Freezing fertility: Oocyte cryopreservation and the gender politics of ageing

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CHAPTER 7

Oocyte Futures

The Global Flow of Frozen Eggs

This study has followed the journey of the egg in the OC procedure, moving from the bioprepared body to the freezer and, after fertilisation, from the incubator to the womb. However, the egg's journey in OC need not find its endpoint in motherhood, whether older or not. In fact, given the potential for failure at every step in OC—thawing, fertilising, incubating, implanting, continuing pregnancy—chances of a single frozen egg resulting in a live birth are as slim as 5% (D. Stoop et al. 2012, 2032). Not only are live birth rates limited, but out of the 2,272 women who froze approximately 20,467 eggs between 1993 and 2012 at British clinics only approximately 10% returned to use their eggs in this period (HFEA 2014b). If, in the long term, a significant percentage of women do not claim their frozen eggs, OC can be considered a new source of eggs that could be circulated in networks of reproductive and research egg donation. The fact that the eggs are frozen moreover shifts the spatial and temporal dimensions of existing practices of both these forms of third-party egg donation.

In this final chapter, then, I consider how the trajectories of the frozen eggs that OC produces differ from those of their "fresh" counterparts in reproductive and research egg donation. One important shift follows from the extended durability of frozen eggs, which means they may be stored in so-called "egg banks"—by analogy to the more familiar sperm banks—which collect a repository of donor eggs for third-party use. In the years following the Dutch 2011 legalisation of OC, three egg banks were founded in the Netherlands and the first UK egg bank, the London Egg Bank, opened its doors in 2013. Egg banks function as hubs for the redistribution of cryopreserved eggs to both local and distant labs and clinics. As such, they do not only regulate and organise the material movements of eggs, but also play a key role in their discursive production in online donor profiles, for example. A second significant shift in egg donation follows from the fact that cryopreservation renders the egg newly mobile. Due to their fragility, fresh human eggs are typically only handled within specialised spaces in IVF clinics and biomedical laboratories (Franklin 2006b, 173).[135] Once frozen, however, the eggs become as mobile as the liquid nitrogen tanks that contain them and may cross unprecedented distances between clinics, countries and continents. Egg freezing is thus the key condition of possibility for the development of a global flow of eggs, affecting

[135] One exception is so-called "Transport IVF," in which egg extraction and fertilisation occur in different clinics and the extracted follicular fluid containing the fresh eggs is promptly transported in heated incubators (Shirley Oaks Hospital 2007).

both reproductive health care and research practices.

This global mobility of eggs should be situated within larger contemporary processes of change pertaining to globalisation and ageing. On the one hand, global developments like the deregulation of financial markets, the ubiquitous reach of communication technologies, the growth of tourism industries and the outsourcing of labour are the conditions of emergence for a globalisation of biomedicine through transnational "reproflows" of technologies, people and body parts in cross-border reproductive care (CBRC) and internationalised research networks (Franklin 2011, 815; Inhorn 2010, 1810). On the other, global population ageing, following from declining fertility and increasing life expectancy, has significant and locally-specific sociocultural, political-economic, and physical effects (Neilson 2003, 161). The emergence of cross-border flows of eggs must be positioned in relation to the increasing age of people seeking fertility treatment—and the concomitant demand for younger donor eggs—as well as dominant narratives on "successful ageing" that advocate individual responsibility for health and functionality. As locus of both reproductive youth and regenerative potential, the movement, procurement and (potentially) therapeutic use of eggs is intimately caught up with a politics of ageing that gains a global dimension when these eggs become mobile.

In this chapter I explore the implications of the transnational mobility of frozen eggs for reproductive and research egg donation practices with two case studies. I first discuss the US-based World Egg Bank, which ships frozen eggs to intended parents across the (Western) world. Focusing on the movement of frozen eggs from the US bank to UK clinics, I consider what factors drive this "reproflow" and how the imported eggs shift the temporality and analyse discursive practices of egg donation. Here the mobility of eggs entails a respatialisation of reproduction, in which the distances between egg banks, egg donors and egg recipients can increase, while online communication takes on a central role in bridging them. Accordingly, I focus the analysis on the World Egg Bank's online presence. I use this case to return to the notion of "distributed ageing" and consider its implications for enlisting women across the globe in egg procurement for distant, technologically-assisted reproduction. The second focus lies on three studies published in 2013 and 2014, that report, for the first time, the successful derivation of human embryonic stem cells created through somatic nuclear cell transfer (SCNT), also termed "therapeutic cloning." I discuss how the long-awaited success of SCNT technology revives the question of research egg procurement at a time when cryopreservation creates the possibility of shipping and banking eggs. In the third section I discuss how the potential clinical applications, financialisation and regulation of SCNT research, along with its dependence on large amounts of oocytes provided by young women, relate to a broader global biopolitics of ageing that intersects with gender and

class differences. As this research in regenerative medicine bears witness to a reconceptualisation of the notion of ageing, it also radically reconfigures the egg's—and particularly its cytoplasm's—relation to bodily time.

