conference, Presentation)

ADG speaks here in a dispassionate tone in this description of the moral imperative to defeat ageing, and – 'playing God' (Evans, 2002) - he makes attempts to persuade the audience of their need for this salvation. I cannot help but feel irritated when I listen to him speak at this event. The data echoes the findings of Vincent (2008), who describes ADG as acting in public as if he believes himself to hold a *"mantel of truth and virtue against sin and error"* (Vincent 2008: 322). In the above excerpt, drawing on a Biblical story and emotive language, ADG claims that *"we"* (as society) have a duty to partake in the task of 'saving' humanity. He says it is a *"sin not to be working to defeat ageing"* and claims *"ageing causes suffering"*. He refers to *"Holy Scripture"* in order to set a moral benchmark for the prevention of ageing as kind of suffering. ADG draws on the parable of the *"Good Samaritan"* (Gospel of Luke 10: 25-37)[100], which celebrates the compassion of the Samaritan and also warns against the Levite's and Priest's legalism

[100] The well-known parable is a story told by Jesus about a man at the side of the road in need of help because of an attack by robbers. The man was ignored by, firstly, a priest and, secondly, a Levite (a man of the law) - both of whom walked by on the other side of the road to avoid helping the man because it did not fit with their religious protocol and cultural norms. Finally, a man from Samaria (a town stigmatised by Jews) stops to help the man because he saw that he was suffering. The Samaritan man binds up the man's wounds and takes him to a local 'inn' for rest.

and adherence to tradition (Wilcock, 2011). It is a story that celebrates 'ethical doings' (Puig de la Bellacasa, 2010). Throughout this account, ADG implicitly likens SENS to the Samaritan. He says that "*we need to be today's good Samaritan protecting humanity of the future",* which refers to public support of ageing research, and also implies that *we* (as representatives of the broader category of humanity) can be protected from the suffering that *we*, as part of *humanity,* have had to endure because of not being born into a milieu where ageing is considered to be problematic. Implicit in ADG'S account, which is an ethical appeal, is an accusation that those in a *"pro-ageing trance"* (a term he has used at other conferences) are, like the priest and the Levite, condemning humanity to suffering; suffering that ADG says that his research programme (SENS) will alleviate. It seems as if he is attempting to enroll the public to SENS' agenda. I cannot help but recall ADG's disregard for generations of humans in the future (see chapter four[101]). It seems clear that there is something inauthentic (Heidegger, 1962) about ADG's care and/or concern in this account.

As well as contradiction/switches between first, ADG's expressed *"compassion"* towards humanity and, second, his verbally stated prioritisation of present over future humanity in this setting, there are other instances that call into question the authenticity of biogerontologists' expressed care for life. Recall RF's claims (see also chapter four) at the Public Debate that he (in his terms) *"cared"* for humans and racehorses alike. I have already suggested that biogerontologists' public accounts, often as rhetorical devices, articulate concern rather than care for humanity (Puig de la Bellacasa, 2011). Here, following Latimer and Puig de la Bellacasa (2013) I reiterate that these public statements do not appear to reflect the kinds of things that biogerontologists predominantly care for in the day-to-day of the laboratory. I have described (chapters five and six) the everyday ethics/moral order of the laboratory setting. To recap, this everyday ethics, or 'the ethical', is different from what Latimer and Puig de la Bellacasa (2013) refer to (based on their study of the biogerontology laboratory setting) as 'Ethics'.

[101] To recap, ADG was asked by an audience at a conference about SENS in relation to the Malthusian argument. His response indicated a prioritisation of the 'living now' and a disregard for the health and wellbeing of future generations if it was at the expense of people alive on the earth currently.

E/ethics, Excellent Science, and Animal (Model) Waste in the Laboratory

Latimer and Puig de la Bellacasa (2013) differentiate between first, day-to-day laboratory enactments - as *"fuzzy"* (Puig de la Bellacasa, 2013: 162) and continuously present in scientists' day-to-day socio-material entanglements - as the 'ethical'. Second, they figure 'Ethics', which they describe as formal ethical guidelines and procedures that are the currency of 'Ethics Committees' and the like. At the MWL and the CFL, Ethics' (fixed guidelines and procedures) played a role in directing biogerontologists' choice of flies and worms over other species (see chapter five). In accounts, researchers addressed Ethics in a legalistic manner. For example, at the CFL one afternoon, James, Dr Starr and I sit at the bench and discuss 'Ethics' in relation to the advantages of working with flies over other model species. Dr Starr says *"with fruit flies there is no Ethical code like there is with mice"*. James nods in agreement. I have heard this account (given by biogerontologists) before within the context of using flies and worms for research. I talk with Dr Kennedy (CFL co-head) in his office. He offers a hypothetical rationale for choosing different animals for biology research:

> *"Rats are more representative of the human liver than mice, and so they'd be the next animal I'd use after flies, but it'd require stricter Ethics procedures. If I had a good result with flies, I'd want to work with rats, and if that were successful I'd patent it straight away and see if it worked with other animals, although larger mammals are too long lived for these experiments. If the result involved something that humans already are exposed to, like Resveratrol[102], for example, and there was a good result in the animal experiments with no side effects, then the next step would be thinking about human trials."*
>
> (Dr Kennedy, CFL Co-Head, Interview)

As Dr Kennedy gives this account, as well as ordering the 'strictness' of Ethics procedures (= 1. Rats, 2. Mice, 3. Flies), he constitutes a hierarchy of species for biology research purposes. This is in relation to first, Ethics and, second, how Ethics makes research more difficult. In this hierarchy, the more similar the make-up of the animal to the human body, and/or the larger the animal, the more desirable the animal

[102] 'Resveratrol' is a pre-existing chemical (found in red wine) that has been found to slow the ageing process in mice. Biogerontologists claim that it is easier to think about human medial trials for chemicals already considered safe to ingest.

for biology/biogerontology research, yet the more stringent the Ethical guidelines and resultant procedures. This idea is found in the 'Animals (Scientific Procedures) Act (ASPA) 1986' that is found online at the Home Office website[103]. Here, protocol for research is determined in relation to animals' weight and type (e.g. rodents up to 500g, birds up to 250g). The use of 'great apes'[104], it describes, was banned in 1986 and there are 'special protections' on animals like dogs, cats, horses, and monkeys. Furthermore, research using these kinds of animals is only permitted when no other animals will suffice. Russell and Birch (1959) describe the '3 Rs'[105], which shows the non-wasteful – contrasting notions of a wasteful relation to animal (models) that I have described - protocol of only using (a minimal amount of) animals where necessary, using the least invasive techniques that are possible. The ASPA 1986 says: *"'a protected animal' [for the purposes of this Act] means any living vertebrate other than man and any living cephalopod[106]"* (ASPA, 1986: 2). Worms and flies are invertebrates and thus they are not considered to be protected animals.

Returning to the extract, Dr Kennedy says that the "*next step would be thinking about human trials",* which is, he implies, the last step before any intervention is offered to the public. He says that the conditions for this would be *"a good result in the animal experiments with no side effect",* which reiterates a value placed on protecting humans from unwanted effects from chemical intervention (as part of 'good science') and it also demonstrates very little concern for animals that are subject to the same effects. In the account, Dr Kennedy, in claiming to value *"good results"* and efficient research progression, appears desensitised to the idea of harming animals. Researchers across the data figured Ethics, and its procedures, as a hindrance and/or boundary to research. Furthermore, the general view taken was that that those opposing animal research were

[103] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/308593/ConsolidatedASPA1Jan2013.pdf
[104] Orang-utans, gorillas, chimpanzees and bonobos are considered 'great apes' (ibid).
[105] The **'3 Rs'** (http://www.understandinganimalresearch.org.uk/how/three-rs/) (accepted internationally) are: 1) Replace (the use of animals with alternative techniques, or avoid the use of animals altogether), 2) Reduce (the number of animals used to a minimum, to obtain information from fewer animals or more information from the same number of animals), and 3) Refine (the way experiments are carried out, to make sure animals suffer as little as possible. This includes better housing and improvements to procedures which minimise pain and suffering and/or improve animal welfare).
[106] *"Any mollusk of the class Cephalopoda, having tentacles attached to the head, including the cuttlefish, squid, and octopus."* – www.dictionary.com

misled. Following Dr Starr's reference to the *"Ethical code"*, James and I discuss activists protesting animal research at Countryville University:

> *James: "There have been some student groups against animal research recently." [James speaks in an annoyed tone]*
> *Sophie: "Yes, there were always little pockets of protesters during my time as an undergraduate. It seems that lots of groups are against animal research."*
> *James: "Yes. It's a perceived evil, not a real evil. It has to be done, and those people have benefitted from it."*

James tells me about some protests held that challenged animal research at Countryville University. He appears annoyed by these. I tell him that I have witnessed the same at my university. Next, he disposes of protesters' actions by framing animal research as a *"perceived evil"* rather than a *"real evil"*. This accomplishes a policing of the E/ethical and its boundaries and this supports Evans' (2002) suggestion that modern scientists constitute their own ethical appropriations. James says, referring to animal research: *"It has to be done, and those people have benefitted from it"*. This firstly reinforces the priority of human welfare over animal welfare. Secondly, this supports the assumption, prevalent in modernity, that science is valuable to all members of society (Shapin, 1997).

A prioritisation of human welfare is implied in experiments through what appears to be a wasteful relation to animal (models), which are made to stand for both genes and all of life (see chapters five and six). This relation 'effaces' (Bauman, 1990) - facilitated by a 'mass' scale (Bauman, 1989) - the individuality of animal (models) used for experimental purposes and it accomplishes the disposal of (what can be thought of as) the animals' 'creatureliness', or 'critterness' (Beatson and Halloran, 2007; Haraway, 2008; Wirzba, 2015). As I have described (chapter five), as an extension of benchside-hands, the animal (models) used for each experiment become researchers' experimental instruments. For example, in the microscopy room (see chapters five and six), Amelie throws into a bin a glass slide she has been carefully studying under the microscope.

The bin is full of similarly thrown slides. As part of her research project works with small numbers of worms that are separated from the mass:

> *Amelie: "After I've used a worm once, I'll throw it."*
> *Sophie: "Is that because it'll be out of sync with the others?"*
> *Amelie: "Yes. Some people who are really strict about animal ethics wouldn't really approve of it being used only once because they are still animals, although some wouldn't class them as such, because they sense food and express hormones for example."*

After throwing the slide in the bin, Amelie tells me that after she's *"used a worm once"*, which in this case relates to extracting (using a pick) worms from the 'mass' of approximately fifty worms on a plate, she will *"throw"* it in the bin. I ask Amelie if her reason for disposing of the worms is so that they are not *"out of sync"* with the rest of the worms in the batch. She replies *"yes"*, for she is undertaking 'good science'. Whilst Amelie begins by referring to individual worms, here she refers again to the 'mass' by way of mentioning the *"others."* However, Amelie tells me that worms are animals because they *"sense food and express hormones"*. This figures the worms in relation to a biological process, but she tells me that some do not class worms as animals in the same way that she does. I am disconcerted by this account because I take the view that a worm is an animal. Rolling her eyes, Amelie tells me that the researchers who are *"really strict"* (Amelie) about animal Ethics would disapprove of her throwing of the used slide in the bin after only using the worms once. This statement is ambiguous, and I am unsure whether she is referring to Ethics or ethics. I initially assume that she is referring to the former because 'strictness' is normally used within the context of describing adherence to a formal code, but in this instance, the case remains ambiguous. Though Amelie does not refer to pain in this interaction, worms' pain is part of the more general language of the laboratory and other MWL researchers reassure me on a number of occasions that the worms *"cannot feel pain"*. I have already described (chapters five and six) that researchers appear compelled to make progress in their research, which is not surprising in an academic department. Moreover, I observe across the data a stronger priority placed upon adhering to Ethics (as 'good science') based upon this progression. Career progression becomes 'the ethical' (Latimer and Puig de la

Bellacasa, 2013). However, it is working with animal (models) that opens up the space to challenge this value as a totalising value.

Animal Models and Multiplicities: Ambiguous Routines of Care

I have described the day-to-day routines of care that take place at the CFL and the MWL (chapters five and six). I will recap. Primarily, *care*ful, rigourous, and consistent breeding, maintaining, picking, tipping, and feeding (amongst other tasks) enact care for 'good science'. An example is Gonzalez's (MWL PD researcher) weekend overtime that he willingly carries out in order to ensure that the worms that he was going to use for a lifespan experiment were all at the same stage (L4) when the experiment started. In addition, I recall James explaining to me that unhealthy flies are disposed of in the 'fly morgue' because they damage the other flies, which in turn damages the quality of an experiment. I also described that results from experiments that 'do not fit' (Munro, 2013b) with 'good science' are disposed of (e.g. when 's images of worms' were not likely to yield a quantifiable and thus publishable result).

In terms of the technical aspects of the laboratory, care is taken (budget permitting) to make sure that the laboratory is maintained at the highest possible standard. At the MWL's weekly 'Lab Meeting', researchers raise any concerns about faulty equipment. Jackson (PD researcher) mentions a microscope that is 'failing'. However, Professor Hurst subsequently explains that the budget will not extend to buying a new one. Also, Jackson refers to old, broken incubators that can no longer be used and are *"wasting space"* (Jackson). Furthermore, during the time I observed researchers in the microscopy room, I observed a careful routine undertaken when using the microscopes – for example, the careful wiping of oil from 'The Zeiss' (the best microscope) after it has been used to study worms. I have also described the way that researchers care for their own (what might be thought of as) 'upward mobility'. This is shown by the pursuit of publishing papers in 'good' journals as part of 'good science'. I have also showed that there is a sense of friendship and support between researchers at both laboratories as they celebrate successes with one another and support each other when something does not go as planned (e.g. a 'journal' rejects an article that a researcher has worked hard on for months).

I have already suggested that these laboratory routines (as findings) support Latimer and Puig de la Bellacasa's (2013) findings that biogerontologists are, alongside adhering to Ethics, compelled to care for the ethical – for example, 'changing the [animal models'] nappies', and 'looking after the [academic] children' – as part of the laboratory's moral order. This moral order is, arguably, commonplace in most science laboratories (see Friese, 2013; Kerr and Garforth, 2015). Whilst there is a sense of 'correctness' as part of these practices of 'good science', I have described that this is not always the same as Ethics (Latimer and Puig de la Bellacasa, 2013). I have referred to ambiguous moments of 'harm' to the worms/flies (chapter five). I described that researchers at the MWL pick using a platinum nib because this type of nib cools quickly after it has been cleaned in the flame of the Bunsen burner. Hannah (MWL technician) explains that this type of nib is used because it causes *"the least harm to the worm"* (Hannah). In this particular situation, the word "*harm"* is used, which denotes a form of violence in relation to worms' welfare. The use of the word *harm,* contrasts with a word like *damage,* which implies a more functional enactment. 'Harm' evokes feelings of pain, and the avoidance of harm implies a care for the welfare of the organism. Thus, the use of the word *"harm"* led me to believe, on first instance, that researchers' cared for the welfare of their animal models. This was reiterated by the continuous unsolicited accounts given to me at both laboratories about the worms/flies' inability to feel pain. However, Hannah also explains researchers' choice of picking tool within the context of 'good science':

> *Sophie: "I found picking very hard."*
> *Orla: "Yes it took me a while to get the hang of it."*
> *Hannah: "In some laboratories in America, researchers use eyelashes to pick worms with rather than metal nibs because eyelashes are softer and cause less harm to the worm."*
> *[Both Eva and Orla look very taken aback]*
> *Orla: "Wow!"*
> *Eva: "That'd be so hard to do!!!"*
> *Hannah: "The standard is high in America and it is very competitive. At some laboratories they often have two PhD researchers working at the same project so that they compete to finish the project."*

Hannah uses the word *"harm"* again to describe (to the graduate researchers and I) that in some laboratories in America (Hannah was trained in working with worms in the US) that worms are picked with eyelashes rather than metal nibs because they are *"softer"*. However, the use of the word *"harm"* is situated in between a statement about the technical aspects of picking and a statement about a *"high standard"* of research in America. Compared with other times where researchers (particularly Hannah) have described minimising *"harm"* whilst picking, there is more of a sense that the practice of care is orientated towards the accomplishment of 'good science', yet there still appears to be an ambiguity because of the implicit alternate meaning in the word *"harm"* that circulates care for other life/lives. Consequently, I cannot be sure what is being cared for in these kinds of instances. It appears that researchers practice care for *both* good science and the welfare of the worm, or (what I refer to as) 'science for good' (Shapin, 1994; Latimer and Puig de la Bellacasa, 2013; Thompson, 2013). This is despite the latter contradicting the 'head-knowledge' (that the worms do not feel pain) that is circulated in the laboratory setting. This 'head-knowledge' preserves the moral order. Eva and Orla both appear surprised at idea of picking with eyelashes, which is a moment of affect expressed in relation to technical expertise that is a 'higher' level than their own. Here, Eva and Orla are moved by picking as a mundane routine that facilitates the laboratory's *"Wow!"* moments (Latimer and Puig de la Bellacasa, 2013: 163) (e.g. Amelie's glowing worms).

Awkward Eugenics: Humour, Irony, and Waste in the Laboratory

At times in the laboratory, researchers seemed aware of the 'violent' set of languages that they operationalised as part of their day-to-day practices. Researchers often responded (again, as part of repairing the moral order) with humour during uncomfortable moments, particularly when discussing 'eugenics' as part of the laboratories' 'world of genetics' and its purity rituals (see chapter five). Thus, the practice of humour itself was a kind of 'ethical doing' (Puig de la Bellacasa, 2010). Douglas (1966) writes of the significance of purity rituals. She observed how these rituals accomplish a policing of the borders between firstly, what is sacred, pure and celebrated and, secondly, what is profane, dirty and to be disposed of. As part of the current study, I have shown that this happens in public biogerontology (e.g. the public disposal of ADG and SENS' 'bad science'). Douglas argues that it is the difference

between the 'sacred' and the 'profane' (what is disposed of and what is not disposed of) that orders society and space (Munro, 2013a). In the laboratory setting, similar rituals occur involving the disposal of '[flies/worms] out of place' in bins and in *"fly morgues"*, which I have described as large glass containers designated for 'redundant' batches of model flies. Recall the moment I first arrived at the CFL and Dr Kennedy tells me: *"It's a fruit fly massacre in here"*. Furthermore, I described that the constitution of animal (models) as 'redundant' occurs for the following reasons: 1) the batch has already been used for experimentation and has served its purpose/the experiment has failed, 2) there is an irregularity in the batch (e.g. the organism is damaged or ill), and/or 3) a mistake has been made by a researcher in preparing/creating the batch (e.g. a mix up in labeling different batches of animals or carelessness in breeding a particular strain). I am also told that it is 'best practice' to have as few variables as possible so that an experiment is repeatable and reliable. Having healthy flies, Xavier (CFL PhD student) tells me, is essential when trying to isolate phenotypes like lifespan, which, despite the ambiguities that I have described, reiterates the notion that 'good science' is often prioritised over organisms' well-being.

At both the MWL and the CFL, as flies and worms are reduced to their genetic components for the sake of experiments, it is the *gene* that becomes the object of purity (and disposal) rituals. Thus, an instrumental and/or wasteful relation to the gene is accomplished. Moreover, taking the gene - via the medium of the animal (models) - as being made to stand for life (Latimer, 2013b), this enactment, in a similarly instrumental/wasteful relation, disposes of life where life is no longer useful. Much debate surrounds 'the new eugenics' (Latimer, 2013b) in terms of biology research and also the transposition of this 'new genetics' to humans (see Evans, 2002; Latimer, 2013b). Consequently, selective breeding and eugenics are at times 'uncomfortable' topics (Thomas, 2014; Strange, 2015), yet they are increasingly prevalent. At the CFL, I find Thea (PhD student) (herself a virgin to research as a first year student) attempting to catch young, virgin flies. She is flustered, and I can tell that she is immensely frustrated by the task at hand:

Sophie: "What are you doing today?"

Thea: "I'm trying to catch newborn female virgins, look you can see the pupae. They are the beige cases all around the bottle." [she is looking through her microscope]

Sophie: "Okay!"

Thea: "If there's a black spot in them, then that means that they'll be hatching the next day. They don't mate until six to eight hours after they've enclosed. You need virgins when you're trying to isolate characteristics. It means that you can isolate which strains the flies have mated with and this is important for controlling breeding." [she gestures for me to look in the microscope, I look in]

Sophie: "I think I see."

Thea: "I identify the females by how pale they are. The males are dark, the females are pale."

Thea: "I'm having problems though. I'm trying to isolate the females before they mate, but because the university funding that I have for my PhD doesn't cover living costs, I have to live at home with my mum and dad. They live far away and I keep arriving late. I couldn't get in until 11am this morning and lots of the young female virgins that I'm trying to isolate have already mated."

James: "How about putting them in the 17 degree incubator instead of the 25 degree incubator if you can't get in early."

Thea: "Yes I'll try that, I just can't get in any earlier. Its annoying, I always find virgins when I don't even want them, its like seriously, are you having laugh." [Thea is very frustrated, and she begins laughing awkwardly as if admitting defeat]

Thea tells me that she is *"trying to catch newborn virgin"* flies. She explains that the bottle that she is working with contains flies that are at a range of four different stages: 1) adult fruit flies, 2) pupae waiting to hatch, 3) recently hatched virgin flies, and 4) flies that have hatched and mated with a fly of the opposite sex. Thea shows me the flies with the *"black dot"* that will be *"hatching the next day"*. She explains how once flies *"enclose"* (to recap, this means to hatch from the pupa) it is *"six to eight hours"* until

they begin mating with flies of the opposite sex. Thea had wanted to *"catch"* lots of newly enclosed female flies (identified by pale characteristics in relation to the darker males) before they mated so that she could isolate them. She tells me that if she isolates virgin females, which she would put into a different bottle, she would then have a batch of flies that are not going to mate or give birth to larvae whilst in that particular bottle. The isolated virgin females (all at approximately the same stage) would then, she says, be used for breeding with a batch of male flies. Thea tells me that this rigour is *"important for controlling breeding"*, which further circulates in this laboratory setting the standardisation and control that is implicit in 'good science' (Davies, 2013).

However, Thea continues to miss the virgins because she cannot get into the laboratory before 11am. This is because she has to travel from her parents' house each morning as her (apparently) small grant does not cover her living costs. She is, in this case, unable to make the flies (as nature/life) 'fit'; neither is she able to 'fit' the flies' natural rhythms. James, who is a more experienced PhD student, tries to help her regain control and he suggests that Thea keeps her flies at 17°C rather than 25°C. This is because, he explains, at the lower temperature the flies will take longer to enclose. Thea receives the advice gratefully from James because he is the more experienced PhD student. This reinforces the laboratory hierarchy (see chapter five). She talks of the unpredictability of catching the virgins as she tells me, in a frustrated tone (whilst also laughing), that the virgins are only there when she *"do[es no]t want them"*. Thea is 'punctualised' by the flies (Munro, 2004, Latimer, 2013a), and working with the nature's 'rhythms' (Puig de la Bellacasa, 2010; 2015) does not fit with 'good science' that demands results. However, the flies are moving Thea to the point of laughter (albeit immensely frustrated laughter). Whilst rolling her eyes, she says *"are you having a laugh?"*. In her 'failed' attempt at controlling the 'liveliness' of the flies as other life (Davies, 2013: Puig de la Bellacasa, 2010; 2015), Thea appears to value the flies' 'purity'. In addition, she mobilises a discourse of the desirability of young, *"virgin"* females. This is a controversial discourse when describing humans because it is often situated within the context of women forced into the sex-trafficking industry as part of a lack of access to *"dominant symbolic circuits"* (Skeggs, 2011: 503). To elaborate, whilst these women are already significantly undervalued, 'young virgins' are more desirable to clients.

Furthermore, women in the industry who are not young virgins are less valued than those who are young virgins[107].