"Eggs without Borders": The World Egg Bank

The US-based World Egg Bank is one of the first companies to turn the global movement of cryopreserved female gametes into its core business. Specifically targeting the international demand for donor eggs, the World Egg Bank procures eggs from American women and transports them to contracted fertility clinics in countries like the United Kingdom, Canada and Australia. Combining gamete mobility and egg banking, the World Egg Bank offers insight into the transnational trajectories of frozen eggs. In keeping with the geographical orientation of the earlier chapters, I focus on the United Kingdom as a recipient country of the World Egg Bank's shipments.[136] In this arrangement, the geographical distance means that UK egg recipients don't primarily encounter the clinic where the eggs are donated by visiting a building and meeting its staff. Rather, online communication plays a key role, both in choosing a clinic and arranging the donation. For this reason, I also focus the analysis on the discursive construction of the online presence of the World Egg Bank. This section explores how this practice not only imports eggs, but shifts the regulatory, temporal and discursive dynamics of egg donation in cross-border reproductive care (CBRC).

Many institutions in the fertility industry have based their business model on national disparities in egg scarcity, procurement regulations and treatment costs, but the World Egg Bank (TWEB) is one of the first to do so by moving eggs–rather than people—across national borders. Founded in 1996, the company originally focused on recruiting and screening egg donors, but began to freeze eggs as, self-reportedly, the first commercial egg bank worldwide in 2004.[137] It has been shipping frozen eggs internationally since 2007, distributing over 3000 frozen eggs within the United States and abroad, with destinations including five fertility clinics in the UK. TWEB's roster includes 450 donors, some of whom have eggs frozen for donation, while others undergo

[136] I do not include the Netherlands because TWEB has not (yet) shipped eggs to this country.

[137] TWEB is a commercial egg bank governed by a management team, consisting of a president, a medical director and a scientific director. The president, Diana Thomas, is highly visible on TWEB's website in various videos directed at potential patients, in which her own experience with egg donation is foregrounded to claim authority and build trust: "We understand what you are going through" (TWEB 2011). In a video featured on the website's homepage she states: "because I was one of the first women in the world to conceive and have children through donor eggs nearly 20 years ago, I still stand for the right for women everywhere to have a chance to hold a baby in their arms" (TWEB 2014). TWEB also has a scientific and medical advisory board with experts including Dr Kuwayama, who is a key player in developing the vitrification technique for egg freezing and was responsible for the first children born from vitrified eggs in the US and Japan (TWEB 2015b).

stimulation and provide eggs only when selected by intended parents. In both cases, eggs can be frozen, transported and subsequently fertilised and implanted at the recipient's clinic.[138]

Eggs become mobile once they are stored in special dry vapour liquid nitrogen shipper tanks. In these tanks the eggs can safely remain for 7-10 days in cryogenic temperatures below -150˚C (Cryoport 2014). Various international courier companies specialise in shipping reproductive cells, including Kýnisi (UK), Time and Temperature Courier (India) and Cryoport (US), the latter of which TWEB employs. These companies are part of the infrastructure for moving frozen eggs through bio-cryogenic "cold chains," which are largely already in place given the existing transportation of various cell and tissue cultures for clinics and laboratories globally.

Traveling in the opposite direction of egg recipients seeking donor eggs abroad in CBRC, frozen egg trajectories will likely develop along existing pathways between wealthy nations with egg shortages and popular donor-egg IVF destinations with relatively permissive egg procurement regulations. A case in point is the Ovobank Spain, the first European egg bank shipping frozen eggs across national borders. Its location reflects the popularity of Spain as a "fertility tourism" destination for donor eggs, responsible for over half the donor-egg IVF cycles in Europe (Kupka et al. 2014, 2101). Spain is particularly popular among UK intended parents, for whom local gamete shortage—particularly eggs—is the top motivation (71%) to travel to overseas clinics (Culley et al. 2011, 2373–6; Shenfield et al. 2010, 1364–7). Ovobank Spain presents a variation on CBRC in which foreign patients can partake of the Spanish availability of eggs without leaving their home country. Whereas Spain's relative proximity and available travel options are attractive to many UK patients, once eggs can be shipped, limitations on the distances people are willing to travel are no longer a consideration. Consequently, frozen egg transfers could raise the popularity of egg banks further afield, such as TWEB, thereby globalising the donor egg market more than is currently the case.[139]