I have described how the 'hands' selectively breed and/or cross flies with visible traits (e.g. curly wings) with flies that have the 'gene of interest' (see chapter five) for identification purposes. Birke et al. (2007) describe the 'control' and consequent 'sacrifice' of life as an undesirable characteristic of modern life science. At particular moments in the laboratory setting, biogerontologists describe controlled breeding practices using an awkward, ironic style of humour. At the CFL, I sit one afternoon with James (PhD student) and Kurt (MRes student) whilst they are, in their own words, *"purifying"* a batch of flies for a forthcoming experiment. James explains that after several rounds of interbreeding, they have created a new strain of flies. In this new strain the curly wings trait has been linked to the gene of interest. James, as part of preparing the flies for this experiment, examines the flies through a microscope. Suddenly, he grins and turns to catch Kurt's eye because they have had some success; a 'Wow! Moment' (Latimer and Puig de la Bellcasa, 2013):

> *James: "Success!!" [James takes a knocked out fly from the gauze. He is excited]*
> *Sophie: "What's happened?"*
> *James: "Have a look at that! The curly wings are visible with the naked eye!!"*
> *Kurt: "Great!"*

James tells me excitedly about his success. The operation is successful because *"the curly wings are visible with the naked eye"*. I remember that the curly wings trait is one of the more visually obvious genetic makers used at the CFL - to recap, this is amongst markers like *"Tubby"* (larger body), *"Singed hair"* (shorter hair), *"White Eyes"*, and *"Red Eyes"*. I take a look through the microscope and see the curly winged flies. James and Kurt have successfully crossed the flies with the gene of interest with flies with the curly wing trait. This strain will, therefore, be the most useful for the lifespan experiment that they have been planning together. This is a moment of shared

[107] This information is widely available from research groups and charities like 'Stop The Traffic,' 'National Freedom', and 'A21'.

excitement, which is made clear by their enthusiastic tone. Kurt replies by exclaiming *"great!"*, which shows that he is also pleased with this success. It seems like the *"purification"* (James) of this batch of flies is going according to plan. Later in the day, James and Kurt draw more explicitly upon this discourse of eugenics whilst they are at the bench:

> *[James is 'gassing' flies – a strain that are supposed to be red eyed - on the pad, identifying them under the microscope and putting them back in the vial/bottle]*
> *James: "I'm fly pushing this afternoon because when I was looking at the stocks I thought that I saw some white in their eyes after outcrossing."*
> *Sophie: "Okay. Great attention to detail."*
> *James: "Yeah, me and Kurt are doing this. We should be doing the experiment, but the flies haven't been purified enough."*
> *[James continues pushing flies and identifies a number of red eyed flies]*
> *James: "Oh look at you beautiful red eyed flies, can't all my others be like you." [James seems happy, yet articulates this in a mock-eerie tone, whilst tapping his fingers together]*
> *[Everyone laughs]*
> *James: "People call me a fly Nazi. I gas them, I practice Eugenics trying to find the master race and then I dispose of them." [James is a little 'tongue-in-cheek' in the way that he says this]*
> *Kurt: "People say that to me too."*
> *[Everyone in the laboratory laughs, albeit a little nervously]*

James begins by telling me that he has potentially seen *"some white in the eyes of [a batch] that he was outcrossing"*. He is expressing a desire for the entire batch to have red eyes, and despite his and Kurt's plan to work on another experiment that afternoon, they instead work on purifying this batch. *"Oh look at my beautiful red eyed flies, can't all my others be like you"*, James (happy with another 'success') says this jokingly in a mock-eerie voice, as he identifies several red-eyed flies in a row under the microscope. James and Kurt claim that people (perhaps referring to their peers) call them *"fly*

Nazis". James explains why: *"I gas them, I practice eugenics trying to find the master race and then I dispose of them"*. James and Kurt's accounts are given in a humourous manner, yet their humour is undoubtedly dark and ironic. This appears intentional on their part. We all laugh, half nervously, as James finishes talking. This interaction is emblematic of 'good science' because these researchers are not satisfied until 'purification' of the flies has been achieved. However, a discourse of instrumentality is also circulated alongside discomfort with the idea of selective breeding (or 'eugenics'). This is unsurprising given controversial debate about the moral appropriateness of such practices (Evans, 2002).

With violent talk of *"massacres"* and *"gassing" "them"*, a sense of mass scale is present. Furthermore, the division between humans (researchers) and animals – thought of in terms of 'human-exceptionalism' by some authors (Latimer, 2013a) - alongside a discourse of Nazism, as a 'violent imaginary' (Cavanaugh, 2003), is facilitated by this mass scale (Bauman, 1989). Like in the case of Amelie's worms (that she threw in the bin once they had been used) flies are seen in this instance as part of a mass and are subsequently 'effaced' (Bauman, 1990), which contrasts a life being individually valued. Birke et al., (2007) similarly argue that the 'mass standardisation' of animal models (as instruments) legitimates often brutal and/or violent behavior and language. Furthermore, the *"disposal"* of impurity exemplify 'purification practices' emblematic of modern science and, more widely speaking, modernity (Birke et al., 2007). However, it might also be the case that these bright young researchers are, to a degree, uncomfortable with what they are doing and are subsequently 'covering it up' with humour. This also rings true for Thea's pursuit of 'young virgins', which is a running 'joke' at the CFL.

In both cases, there is ambiguity in the instrumental/wasteful relation to the animal (models); a relation where their lives are not valued beyond their experimental 'use'. Whilst the humour, as an 'ethical doing' (Puig de la Bellacasa, 2010) of sorts, implies discomfort, it is also disconcerting because it is not acceptable to refer to humans using this language. However, the researchers' own disconcertment with their own practices demonstrates the presence of the ethical in this setting, yet the exchange between Kurt and James also reinforces the prioritisation of human lives over animal lives.

Biogerontologists' Switching Extensions: Humans, Animal (Models), and Affect

It should be clear by this point in the thesis that animal (models), as researchers' (mostly the hands') instruments of 'good science', are a significant part of the daily routine and rhythm of the biogerontology laboratory. Furthermore, I have shown that humans and their biomedical futures are the focus in public (chapter four) and animal (models) are the focus of the laboratory 'present' (chapters five and six). I first observed public biogerontology (and at events like the Public Debate), and whilst the animal 'model' was not referred to in this type of public setting, this was implied because of regular switching between humans and animals (e.g. RF's supposed 'care' for racehorses and then for humans). To recap, biogerontologists pick 'short-lived model organisms' (Gems, 2000) because they are useful when conducting lifespan experiments (see chapters five and six). This is in light of the 'slow-ness' of studying and waiting for ageing in the laboratory (Milne, 2015). Whilst the term 'model' was often used outside of the laboratory setting in more formal academic publications (e.g. journals articles), it was not used at the bench. Researchers preferred to talk about *"flies", "worms",* and/or *"the organisms"*.

In interviews, researchers explain the model organism as an animal that *"stands in the in the place of humans in experiments"* (Dr Kennedy, CFL co-head). The animals become 'consumer goods' (Birke et al., 2007), as companies (i.e. the companies that market their products at conferences) breed and sell specialised and standardised animals as models, which, they argue, represent humans more accurately because of a standard of 'professional' breeding services. As Dr Kennedy, echoing Birke et al., (2007), explains to me in an interview, the *"closer"* - or more 'biologically near' (Latimer, 2013a) - a model organism is to a person in terms of shared (what can be thought of as) 'substance', the more desirable that the organism is for research purposes. Yet, Birke et al. (2007) highlight that the extremely standardised nature of model organisms does not accurately replicate the heterogeneity of humans and life in general. Moreover, I have already explained in this chapter that there is a trade-off between the biological nearness and the Ethics procedures for a given animal (model).

Whilst I have made a simplistic distinction between 'human biomedical futures' and the 'laboratory present', the relation between researchers and their animal (models) is far

more complex. In public, biogerontologists sometimes switched between talk of humans and talk of animal (models). In the following extract (taken from an online 'Wellcome Trust' promotional video), Professor Gems (head of The Institute of Ageing, University College London) and Cassandra (one of Professor Gems' PhD students) discuss some of their current research. Like the MWL, Professor Gems' laboratory studies ageing using worms as a model organism. In the extract, the worm as a model (for both humans and genes) becomes as 'site of crossing' (Latimer, 2013b) between human and animal ageing:

> *"Ageing is a trait like any other. It's a genetically controlled trait like any other, like eye colour or hair colour or whatever. What we try to do is use very simple organisms that are very easy to work with in the laboratory, cheap to work with, to identify genes that control ageing and then to find out what those genes are and what they do, and there are reasons for optimism there because remember that many of the genes that encode for the worm are the same genes that encode for humans. In fact some of the genes that control ageing in worms are present in humans and we've shown that those equivalent genes can control ageing in many other organisms, so in fruit flies and in mice for example."*
> (Professor Gems, UCL Head, Promotional Video)

Professor Gems begins this section of talk, which is accompanied by a camera 'shot' of him sitting in an office (deskside), by making the claim that *"ageing is a genetically controlled trait like any other, like eye colour, like hair colour or whatever"*. This reiterates the story about the geneticisation of ageing (see chapter six). Thus, he begins by drawing on this discourse and also language related to humans in relation to these *"traits"* (this might be assumed because worms do not have observable eye or hair colour in the same way that humans do). Using the 'gene', Professor Gems makes a switch to talking about controlling ageing in worms. He says that worms are chosen not only because they are *"simple"* and *"cheap to work with"* (reinforcing the idea that worms are instruments) but also because *"many of the genes that encode for the worm are the same genes that encode for humans"* including the *"genes that control ageing"*.

Professor Gems, therefore, validates the switch between humans and animals in terms of 'biological nearness' (Latimer, 2013a). Professor Gems informs the audience that the 'genes' in question also are found in other organisms (like flies and mice), which Professor Gems (alongside other biogerontologists that I have spoken with) refers to as 'short-lived organisms'. Professor Gems has not used the category 'animal', yet this is implicit in the account that he gives. He has also used the category 'ageing' (rather than 'lifespan'). This is characteristic of the public setting (rather than the laboratory setting). The video is interesting because the two settings (laboratory setting and public setting) are visibly intertwined. In the same video, Cassandra begins to describe her research, and in the opening 'shot' she is sat by a microscope looking at worms (benchside):

Figure 9: Screen shot from 'Wellcome Trust' Promotional Video[108]

> *[Cassandra is looking down microscope] "Ah hah! We've got worms. When you shine a UV light on a worm, it just comes up blue [shows a blue screen with a faint blue worm shape slithering]. I haven't put that [fluorescence] there, that's just part of the worm. We think that the death of a worm kind of almost happens in the intestine, this is almost like a heart attack we're seeing, its like a trigger of death that once started doesn't stop…Look, you can see the brightness, there*

[108] Video – which has been made publically and freely accessible as promotional materials - can be viewed online: https://www.youtube.com/watch?v=pAw5rjgHWc0

> *this is it, and you can see that it's still alive but its just getting much, much brighter! That spread is death [She sounds very excited at this point]. That's showing the cells dying and you can see that it completely consumes the worm. But can you see how bright that is compared to before. It's a real live death, if you were."*
> (Cassandra, UCL PhD Researcher, Promotional Video)

Cassandra, who is looking down the microscope at magnified worms, begins by explaining that the worms glow blue in the microscope without adding *"fluorescence"* to them (see chapter five and six). Cassandra tells the viewers: "*we think that the death of a worm kind of almost happens in the intestine, this is almost like a heart attack we're seeing, its like a trigger of death that once started doesn't stop"*. Here, she reduces the death of a worm to a pathological, biological process that happening *"in the intestine",* which is shown by the right-hand worm's (Figure 9) 'brightness' compared with the 'more alive', 'less bright' left-hand worm (Figure 9). This image, Cassandra asserts, shows the *"spread [of] "death"* as the dying cells *"[consume] the worm"*. Next, she says *"this is almost like a heart attack we're seeing"* - drawing on (seemingly allegorically) a human medical language of diagnosis in order to describe what is happening to the worm – and then explains: *"like a trigger of death that once started doesn't stop"* (Cassandra).

Cassandra describes this instance, drawing still on the video of the worms, as a *"real live death"* (of the worm). In doing so, she makes a switch back to the animal world. This is evident because she is extremely excited by what is happening (demonstrated by her enthusiastic tone). Similarly to the instance of James and Kurt's reference to *"fly Nazis"* (see earlier section of the current chapter), whilst Cassandra celebrates death in the worm, it would not be appropriate to talk about 'real live' *human* death in the same way. However, in this moment, Cassandra appears affected by this instance of 'good science' rather than by death itself. Furthermore, the moving image is, again, the 'site of crossing' (Latimer, 2013a) between the worlds that Cassandra switches between.

Professor Gems begins by talking of slowing *human* ageing because ageing and death, he reiterates, are problematic. After focusing upon Cassandra, who mainly talks about

the *animals* and also ageing and death as exciting, the promotional video ends with Professor Gems describing the 'big story' (Latimer, 2014) - that ageing is plastic - in relation to 'human biomedical futures'. The video exemplifies biogerontologists' complex switching within the 'public' laboratory setting between head and hands; between deskside and benchside. This complexity is part of the continual accomplishment of the ordering of biogerontology. Furthermore, Cassandra's being moved by a 'good death' (see Vincent, 2008) at the bench publically circulates the practical care of the hands that normally underpins the public concerns of the heads like Professor Gems. In addition, at the end of the video the text reads: *"We are a global charity dedicated to achieving extraordinary improvements in human and animal health"*. In this sense, the video - which brings together human/animal worlds and benchside/deskside worlds - is used to legitimate the charity and the research. This exemplifies the agendas that position biogerontologists (Latimer, 2008).

(Subverting) Agendas: Critters, Techné, and/or 'Ethical Doings'

I described at the start of the thesis (see chapter one) the way that Heidegger (1977; see also Latimer, 2013a) figures technology as essential to 'being-in-the-world', for Dasein 'dwells' in the world in relation to a continual assemblage of her/his multiple extensions (Latimer, 2013a). To recap, Heidegger (1977) describes - within the context of humanity's relation to nature - the difference between technology as 'techné' and technology as 'modern technology'. Techné can be thought of as 'skill', 'craft', or 'art' (doing by 'poiesis') that brings forth/'reveals' authentic wo/man (Heidegger, 1962; 1977; Latimer, 2013a). This contrasts with 'modern technology', which, Heidegger argues, *"puts to nature the unreasonable demand that it supplies energy that can [then] be extracted and stored as such"* (Heidegger, 1977: 14). Modern technology is thus a result of an instrumental relation to nature (the kind of relation that I have described throughout the four analytical chapters of this thesis) where animals (models) and/or other technology become a 'means to an end'. The instrumental/wasteful relation to nature that is enacted at the MWL and the CFL is, arguably (Foucault, 1977; Bauman 2007; Evans, 2002; 2011), woven into modernity. Feenberg (2004), a post-Heideggarian scholar, proposes the recapture of the essence of techné in light of modernity's 'perils':

> *"The task of a post-Heideggerian philosophy is to conceive a technology based on respect for nature and incorporating life-affirming values in its very structure, the machines themselves. I understand this utopian demand as an implicit recovery of techné in a modern context, freed from the limitations of ancient Greek thought and available as a basis for a reconstructed modernity."*
> (Feenberg, 2004: 4)

Across the data, biogerontologists seemed to be enrolled in their institutional agendas (both individual institutions and funding bodies and also the broader agenda/s of the field); agendas that override individual desires and/or perceived autonomy (Latimer, 2008). However, across the data, there were moments where a more 'poetic' (to use Heideggarian language) approach to biogerontology became visible. On many occasions, researchers gave accounts of the pressures that had an effect upon their research practices. Yet this was, in particular moments, accompanied by delight in particular aspects of research. Kate (MWL PD researcher) explains to me that she is 'under pressure' because her current post is coming to an end, which means that she will not only need to 'publish', but she will need to find another job. However, she explains some of her frustrations:

> *"There's just not enough time!! Since Christmas I've spent a month reading, because I've been writing this review. I haven't had the time to read others' work like this, since probably the last six years. [Kate is very animated, and seems excited at this prospect]. It's so good because you learn so many different things: like 'oh they did that, and, that's already been done' and you come up with so many ideas, new concepts. But, you know, we all really read as much as we can as we go along. But there are just so many limitations, especially as there are other things going on, like teaching, things like that, students knocking on the door wanting some help. You don't want to turn them down either, because you want to help others do the same thing. But there are limits on what you can achieve."*
> (Kate, MWL PD Researcher, Interview)

Kate tells me that as a result of writing a review paper, she has been reading other academic publications *"like this"* for the first time in six years. She is pleased because she *"hasn't had the time to read others' work like this in six years"*. Kate explains that reading is a *"good"* thing because one learns *"so many different things"* (Kate), including about past and current research. Thus, it appears in this account that the work of others is a source of inspiration for her own work. Kate is excited at the idea focussing on reading and, subsequently, she tells me that she has been having new ideas as a result of learning about other experiments/findings. This account reveals Kate's (authentic) desire to read, yet, paradoxically, reading is instrumental to 'good science' and/or her research agenda. There is a switch in Kate's account as she begins to focus on the pressure created by the agenda/s in which she is enrolled. She exclaims that there are *"just so many limitations [on reading]"*. This is because of so many other things going on – for example, *"teaching [and] students"* (Kate). Whilst she expresses a desire to pass on her knowledge to others (*"you want to help others do the same thing"*), Kate implies that there are time limits placed on her research. It seems that she would be pleased if these limits did not exist. This is a story that I hear many times from researchers who tell me that they are pressed for time because of university teaching and administration agendas. These are part of 'good science' and also an effect of budget (and other) limits. The (hierarchical) division of labour becomes significant when thinking about institutional agendas. PD researchers explain to me that they are limited by their heads' agendas. However, heads tell me that their research projects are limited because available funding is limited. The heads also tell me that their benchside involvement is limited by all of the other roles that they are required to do as part of their (highly sought after) permanent positions at the top of the hierarchy (chapter five).

At *The Mainstream Biogerontology Conference*, I speak with Dr Beer. His department also studies worms, genetics, and ageing. Over the conference dinner, Dr Beer tells me that whilst he is under a lot of pressure from funding bodies, he thinks science would be different it if it was a *"craft"*. This is a term that he uses to describe a non-instrumental relation to research, and, as he speaks, I call to mind the idea of techné. He says that he is known amongst his peers (including current and past colleagues) for his great enjoyment (as he speaks, his face lights up) of the technical aspects of working with worms (benchside). On a different occasion, Dr Beer explains why he misses the bench:

> *"I like doing things in the lab, the technical aspects, I like knowing how to do things, and, you know, developing techniques, and refining techniques. [Dr Beer speaks in a very excited tone, and his face lights up] I've always been someone who's enjoyed that, people have come to me. One of the problems about this job is that I don't get to be in the lab as much as I'd like to, because I've got all these other responsibilities… [Dr Beer rolls his eyes]. I basically volunteer myself as a research technician and I get told to go to the lab about twice a week for a few hours, and then what to do etc., and that worked better for me than having my own project."*
> (Dr Beer, Pebbleside University, Interview)

Dr Beer reiterates that he likes the *"technical aspects"* of working with worms in the laboratory and points towards (situated within the context of the interview) tasks like breeding and maintaining differing strains of worms, alongside the practical aspects of laboratory experiments (e.g. *"developing [and refining] techniques"*). He complains that he does not *"get to be in the lab as much as [he'd] like to"*, which occurs because, he explains (whilst rolling his eyes), he has *"got all these other responsibilities"*. This contrasts with the preferences of other heads (like Dr Kennedy) who do not express such positive feelings when discussing benchside tasks. Professor Hurst works mostly deskside, yet when I see him on one occasion working with worms at the bench (as part of overseeing a researcher), he looks to be content and caught up 'in the moment'. All of the heads agreed that there were too many tasks to carry out (i.e. proposals, teaching, marking, administration) that detracted from research-related tasks, which is what they *really* want to be doing (whether benchside and/or deskside).

Dr Beer's account exemplifies not only his relation (as a head) to a particular agenda, but is also demonstrates that he is able to break from his agenda as he studies flies as an 'end' in itself. Dr Beer emphasises later in the interaction that he is *"not one of those ageing scientists who wants to live forever, or even cure the problem of ageing"*. Instead, Dr Beer finds ageing to be an *"interesting problem"* (Dr Beer). Other heads also talk about their love for *"mystery solving"* (Professor Hurst) and also *"tinkering"* (Dr Kennedy) with experiments. Whilst taking the lift up to the MHAI, Professor Hurst tells me that ageing is biology's *"big problem"*, that it needs to be *"solved"*, and that he

"wants to solve it" (Professor Hurst). Later, over a cup of coffee, he tells me he has been captivated by this *"mystery"* since he was young graduate student studying genetics.

In the case of Dr Beer, whilst he does momentarily break from the agendas that he is influenced by, his engagement is with the worms as 'mass' as part of 'good science'. However, there are moments in the 'laboratory present' where researchers are moved 'in the moment' by individual organisms. These moments also enact a break from scientific agendas. At the CFL, I find Thea at the bench. Kurt and James are also there. I find them 'caught up' gazing at flies that they are 'being-alongside' (Latimer, 2013a):

> *[The laboratory is silent. I watch Thea, Kurt and James, who look tired, as they check on various things under the microscope. Suddenly I hear laughter.]*
> *Thea: "Awww! Look, I've got a shy fly over here… [Thea smiles] it's covering it's face with its wings.''*
> *[Kurt and James have a look]*
> *James [looks through the microscope]: "Awwww!"*
> *Kurt [also looks through the microscope]: "Awwww!"*
> *[There is a long pause before Kurt and James start a conversation about football. Thea carries on with her work]*

Before this interaction, Thea is studying flies under the microscope. She is still catching young virgins. I hear a little giggle. Still giggling, Thea stops what she is doing and exclaims *"i've got a shy fly over here"*. Kurt and James make their way over to observe this particular fly. The three researchers take it in turns to look through the microscope. At differing times they make a noise: *"Awwww"*. This noise implies that they find the 'shy fly', 'cute', and 'endearing' because it is *"covering its face with its wings"*. Here, the researchers are 'moved' by this individual fly. Prior to this moment, Thea was attending to catching young, virgin flies (a task that she dislikes). However, in his moment, Thea, James, and Kurt break from their agendas, and, in a moment of awe and/or for the flies as 'creatures' (Wirzba, 2015), or 'critters' (Haraway, 2008), they moved by the fly's nature and its 'liveliness'. In this moment, it seems that the fly is no

longer an instrument and/or a model organism. However, the moment (like the flies) is short-lived, as Kurt and James, who appear re-energised, begin a conversation about which team they think is going to win the football game tonight. After this moment, what was previously a flat, quiet benchside atmosphere becomes lively. In this moment of 'being alongside' (Latimer, 2013a) and/or of partial 'ethical doing' (Puig de la Bellacasa, 2010), the fly is not reduced and/or transposed.

Re-Introducing 'Big Questions': Mystery Amidst the Mundane

Hamilton (2013: 266) draws on Latimer's (2004) notion of 'strong moves' in a consideration of how the *"reinterpretation of objects might constitute a form of 'cultural magic'"* as part of *"practical scenarios in which such magical transformations play out"*. Drawing on Shapin (1997: 155) I substitute Hamilton's 'magic' for the word 'mystery'. I draw on 'mystery' because is retains an aspect of what Shapin argues is 'essential' nature of science. This is because scientists have traditionally been concerned with solving the unknown and answering 'big questions' through their particular, empirical, way of knowing (Shapin, 1997; Evans, 2002). Moreover, Weber (1905) refers to the 'disenchantment' of the West in the early twentieth century. This arises, he argues, from a rational and mechanical way of 'knowing'. However, there were moments across the data that arguably exemplified re-enchantment in the 'laboratory present' (e.g. Kurt, James, and Thea's being captivated by the 'shy fly'). Such enchantment might be thought of being part of the 'revealing' of biogerontologists' authentic care/s (Heidegger, 1962; 1977), for Feenberg (2004) states that it is 're-enchantment' that holds potential to reinstate a relation of techné between humanity and nature and/or technology.

Recall the time that Amelie (MWL PD researcher) studied the effect of the PK protein upon the lifespan of longer-lived DAF-2 mutant worms (chapters five and six). To recap, I showed a moment where Amelie expresses 'awe and wonder' on account of images of 'glowing worms'. She begins this process by 'making up' slides in the laboratory and then she travels to the microscopy room in to analyse her images. After conducting *"initial visual analysis"* (Amelie), Amelie speculates that a particular worm (the long-lived DAF-2 mutant) shows *"increased signs of brain ageing"*. However, Amelie pauses for a moment and, completely captivated, stares at the glowing patterns

of 'dots and shapes' on the screen and exclaims: *"these are very pretty"*. The moment comes to an end as Amelie, deferring back to her routine of 'good science', wipes the oil from the microscope in order to leave it in good working order for the next user.

I assume initially that the image is a 'site of crossing' (Latimer, 2013a; 2013b) between the worlds of science and art. However, when I socialise at an art exhibition with the MWL researchers, I realise that Amelie is not seeing what I am seeing. She is fascinated by what she sees in front of her in the microscopy room, yet what she sees in front of her is a pattern of shapes determined by her perspective as a biologist. At the art gallery, as we traversed the corridors looking at 'abstract art' and sculptures, Kate (MWL PD researcher) turned to me (looking confused) and said: *"this is a very other way of looking at things, or perhaps we're the other"*. Rather than seeing the art at the exhibition in the same way that they might images in the microscopy room, the MWL members appear confused by the abstract art before them. However, in the microscopy room, Amelie is transfixed with these *"pretty"* animals that she is arguably 'alongside' (Latimer, 2013a) (on the screen) as techno-scientific entanglements (Haraway, 1991; 2008).

Drawing on Evans (2002), I have made reference to biogerontologists' 'thin' debate (see chapter four). To recap, Evans argues that the tendency for 'thin' rather than 'thick' debate (exemplified by ADG and RF at the Public Debate) disposes of big questions about life and social life; the kinds of questions that Turner (2009) argues are important to consider in light of radical biogerontology and its implications for society and also subsequent understandings of humanity. In the biogerontology laboratory's moments of 'mystery' (Shapin, 1997), space emerges in which to re-engage with 'big questions' that are disposed of in biogerontologists' (often banal) public accounts (see chapter four). Thea is still trying to catch young, female virgins. She begins to talk about her PhD, but - as part of a 'strong move' (Latimer, 2004) - then switches topics. She begins to reflect upon the 'wonders' of life, nature, and its origins:

> *Thea: "I think about flies when I go to sleep. I need to plan for the next day. Flies are really interesting animals. I looked at fly breeding for my undergraduate project…when a male is trying to win over a female, they*

make a little song with their wings" [Thea smiles enthusiastically and does a little impression. We both laugh]

Sophie: "Wow that's so clever."

Thea: "Yes! Amazing!"

Sophie: "What are you doing today?"

Thea: "Well now I want to catch young female virgins and males to cross. I'm trying to breed flies with an acer deletion. I'll show you." [Thea explains and drew pictures in my notebook for me. I didn't really understand, but I recognised the diagram of –A-A as two recessive alleles because James had already explained about alleles]

Sophie: "What does that involve?"

Thea: "Putting the right combo of flies together so that they get it on and also a bit of luck. As the diagrams show, if you have parents with one deletion then you will get some children with the deletion and some without. The ideal is –A –A. To identify the children, you have to mangle them up a bit so they release DNA, then you put the DNA in a machine with jelly connected to electricity and then you can identify deletions and/or the DNA and then you know which flies to put together in the vial in the hope that they'll breed."

Sophie: "Okay!"

Thea: "[I watch as Thea concentrates on the flies under the microscope] Virgins lay unfertilized eggs, although this batch with the deletion hasn't been laying too many. [Thea continues looks through the microscope] It's kind of like chickens with eggs that we eat [Thea moves away from the microscope and looks up at me, whispering]. It's all quite amazing all of this, reproduction and things."

Sophie: "Yes."

Thea: "Yes and sometimes there's just some things that can't be explained by science."

Sophie: "Yes!"

Thea: [Thea becomes enthusiastic again, yet this seeming enthusiasm is mixed with a perplexed look] "Fair enough there's a big bang, but why were the bacteria there, why!?!"

[Thea continues to catch young virgins]

Thea begins by telling me that she *"thinks about flies when she goes to sleep"*, which reinforces the notion that she is 'punctualised' (Munro, 2004; Latimer, 2013a) (chapter five), and also affected by her winged research 'subjects'. She says that she finds flies to be really *"interesting"* animals. She explains excitedly about the delicate mating rituals that attracted her to the idea that she might study animals at this academic level. At the same time, she is smiling and imitating the flies that sing a *"little song with their wings"*. She is delighted by flies and by their 'nature'.

When I ask Thea what she is doing, there is a switch in the conversation back to laboratory routines. She explains again that she is trying to catch young male and female virgins so that she can cross them. She is trying to breed flies with an *"acer deletion"* and she notions to the idea of controlling reproduction as she explains that the 'ideal' situation (with regards to this deletion) is the absence of *"-A"* alleles. There is another switch when she tells me (with an air of uncertainty) of her *"hope"* that the flies will breed. Drawing on a discourse of 'family', Thea tells me that the ideal situation is when both parents have the Acer deletion (Acer being the name of the gene) because it means that the children will also inherit the Acer deletion. Thea does not explain why she is trying to find the Acer deletion, but she explains that in order to identify the deletion in the children she will "*mangle them up a bit so they release DNA"*. Next, she will *"put the DNA in a machine with jelly connected to electricity"* and *"identify deletions in the DNA"*. In this account of 'good (reductionist) science', the ambiguity of the word *"mangle"* juxtaposes the precision of the particular combination of alleles (the Acer deletion) that she describes.

If Thea is successful in catching the virgins, DNA analysis will be her next step. She describes catching the virgins as being down to *"luck"*. Luck does not normally play a part in the laboratory's practice of control and standardisation. Thea explains to me that virgins lay unfertilised eggs, which, she explains, are *"like the… eggs that we eat"*. In the next moment, Thea lifts her head from the microscope and whispers to me: *"it is all quite amazing… reproduction and things"*. She is enthusiastic, but she also has a perplexed look on her face as she says: *"there's some things that just can't be explained*

by science". Subsequently, Thea begins to think about the origins of the 'big bang': *"fair enough there's a big bang, but why were the bacteria there, why!?!"*.

At the end of the extract, Thea seems captivated by this 'big question' about life's origins (and the 'big-bang'). This moment also opens up space to consider the 'ends' (Evans, 2002) of biogerontology, especially given that biogerontology is a field seeking to redefine ageing and life (as mechanistic). Like in the case of the 'shy fly', there is a shift in the moment to a relation of 'being alongside' (Latimer, 2013a) as part of the (partial) 'ethical doings' (Puig de la Bellacasa, 2010) of the 'laboratory present'.

Summary

In this chapter, I illuminated biogerontologists' multiple matters of concern and/or care, which extended Puig de la Bellacasa's (2011) distinction between these (see chapter one) to the biogerontology laboratory setting. Furthermore, I showed that these matters are not simplistic and clear-cut, but complex and partial. First, I returned to biogerontologists' public accounts of a concern for humanity (see chapter four). Next, drawing on definitions of 'Ethics' and 'the ethical', I advanced the research of Latimer and Puig de la Bellacasa (2013) (see chapter two) by exploring the ethical in relation to both accounts/enactments of 'Ethics' in the biogerontology laboratory setting and public enactments of Ethics (see chapter four). Furthermore, an exploration of the ethical pertained to examining futher practices of care, as a practical and affectual labour, in the laboratory setting. I reiterated that the animal (models) are biogerontologists' instruments of 'good science' in the 'laboratory present', for animals were disposed of when no longer useful (see chapter five). Where the data presented ambiguities between (what I refer to as) 'good science' and 'science for good', this extends to the field of biogerontology the contentions of authors (i.e. Shapin, 1994; Thompson, 2013) arguing that these are not separate accomplishments, but are (both) part of 'good science' as excellence.

I made visible a discourse of 'human exceptionalism', as scientists discussed the animal (models) using language that would not be used to discuss humans (e.g. 'eugenics' and being 'excited by death'). I also showed that these 'violent' languages were part of ironic humour drawn on to repair the moral order and to 'cover up' uncomfortable

practices. I describe this and other instances as 'ethical doings' (Puig de la Bellacasa, 2010) (see chapter two), which transposes this concept from naturecultural environments to the (mostly) controlled 'liveliness' of the biogerontology laboratory and biogerontologists' relation/s to animal (models), as biogerontologists (at particular moments) enact, both implicitly and explicitly, a relation of care toward other life/lives. Consequently, I suggested that the animal (models) become a 'site' for the relation of 'being-alongside' (Latimer, 2013a) (see chapter one) at the bench, which also highlights the importance of thinking about partial affectual relation/s in this laboratory setting. I suggest for the purposes of analysis that the moments elucidated in this chapter are 'moments of re-enchantment', and that framing these moments in this way enriches Latimer and Puig de la Bellacasa's (2013) conception of 'good science' as 'the ethical', and also makes use of authors' (Puig de la Bellacasa, 2010; Latimer, 2013a) thinking about, and *with,* moments of affect within the context of the current setting. This is because such moments not only extend focus to the liveliness, spiritedness, and connectedness of life, but they also order these moments in relation to the ordering/s of science and its institutional agendas, and also elements of mystery, magic, and/or the unknowable that might otherwise be absent from scientific practice.

I showed that these moments of re-enchantment – highlighted through the 'zoom lens' that a 'motile' (Munro, 2001) approach permits - opened up space for biogerontologists to disentangle from the institutional agendas in which they are suspended. This is because a non-instrumental relation to nature, as techné (Heidegger, 1977) (see chapter one), is recovered, which is, Feenberg (2004) contends, towards the 're-enchantment' of S&T as both an institution and a 'modern' mode of thinking. This finding enriches Davies' (2013) suggestion that non-standardisable 'liveliness' of living organisms, rather than being something to be avoided, adds significant value to S&T. Thus, it was 'ordinary' benchside animal (model) experiments – contrasting the grandiose nature of public biogerontology - that emerged as significant in this setting. Thus, I argue it is 'present-moment' contact/touch that is the 'site' at which biogerontologists circulate a non-instrumental understanding of life. I expand upon these ideas as I conclude the thesis in the next (and final) chapter.

Chapter Eight

Conclusions

Summary

To summarise and recap for the reader, in the four analytical chapters preceding this final chapter (chapters four, through to seven), I explored the emergent field of biogerontology at its sub-sites (public events, laboratories, media/internet/academic publications). Drawing from participant observation at public biogerontology events, alongside the observation and transcription of public events published and freely accessible on the Internet, I began my analysis in **chapter four.** Here, I explored, through analysing biogerontologists' discursive practices in the public domain, the key, and often competing, discourses (or stories) circulated by biogerontologists as part of legitimation practices. I drew on a public debate between two biogerontologists as a locus for discussion of big and smaller stories - told in this public setting - about the 'mechanisms' of ageing. I showed that these two biogerontologists (who represent, what I call, 'mainstream' and 'left-of-field' perspectives in biogerontology) figured a 'shared' perspective that ageing is plastic, problematic, and to be intervened in. I showed how, publically, biogerontologists figured their research in relation projected 'human biomedical futures' (rather than the 'animal laboratory present') and a moral imperative to 'save' humanity by 'defeating' ageing, which was figured as 'bad'. Consequently, biogerontologists circulated a distinctly anti-ageing discourse as part of 'thin' debate that disposes of (big) questions pertaining to the field's 'ends', which extends the work of Evans (2002) to the field of biogerontology. In addition, I showed that biogerontologists mostly debated *values* - in a banal manner - rather than stating *facts*. This was as part of the 'constituting of classes' (Latimer, 1997; 1999) by the mainstream, who profess *care* for 'good science', yet enact *concern* for human life. This was evidenced by the mainstream's public rejection of the 'left-of-field' because of its failure to practice 'good science'. 'Good science' (as rigourous and excellent scientific method) was articulated as a key concern for biogerontologists in this setting. This key finding, as well as demonstrating the value placed upon upholding the discipline/s of science, upholds Puig de la Bellacasa's (2011) contention that the enactment of 'matters

of care' is neglected in talk of 'matters of concern' (see chapter one), yet the chapter highlights the public nature of concern demonstrated in public biogerontology. This provides a platform for the comparative aspect of the study of biogerontology's multiple sub-sites. Furthermore, the stories projected in public about the value of 'youthfulness' and 'usefulness', and also the 'big story' (Latimer, 2014), demonstate in this sphere the productivist discourse forwarded by biogerontologists to members of the public.

In **chapter five**, I offered a detailed description of the biogerontology laboratory setting (the 'laboratory present'). Here, I primarily drew on data collected at two laboratories: The MWL and the CFL. In order to lay a foundation for chapters six and seven, and to elaborate upon the 'doings' of the laboratory, I described the socio-spatial layout of these laboratories and the day-to-day practices, routines, and repetitions of the 'world' of worm and fly genetics. This was a world constituted by researchers through 'mundane' practices such as picking, tipping, gassing, feeding, breeding, maintaining, and experimenting. Through observing these routines, which I observed to be routines of care (as a practical and affectual labour), a story was told about the control, standardisation, and apprenticeship that rigourous scientific practice entails. Thus, I showed that the value of and/or care for 'good science' is also enacted by researchers in the laboratory setting through the accomplishment of these daily tasks, routines, and accounts. Furthermore, I described an implicit classificatory system, with the MWL figured as a 'first-class' laboratory in comparison to the CFL, which was figured as 'second-class'. Also, extending the work of Latimer (1997; 1998) to the biogerontology laboratory, I described the division of labour/'labour of division' and/or the classification of different laboratory roles. These roles can be simplified to the 'heads' (heads of laboratory) and 'hands' (PhD and other students, PD researchers) (Pallí, 2004), which was an ordering that was enriched by my finding of a distinction between 'deskside' and 'benchside' work/roles. Additionally, in terms of tasks themselves, particular tasks like 'doing molecular biology' were ascribed more value than the 'manual labour' of tasks like tipping and picking. Moreover, in exploring the relations between biogerontologists and their materials, with a focus upon their relations with/to animal (models), I began to show that there is an instrumental relation to life enacted by biogerontologists as part of their day-to-day routines of care for 'good science'. I also showed that ageing was subject to 'geneticisation', which became a story that was told

about ageing *and* life, as animals were made to stand for humans *and* genes, which were made to stand for life as part of *life*span experiments. Description of the 'doings' of these lifespan experiments opened up space for the 'meanings' of these experiments to be articulated in chapter six. Furthermore, setting the scene for chapter seven, the ambiguities and complexities of care – for example, using an eyelash to 'pick' worms – were introduced, as researchers switch between different relation/s of care; between 'good science' and 'science for good'. The material was shown to be implicit in these relation/s, and I also showed that the instrumental and wasteful relation/s between researchers and their materials as part of doing 'good science' – particularly the animal (models) – told the productivist story of usefulness that was told in the public setting.

In **chapter six,** I built upon the previous chapter's description of the everyday laboratory engagements, enactments, and/or 'doings' of biogerontologists in the 'laboratory present'. Drawing on the data taken from the laboratory setting, alongside other types of data (i.e. academic publications, interviews, conferences), I examined a number of biogerontologists' experiments in order to further understand what 'ageing' is made to mean by each. A key finding is is that through these experiments, three different understandings of ageing – as 'biomarkers' (Moreira, 2015) - were enacted: 'lifespan', 'healthspan', and 'neurofunction'. These enactments of ageing accomplished 'good science' because – challenging Moreira's (2015) contention that ageing has been 'destandardised' – each can be measured, standardised, and/or quantified, which is as part of the 'simplication' (Star, 1983) of what Professor Hurst refers to as 'chaos' when faced with 'unquantifiable' results that were not compatible with scientific method (Porter, 1995). However, I showed that biogerontologists represent and publish results in the form of quantifiable data drawn from experiments as part of this process. Moreover, I showed that biogerontologists dispose of results that are not quantifiable and are subsequently incompatible with scientific method and publication, which reinforces the story about care for 'good science' as scientific rigour and excellence. I suggested that through the quantification of ageing, alongside circulating the instrumental relation to life through the reoccuring story about youthfulness and usefulness, researchers in the laboratory setting reproduce ageing as a quantitative category, subsequently disposing of qualitative aspects of ageing and the 'becoming' of the lifecourse. In addition, I suggested that life itself becomes, according to

biogerontologists' perspective/s that were made visible through the data, standardisable and/or quantifiable. However, moments of the 'unknowable', or what I refer to as 'mystery', were opened up as challenges to these aspects of 'good science'. Where Munro (2013b) refers to 'making it fit' (see chapter six), in particular moments across the data, the liveliness of the animal (models) simply did not fit. These moments of ambiguity opened up space for the thesis' key findings to be explicated chapter seven.

In **chapter seven**, I built upon the prior three analysis chapters in order to make the main argument of the thesis. In particular, I drew on the finding shown in all three previous chapters that biogerontologists are predominantly concerned for and/or care for 'good science' (as rigourous scientific method). This was shown to be a value and an accomplishment produced and reproduced at the different places/spaces at which biogerontology is 'done' (e.g. academic publications, conferences, laboratories, interview accounts). Whilst biogerontologists care authentically for 'good science', in chapter seven, I showed that care - as the 'ethical' in the biogerontology laboratory (Latimer and Puig de la Bellacasa, 2013) - is ambiguous, partial, and thus complex in its nature. I specifically illuminated this complexity, as biogerontologists made switches between their worlds of care, alongside using ambiguous language and humour to repair the moral order. Thus, alongside demonstrating the value of a 'motile' approach (Munro, 2001), I showed the complexity and ambiguity present in biogerontologists' enactments of care, which at particular moments were *for* (animal) life. In these moments, researchers made a switch from an instrumental relation to life as part of the efficiencies of science, to care for (animal) life in moments of 'being alongside' (Latimer, 2013a) (see chapter one) and momentary 'ethical doings' (Puig de la Bellacasa, 2010) (see chapter two). Such 'moments of re-enchantment' amongst the 'hands' at the bench were authentic enactments of care that subverted the constraints of scientific discipline and agendas that elevate efficiency, 'fast' science, and thin debate, whilst also reinforcing the productivist discourse that I have problematised. Thus, I showed additionally how biogerontologists – in relation to ageing and these institutional agendas within which they are entangled - switch in their attachments between the human and the animal. I showed that it is often in the present-moment awareness and/or encounter of 'creatureliness' (Wirzba, 2015), or 'critterness' (Haraway, 2008), at the bench that a non-instrumental relation to the animal (life) is enacted, as

biogerontologists switch momentarily from the agendas that enroll them. Drawing on Feenberg, I suggested this relation is also toward a recovery – albeit partial/momentary - of 'techné' (see Heidegger, 1977; Feenberg, 2004), which is, in essence, a non-instrumental relation to nature. Following previous chapters, this chapter brought to the fore the significance of the hands' benchside 'physical touch' for the *practice* of care.

Discussion

A key area for concern is the implicit and explicit anti-ageing discourse present in biogerontologists' public accounts of the 'big story' about ageing - that it is plastic (Latimer, 2014) - and, as the data showed, an aspect of life that is 'bad' and biomedically problematic. Particularly, Vincent (2008), Latimer et al. (2011), and Latimer (2014) have articulated the dangers of this potentially 'effacing' discourse for the health and lives of older people, and I extend this argument to *all* of life that is represented 'benchside' in biogerontologists' lifespan experiments. This, these authors write, is in terms of the socio-ethics of the exclusion and stigmatisation, or marking (Goffman, 1963), of older people as 'social problems' (Latimer, 1997; 1997; 2014), and I argue that this kind of critical interrogation is necessary in order to defend ageing, life, and the 'becoming/s' of the lifecourse. To reiterate, biogerontology is thus an important site for investigation:

> *"As with any bio-scientific intervention in biological life that has the potential to refashion life conditions and everyday social relations, a social perspective [of biogerontology] can reveal often complex underpinning socio-ethical issues."*
> (Latimer et al., 2011: 4)

Public biogerontology is a backdrop for the legitimation of the field in sum (see also Davies, 2012; Latimer, 2014; 2015), and it is a key site for the (worrying) disposal of ageing described (see chapter four). I show that these disposals are made in public as part of a concern, and/or a an 'inauthentic' (see Heidegger, 1962) compassion/care for humanity, which is evidenced across the data by biogerontologists' distinctly anti-ageing language and also by seemingly contradictory and polemic accounts. This argument is important to consider - especially given Vincent (2008) and Latimer et al.'s (2011) argument that biogerontology is constitutive of socio-cultural attitudes towards

older people – because it adds another layer to the ethical considerations of these authors that have gone before. Moreover, I also suggest that an authentic, practical and affectual 'ethics of care' is integral to countering ageism. The removal of the '*anti*-ageing' story that is part of biogerontologists' 'future-making' might also play an important role in creating a society where older people are valued and celebrated, and also a society where *all* people are valued and celebrated. Consequently, my findings move forward the work of Latimer et al. (2011) and Vincent (2008).

When discussing complex and society-transforming issues – such as slowing ageing and decreasing the birth rate - that fundamentally, as part of an anti-death and anti-ageing discourse, transform understandings of life, death, and ageing in humanity, biogerontologists' banal/glib accounts (see chapter four) constitute 'thin debate' that fails to take into account the complexity of these issues (Evans, 2002). To recap, Evans argues that Bioethics councils use 'rational argumentation' as *"proper method of making ethical decisions about research involving human subjects"* (Evans, 2002: 73). With Evans, I argue that if qualitative discussion in biogerontology is completely replaced by pragmatic, rational discussion where the *means*, rather than the *ends,* are debated (exemplified at the Public Debate), then it is unlikely that important social, cultural, and ethical issues pertaining to the field's means *and* ends will be discussed to an appropriate degree. However, by taking a complex and 'motile' (Munro, 2001) approach to biogerontology, I offer an approach that offers a more nuanced reading of any given scientific field than Evans, who offers a more totalising argument.

Biogerontologists' ordering/s were a key finding. Biogerontology's 'thin' public debate not only disposes of 'big questions' asked by members of society (whose *lives* are at stake), but it disposes of 'bad science' as part of a 'constitution of classes', which extends Latimer's (1997; 1999; 2013b) arguments to the field of biogerontology. Biogerontologists order 'good' and 'bad' science (or biogerontology), and this distinction emerges as a more valuable debate (to biogerontologists) than the debate about ageing itself. This finding supports my argument that 'good science' is a key concern/care in the field. The presence of this value system supports the argument that scientists are positioned in fiscal and/or political institutional agendas. However, drawing on the comparative aspect of my study, this concern for 'good science' (as

'scientific' excellence) emerges as a 'matter of care' in the laboratory setting, and this finding enriches Puig de la Bellacasa's (2011) argument regarding the 'neglecting of things' in technoscience. This is because I offer a hopeful lens by paying attention to the complex *minutiae* of the 'laboratory present'. However, I argue that a concern/care for good science is no substitute for an ethics of care for the value of *all* life. However, excellence in science/medical practice is, arguably, wholly positive. Additionally, as a member of the academic community, I know that rigour in practice is an important part of the academic tradition.

From rigour in picking and tipping; to the heads' cross checking the hands in the 'Lab Meeting'; to being excited by death because it exemplifies a 'good experiment', 'good science' as rigour was shown to be a matter of *care* (Puig de la Bellacasa, 2011) in what I termed the 'animal laboratory present' (compared to the 'human biomedical futures' of the public setting). Furthermore, 'good science' as excellence, rigour, control, efficiency, and standardisation was especially prevalent at the prestigious MHAI/MWL. The comparative (in terms of these different settings) finding extends Latimer and Puig de la Bellacasa's (2013) observation of 'the ethical' in the biogerontology laboratory in that their study focuses only upon the laboratory setting (see chapter two). In addition, the portrayal of the complexity of the continual 'labour of division' (Latimer, 1998) (at both the MWL and CFL) extends Pallí's (2004) distinction between the 'head' and the 'hands' through the further distinction between 'benchside' and 'deskside' activities (alongside the ordering of other benchside tasks). Studying *both* the public and laboratory setting highlights that the heads that give public presentations are (for the most part) not the 'hands' at the bench 'practicing' care. I showed that the 'fleshy' physical touch that is integral to the hands' benchside activities was a significant aspect of moments of care for other life/lives that were accomplished. This develops the work of authors who argue more generally for a 'hands on' and meaningful relation of care in technoscience (i.e. Puig de la Bellacasa, 2009; 2010; 2015; Friese, 2013). This 'fleshiness' is especially pertinent to my personal belief system that places a value upon messy, incarnational aspect of life/spirituality over a merely transcendental and ethereal set of ideals. However, this value was consistently challenged in the field by the value placed upon order and ordering as part of scientific discipline.

Paradoxically, whilst biogerontologists were punctualised by their materials (rather than choosing to 'go with' the natural rhythms of the animals) - which is a relation that Latimer (2013a), drawing on Munro (2004), uses to describe the way that one might be punctualised by pets, or perhaps a smoking habit - biogerontologists also worked hard to 'make [their animals] fit' (Munro, 2013b) in order to accomplish 'good science'. This was demonstrated by the (not always successful) attempts by biogerontologists to 'quantify' ageing (see chapter six); 'quantification' that was based on three laboratory enactments and biomarkers of ageing ('lifespan', 'healthspan', and 'neurofunction'). This is a finding that confirms the work of Moreira and Palladino (2009) in that it exemplifies the complex nature of the way that biogerontologists are re-negotiating biomedicine in relation to understandings of ageing. Furthermore, whilst Moreira and Palladino (2009) suggest the paradox of biological *and* chronological ageing (see chapter two) that is present in biogerontologists' public accounts, this was also found to be the case at the CFL and MWL. My finding/s here also build upon the work of Moreira (2015) because although arguing that the *de*standardisation of ageing has occurred, he argues in favour of biogerontologists *re*standardising ageing via 'standardisable' biomarkers for ageing like the ones shown across the data.

The 'quantification' of ageing was not (in hindsight) a surprising finding, for Porter (1995) iterates that this is an integral aspect of 'good science':

> *"Objectivity is one of the classic ideals of science. It refers to a cluster of attributes: first among them is truth to nature, but there is also impersonality, fairness, universality, and in general an immunity to all kinds of local distorting factors like nationality, language, personal interest, and prejudice."*
> (Porter, 1995: 217)

The 'universality' he refers to is important in relation to the idea of publishing academic papers, and, following Star, I found that *"conclusion pressures"* (Star, 1983: 211) were central to biogerontologists' continual accomplishment of 'good science' and being 'upwardly mobile' in academic careers. Biogerontologists also felt pressured to align with institutional 'agendas' that, at times, arguably hindered their ability to attend to experiments. Public 'boundary work' exemplified the pursuit of credibility that is part

of the field's agenda. However, the 'laboratory present' was space where *ageing* – and subsequently life - is refigured and/or 'refabricated' (Brown, 2010, Latour, 2010) into a quantified 'currency' (Porter, 1995) as an effect of the fleshy, 'hands on' contact at the bench.

I argue that ageing is also 'geneticised' (see chapter five) (see also Latimer, 2013b) as part of the reductionist aspect of biology that focuses upon biological 'mechanisms'. Biogerontologists referred to genes that 'regulate' the quantifiable enactments of ageing (e.g. lifespan). These genes were present as the animal (models) were made to stand for genes in this setting. This is to be entirely expected, especially as part of the 'genetics age' (see Rabinow, 1992; Latimer, 2013b), as, to reiterate, reduction and manipulation are key aspects of the story that biology tells about life (Rose et al., 1984; Rose, 1997; Grene and Depew, 2004). This reductionist approach to ageing (as part of this new genetics) disposes of holistic ontologies of ageing that figure ageing as the source of texture, wisdom, and life experience (Featherstone and Hepworth, 2005, Bothelo, 2014). This approach – in relation to genetic manipulation - also adds to longstanding, wide-ranging, and controversial ethical debate surrounding genetic determinism (e.g. Ramsey, 1975; Howard and Rifkin, 1977; Rose, 1984; Evans, 2002; Bowring, 2003; Habermas, 2003; Latimer, 2013b; Thomas, 2014; Strange, 2015). Moreover, my study situates biogerontology within this particular ethics/eugenics debate, which is a debate excluded from much of the mainstream biogerontology-specific STS literature (e.g. Binstock et al., 2006; Mykytyn, 2006c; Fishman et al., 2008).

The instrumental relation between researchers and their materials (including animals) is reinforced by the genetics-based discourse of eugenics. This discourse is exemplified by biogerontologists' selective breeding practices and the disposal of impure 'strains'. Moreover, drawing on Heidegger's (1977) conception of 'techné' (see chapter one), this instrumental relation is arguably a wasteful relation despite the contrasting sentiment of the '3 Rs' of animal research (Russell and Birch, 1959) as laid out by the field's Ethics (Latimer and Puig de la Bellacasa, 2013) (see chapter seven). Whilst animal (models) were mostly used as instruments of 'good science', a key finding of this thesis is the ambiguity and complexity of what is being cared for; particularly as part of the enactment of 'good science', for *good* as both excellence *and* as a relation of care for

life are entangled (for example, talk of harm: Harm to worms? Harm to science?). Shapin (1994), in a consideration of what 'morally good' science is, suggests an overlap between 'morally good science' (science for good) and 'good results' (good science) (see also Haraway, 2008; Friese, 2013; Thompson, 2013). However, my finding can be distinguished from the findings of Shapin (1994) and Thompson (2013) because, first, they do not differentiate between care and concern, and, second, they offer more totalising accounts of technoscience. Friese (2013) explores moments of care in science laboratories, however, whilst she argues for a care-ful relation, this was often entangled with Ethics codes. I have elaborated upon the moments when care for the animal (models) – as moments of 'being alongside' (Latimer, 2013) and partial 'ethical doings' (Puig de la Bellacasa, 2010) - is expressed both implicitly and explicitly as part of 'moments of re-enchantment'. Furthermore, Birke et al., (2007) argue that studies of care for animal life in the laboratory setting are a 'moral priority'. Following Friese (2013) and Latimer and Puig de la Bellacasa (2013), this key finding of the complexity of biogerontology's care practices contributes to this debate by way of arguing for greater levels of care toward animals being used as part of scientific experiment.

Moreover, as part of this complex ordering, the animals emerged as a 'site of crossing' (Latimer, 2013a; 2013b) between what I term 'good science' and/or 'science for good'. An important finding was that – as part of 'moments of re-enchantment' – when biogerontologists encountered their animal (models) as 'creatures' (Wirzba, 2015), or 'critters' (Haraway, 2008), rather than model organisms, they broke from institutional agendas often bound up with 'good science' and enacted 'science for good'. In moments of being moved/affect by the animals as *living* organisms as part of present-moment contact, biogerontologists - alongside being captivated in moments 'awe and wonder' – reintroduced 'big questions' that might have otherwise been effaced by 'thin' debate. Critical theorist, Feenberg (2004), defines this non-instrumental relation (recovering techné') between humanity and nature as integral to the 're-enchantment of (modern) society'. Feenberg rebukes reason and instrumentality in an age of risk and disaster (at the hands of S&T) - for example, *"world wars, atom bombs, concentration camps, and environmental catastrophes"* (Feenberg, 2004: 12). In my conclusions, I forward Feenberg's more totalising ideas, in essence, and situate these within the complexity and mundaneness of biogerontology *in situ*. Furthermore, in a similar

totalising vein, Turner (2009) highlights similar risk embedded in 'radical' life extension sought alongside a mechanistic approach to ageing and life. It is important – especially at this critical point in history - that debate and discussion of biogerontology (and its implications) attends not just to ideal future worlds often described in public, but also potential risks and/or dangers. However, my findings and conclusions bring empirical depth to these kinds of debates.

Shapin blames the scientific revolution for the "*depersonalisation of nature"* (Shapin, 1997: 162) that replaced the *"English mechanical philosopher [who was] represented as a Godly man, fit to celebrate divine service in the temple of nature"* (Shapin, 1994: 153), for 'solving mystery' was once the key focus of science (Shapin, 1997). Consequently, I suggest that 'moments of re-enchantment' - as a 'repersonalisation of nature' - re-introduce 'big questions' and facilitate biogerontologists' return to 'mystery'. Such moments may not be the most 'efficient' within the context of 'good science', however Stengers (2013) – who highlights scientists' duty of care to future generations – proposes 'slow science'. This is not a *"return to the Golden Age"* (Stengers, 2013: 8), but an alternative to the efficiency, control, and standardisation of fast, result-seeking 'good science' (referred to in the current study) that has been problematic because of its failure to account for particular long term 'side effects' for the 'collective'. Particularly, this can be said for the way that the environment has been neglected in consideration of S&T and its 'side effects' (Latour, 2013; Stengers, 2013). 'Slow science' empowers *"scientists to accept what is messy not as a defect but as what we have to learn to live and think in and with"* (Stengers, 2013: 10). Moreover, Puig de la Bellacasa (2015) argues that the practice of care is imbued with this same 'slowness', which is, she argues, an aspect of working with 'lively' things; things like soil, animal (models), ageing, and life itself (see also Davies, 2013; Milne, 2015). At the CFL and the MWL there was a paradox between researchers' being 'slowed' by the 'lively' animal (models) and their lifecycles and also animal (models) being controlled and 'made to fit' (Munro, 2013b) biogerontologists' 'good science' practices.

However, I show that ageing is figured within the context of efficiency and usefulness, for biogerontologists create a world where life that has 'passed its use' is disposed of (both in public and in the laboratory setting). Given my viewing of biogerontology as a

discursive formation (see chapter one), biogerontologists' discourses, or stories, resonate right down to the 'very grain' (Foucault, 1980). Therefore, by drawing on the story about instrumentality and disposal that is told in relation to ageing, materials, (animal) life, and genes, biogerontologists reinforce the story that older people are to be disposed of 'in the nursing home' (see chapter four) after they have passed their productive age/years (see Latimer, 1997; 1999; Bauman, 2004). To recap, as part of this story, older people are figured as 'lacking' and non-productive (see Latimer, 1997; 1998; Vincent, 2008; Latimer et al., 2011) and materials are figured as objects to be used. However, I argue that 'moments of re-enchantment' at the bench are important because they subvert this relation of instrumentality and/or productivism.

Bauman (2004) - a harsh critic of late modernity's fragile social bonds (Bauman, 2003) and/or increased social distance (1990) - examines the constitution and disposal of 'human waste'. This is within the context of the inclusion/exclusion of human lives in society and thus the value and non-value of human lives. Albeit a totalising perspective, Bauman (2004) critiques the way that populations of (deemed) 'superfluous' migrants are treated as potential 'producers', which is also a consequence of modernity and the fragmentation resulting from processes of individualisation and globalisation (Bauman, 2004)[109]. Elsewhere, Bauman (2003) comments on a more general 'attitude' of consumption, and this 'consumer society' is the backdrop for his later critique (Bauman, 2004). More generally, 'waste' is described as a product of consumption habits particularly prevalent in consumer society, and he argues (Bauman, 2004) that people who are no longer (deemed) useful because they are no longer capable of 'producing' are rejected from the social order (e.g. older people, or people in general) as 'human waste'. This is because the ability to work, Bauman argues, is a significant determining factor for usefulness and value:

> *"Employment as a key – the key – to the resolution of the issues of, simultaneously, socially acceptable personal identity, secure social position, individual and collective survival, social order and systemic reproduction."*
> (Bauman, 2004: 11).

[109] This is particularly pertinent given the political climate at the time of writing given that Donald Trump has recently been elected President of the USA and the UK has voted to leave the European Union. Both 'events' have been situated within discourse/s pertaining to immigration as being problematic.

Drawing from Bauman's (2004) argument, Beaucroft (2015: 3) reiterates this sentiment in stating that it is *"the excess, the superfluous and redundant who no longer fit into society or who for one reason or another are not allowed to stay"*. Across the data, biogerontologists publically referred to the 'untapped usefulness' of older people (e.g. the '85+'), alongside a focus upon 'wellness', 'youthfulness', and 'productivity' (see chapter four). This story resonates with the instrumental meaning of life that is circulated by biogerontologists' instrumental relations to their animal (models) in the laboratory (see chapter five). Consequently, I suggest that biogerontologists re-circulate the problem of 'human waste' that they claim to be trying to 'solve'.

Care for the environment is an underlying concern of this thesis. I showed that biogerontologists clearly prioritised humans over other lifeforms (i.e. animals, the planet) in most accounts/enactments. Furthermore, given that researchers make their animal (models) stand for all of life (in that situated 'results', that reduce all life to genes as part of *life*span experiments, are extrapolated to universal principles like life, death, and ageing), the findings of this thesis can be extended to *all* life. However, as part of the 'partial' reading of the field's practices of care (see chapter one), the moments that break from an instrumental relation to life offer hope within the context of caring for the earth. A characteristic of 'slow science' (Stengers, 2013) is the way that it encompasses concern/care for future temporalities and spaces, which (collectively) includes people *and* planet (Puig de la Bellacasa, 2010), and I extend Stengers' plea for 'slow science', showing that the biogerontology laboratory *in situ* is a key site for this. This is because 'moments of re-enchantment' 'slow down' efficient routines of 'good science', and the re-introduction of 'big questions' (that are an aspect of re-enchantment) constitutes the ontology of slowness Stengers forwards. In addition, speaking about temporality more literally, ageing, to a degree, is a very slow observable phenomenon (particularly in humans), yet researchers claim to counter this by choosing animal 'models' with very short lifespans. However, the moments of care for life that I describe suggest that care for all life and (particularly) 'nature', might become more prevalent in light of not just deep thought/big questions, but the 'present-moments' of care that take place at the bench with the touch of the 'hands'. Thinking *with* Davies' (2013) argument that the (at times) 'uncontrollability' of animal (models) in the

laboratory space provides a necessary challenge to 'scientific thinking', such moments can also be thought of as 'moments of liveliness'.

In sum, the thesis - which constitutes a deep *and* wide reading of the field of biogerontology - contributes not only to laboratory studies of science 'in the making' (e.g. Latour and Woolgar, 1986; Latour, 1987; 1988; Law, 1994), but to studies of science that examine its relation to nature and/or life forms (Birke et al., 2007; Lewis et al., 2012; Davies, 2013; Friese and Clarke, 2012; Friese, 2009; 2013; Candea, 2013; Latimer, 2013a etc.) and care (Puig de la Bellacasa, 2010; 2011; Friese, 2013; Latimer 2013a; 2013b; Latimer and Puig de la Bellacasa; 2013), and studies of emerging, and promissory, scientific fields (e.g. Brown, 2003; Borup et al., 2006; Hedgecoe, 2006, Mykytyn, 2010a etc.). Particularly, the current thesis contributes to studies of biogerontology, its emergence as a promissory field, and the way biogerontologists imagine, accomplish, and constitute ageing, and, also, life (e.g. Binstock 2003; 2004a; 2004b; 2004c; Binstock et al., 2006, Fishman et al., 2008; Vincent, 2008; 2009; Vincent et al., 2008; Lafontaine, 2009; Moreira and Palladino, 2009; Latimer et al., 2011; 2014; 2015; Moreira, 2015 etc.). Given the emergent status of biogerontology, my findings contribute significantly to the (at present) limited grouping of biogerontology-specific literature (see chapter two) that is, for the most part (see chapter two), less critical and/or more totalising than the analysis and findings offered by the current thesis. However, given the challenge to understandings of life, ageing, and death that biogerontology poses, the field (of biogerontology) remains an important site. Whilst the work of this thesis – methodologically and empirically speaking – most similarly echoes the study of biogerontology undertaken by Latimer (2014; 2015) and Latimer et al., (2011), and Latimer and Puig de la Bellacasa (2013), Latimer's (and Latimer et al.'s) work specifically draws focus to the way that *older* people and *later* life are figured by biogerontologists. However, to reiterate, the findings of the current thesis are based on a more general relation of care with a regard to *all* of life – in relation to 'creation care' (see chapter one) - that is (re)introduced by the described 'moments of re-enchantment' (see chapter seven). My contribution also adds to an emerging body of (mostly feminist) technoscience literature that explores care and affect in science laboratories, particularly in relation to the use of animal (models) (e.g. Martin, 1991; Rader, 2004; Davies, 2013; Friese, 2013; Latimer and Puig de la Bellacasa, 2013).

More specifically, the main finding of the thesis - which emerges from a holistic reading of the analytical chapters – is that whilst ageing and life are quantified, geneticised, and made to mean 'usefulness', moments of care for life (as more than productive) are enacted when biogerontologists 'encounter' life itself at the bench. This overarching finding emerges from several key findings. To recap, the first of these findings is the value placed upon 'good science' (as rigour, excellence, standardisation, and control) - public *concern* (see chapter four) for 'good science' and laboratory *care* (see chapters five and six) for 'good science' – that exemplifies the instrumental relation to 'modern technology' that, drawing on Heidegger (1977) to distinguish between 'techné' and 'modern' technology, I describe and extend to this specific research context and its complexities. The second finding is the way that ageing and life(span) are, for the most part, reduced to genes, numbers, and/or productivity as part of 'good science' (see chapter five), yet, as part of biogerontology's complex practices of care, this is – at moments - subverted by 'fleshy' 'present-moment' contact with/alongside the 'liveliness' (Davies, 2013) of animals as 'creatures'/'critters' (see Haraway, 2008; Wirzba, 2015), as animal models become animals as living beings (rather than genes and/or humans) in the laboratory setting and researchers are moved to care for and/or be affected by other life (see chapter seven). Extending the concepts forwarded by Puig de la Bellacasa (2010) and Latimer (2013a) (see chapter one), I refer to these as 'moments of re-enchantment' that are made visible by paying attention to complexity and/or 'motility' (Munro, 2001). This complexity both confirms and refutes Moreira's (2015) suggestion that ageing has been destandardised, but also exemplifies what Davies (2013) suggests to be the value of (moments of) non-uniform science (see chapter two).

Third, the comparative aspect of the study – predominantly between public and laboratory biogerontology - is a significant finding, for I describe the complex ordering/s of the field (figured by biogerontologists) and these enhance the observation of complexity. Puig de la Bellacasa's (2011) (see chapter one) work on 'matters of care' and 'matters and concern', and what is often 'neglected', is of key importance to this division for reasons (authenticity and/or affect) that I have already discussed in the current chapter. Moreover, a key distinction – drawing on Pallí (2004) – is that between the heads' concern for public-biomedical-human-futures (see chapter four) and the hands' care in the animal-based-laboratory-present (see chapters five, six, and seven).

Fourthly, it is in this 'present-moment' benchside setting that 'things' previously disposed of re-emerge as part the 'moments of re-enchantment' (see chapter seven). This finding is significant in relation to the thesis' overarching concern/care for humanity's value of life and also the close, relational social bonds of 'communion' (see chapter one) between people/life. Restoring this relation of connectedness between people (and other life) might remedy the problems emerging from waste and fragmentation that I have discussed in this closing chapter (Bauman, 2003; 2004). Therefore, the wider conclusions of this thesis inspire a distinct sense of hope for the future of biogerontology (and science), for the restoration of the environment, and for a 'return' to the value of *all* of life: past, present, and future (see Berry, 1993).

Berry (2002) considers these ideas in relation to an 'agrarian vision' for society and the connections that join together people, land, and community. He argues:

> *"In a healthy culture these connections are complex. The industrial economy breaks them down by over simplifying them and in the process raises obstacles that make it hard for us to see what the connections are or ought to be."*
> (Berry, 2002: 182)

Berry critiques the industrial economy for the wasteful relation – that I describe in the laboratory setting (see chapter five) - to the land. He argues for a culture of rich connections and/or relations, which includes the extension of relations of 'communion' – albeit it a messy and 'non-efficient' ontology – to all spheres of life. For Berry, this looks like the relations between farmers and their land, and also between people in society. I extend this thinking to science; namely the biogerontology laboratory based upon the current study's findings. Where Berry draws attention to the significance of 'the land' and the 'becomings' of the soil, Puig de la Bellacasa (2015) highlights the importance of the soil - and the ontology of slowness that it promotes - for the subversion of productivism. Thinking *with* these authors is one of the many arrival points of this thesis, for the becomings of life are of critical importance in relation to biogerontology, ageing, life, and death. Taken together with a reading of Stengers' (2013) 'slow science' (see also Evans, 2002), I argue, thinking with these ideas, that the ontology of slowness that I found to be partially present in the biogerontology

laboratory – as 'moments of re-enchantment' (see chapter seven) – embody a more holistic enactment of 'good science'; a kind of science that cares for *all* life and its becomings. Such an arrival point, particularly in relation to the overarching concerns/care of the thesis (see chapter one), opens up space for the examination of re/figurings of life, death, and ageing in cultures that value 'the soil' and/or enact 'alternative' modes of being (in relation to industrial/productivist/capitalist society).

Whilst this ethnography encompasses a broad reading of the field of biogerontology (with a particular focus upon the UK field) alongside a more in depth exploration of two laboratories in particular, the study is not without its limitations. As with any ethnography that encompasses many (sub)sites, depth can often be replaced by breadth and, therefore, a key limitation of the study is the (relatively) short length of time spent as a participant observer at each laboratory setting. Whilst this length of observation was embedded within the context of an in-depth study of each laboratory carried out over several years (see chapter three), the data might be said to lack the richness that may have been obtained from spending, say, one whole year carrying out laboratory observations. However, it has been shown in the current and concluding chapter that a significant finding is the comparative aspect of the study. Such comparison would not have been possible had I focused merely on laboratory-based data. Another limitation of the study is that the in-depth focus extended only to the 'genetics community' in biogerontology. Whilst this emerged as a prominent area of 'mainstream biogerontology', there are other sub-communities of biogerontology that I have not engaged with. However, this is an entirely normal limit of any ethnography. The deep insight gained, particularly through observing behaviour rather than gleaning insight merely from accounts (Jerolmack and Khan, 2014), is, however, of significant value for reasons that I have already described (see chapter three).

Whilst I have described limitations, these illuminate further areas/communities for deeper ethnographic exploration, particularly as biogerontology becomes increasingly prominent in public discussion due to further advancements in the field. Interestingly, at the time of writing, de Grey and SENS are becoming less prominent in the public field, whilst other mainstream biogerontologists become key 'spearheads' instead. This exemplifies the 'success' of the mainstream (several years on from the Public Debate)

in 'disposing' of de Grey and 'bad science'. An example of this is, what the media reports as, the 'world's first anti-ageing drug' (Knapton, 2015), which is based upon recent statements made by Professor Gordon Lithgow of the Buck Institute. Both Lithgow, and other biogerontologists in the UK and US, suggest that the current drug 'Metformin' (a widely used diabetes drug) is, at present, a likely candidate for use as part of developing the first 'anti-ageing pill'. This is because of the way that this drug influences metabolism at sub-cellular level (Knapton, 2015). Similar statements have been made in other fields - for example, researchers at Cardiff University's medical school (see Bannister et al., 2014) report an increase in the lifespan of diabetes patients treated with Metformin. Consequently, compared to the time of carrying out participant observation and interviews (as part of the current study), human trials for these types of medications are now more 'evidently' 'on the cards'.

As biogerontological 'futures' are framed (at least in public) as more likely than ever before, 'slow' (Stengers, 2013) and/or 'thick' (Evans, 2002) discussion and debate about the ethical, cultural, and social issues of the field is vital. Turner (2009) expresses concern about what the world will look like in the future if the once spirited, unique self is viewed as mere disposable soma (see also Cole, 2009), for he heavily critiques *"mechanical methods of studying the human body and therefore…the notion that ageing [is]…simply an engineering problem"* (Turner, 2009: 145). Whilst Turner's more totalising approach to biogerontology argues that biogerontologists fail to embrace the spiritual dynamic of life, the current study, alongside engaging the wider debate surrounding the implications of life-extension by scientific means, offers hope that biogerontologists might continue to enact 'moments of re-enchantment' as they encounter other life at the bench, and, in doing so, that they might re/assemble life as 'more than a useable energy source'; that they might capture the richness and spirited-ness of life as they seek to shape new worlds at the frontiers of science.

> ***"But we now realise that the future is coming towards us at full speed. It may be said that each of us, here, stands as having to imagine how we will answer those who are not here, in this room, but who nevertheless already exist. What will we answer to the children born in this century, when they ask: you knew what you had to know, what did you do?"***
> (Stengers, 2013: 1)

Epilogue: On Slowing Down

This thesis has been a meditation on slowness (amongst other things). It might be gleaned that slowness is one of its 'arrival points'. The reader might remember one of my 'guides' to the field, Dr Ted Tucker. Months away from my official thesis 'hand in date', I speak with him at an academic social event. After the initial small talk (*"haven't you finished that PhD yet?!?"*) he explains to me – glass of wine in hand - his most recent revelations:

> *"To be honest, this whole thing's about stress…we all just need to slow down...stop rushing about trying to get everything done so fast…if we did that, then our bodies wouldn't age nearly as much."*

Smiling, I reply: *"that's the conclusion that I have come to."*

As I write this (near final) paragraph, I sit in a bustling coffee shop situated at a busy interchange in an even busier city. People rush past on their phones; running home from work before heading out again to enjoy everything that the city's nightlife has to offer. I am trying to imagine what slowness might look like here.

Whilst slowness goes against the grain of a lifetime's accomplishment of (educational) efficiency and performance, it has been forced upon me in my undertaking of this PhD project (for life likes to throw unexpected 'things' at any given person). Consequently, this thesis has been grown and not manufactured. I have 'experimented' with slow ethnography. This slowness does not refer to an extended timeline *per se*, but the progressive, barely-noticeable-at-the-time transformation of (in hindsight) *my* once instrumental approach to research and, also, to life itself.

Heidegger (1968) refers to thinking as 'being-thoughtful' and as a joyful and gracious mode of dwelling, speaking, gathering, playing, creating, and Being (see also Robbins, no date). It is with gratitude in my heart that I (finally) arrive at this way of approaching *and* interpreting my (no-longer-a-means-to-an-end) study; a study that has become my 'techné' and my 'revealing' (Heidegger, 1977); my 'ethical doing' (Puig de la Bellacasa, 2010) and my *care*ful contribution to a world in which I see beauty and hope (not merely disorder and decay). It is on this note that I wish to conclude my 'being alongside' (Latimer, 2013a) biogerontology, for hope triumphs.

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