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[138] A previously existing, if rare, variation of transnational egg donation in which cells cross borders is the "mail order" arrangement, which entails shipping sperm to the egg donor's clinic and subsequently transferring the fertilised eggs back to the intended parents for implantation (Heng 2006, 1225).

[139] In keeping with the popularity of Eastern Europe and Russia as destinations for UK intended parents seeking donor eggs, the Russian AltraVita clinic reportedly also exports eggs to UK clinics (Templeton 2010). Waldby notes that the popularity of Spanish and Eastern European clinics follows in part from the availability of donors of "Caucasian" appearance, "which matches that of [a portion of] the North European purchasers" (2008, 23). This is in line with Pollock's assertion that "in anonymous egg donation, phenotype is privileged above all else" because "physical similarity between donor and recipient makes the donation invisible" (2003, 253). While Pollock writes in her ethnographic study of US egg donation that "most of those with the means to use the technology are seeking white eggs, and it is likely that even among those Black egg consumers dark skin is undesirable," Almeling's research into this industry found that clinics have trouble "recruiting diverse donors" and therefore may pay African American women more

The disparities in the regulatory frameworks governing egg donation, and the concomitant differences in the availability of donor eggs, play a key role in motivating TWEB's US-UK egg trade. In contrast with the largely unregulated fertility industry in the US, the HFEA, which licenses all UK fertility clinics, sets limits on the payments for egg procurement.[140] These limits have risen steadily over the last two decades—in part in response to the increasing popularity of purchasing eggs abroad to circumvent UK waiting lists. The HFEA has increased maximum payments from £15 per cycle in 1998 to £250 in 2005 and £750 in 2011 (HFEA 2011; HFEA 2012). The maximum payment for donors of imported eggs was, however, maintained at £250 in loss of earnings per cycle (Jardine 2012). Testifying to the influence of financial compensation in motivating egg donors, the number of egg donors increased by 35% in the two years after 2011 (HFEA 2014a, 13). Although around half of the UK clinics reported an increase in egg donations after 2011, donor shortages remain—particularly for intended parents of racial minorities seeking phenotypically similar donor eggs—and British patients continue to travel abroad to seek treatment with overseas donor eggs (Waldby 2008, 23; Smith 2012; Taneja 2013; Nutt 2014).

Notably, the HFEA regulations only seek to avoid the financial inducement of potential egg donors, while other parties, such as TWEB, Cryoport and the recipient's clinic, may operate on a commercial basis—i.e. be financially induced to engage women in egg procurement. In UK and US fresh egg donation, intended parents typically pay for the donor to undergo a cycle, irrespective of the amount of eggs produced. This arrangement reflects the ethical justification upheld by both the HFEA and the ASRM—if with different monetary standards—that women are compensated for their time and expenses, rather than for their bodily tissue (ASRM 2007). However, in frozen egg donation practices, such as TWEB's, the recipients order a specific number of eggs, instead of linking payment directly to the donor's cycle.[141] As a result, the number of tradable eggs a woman produces per cycle directly translates into her profitability for the organisation. This creates a tension not only between the health risks of

for their eggs (Pollock 2003, 251; Almeling 2011, 173). With transnational egg donation, the national origin of donor eggs, alongside the construction of race and ethnicity categories by institutions like TWEB, may also inform egg recipients' choices. Whatever the dynamics of supply and demand, in egg donation practices such as TWEB's, "race/ethnicity is genetically reified to the degree that it serves as the basis for program filing systems" (Almeling 2011, 57). For a critical discussion of "the assumption that skin tone is a given phenotypic attribute" in the context of egg donation, see Thompson (2009, 133).

[140] In the US, no legal limits on egg donor compensation exist. The ASRM does, however, state that "sums of $5,000 or more require justification and sums above $10,000 are not appropriate" (2007, 308).
The HFEA regulations are in keeping with the *European Tissues and Cells Directive*, which prescribes that "Member States shall endeavour to ensure that the procurement of tissues and cells as such is carried out on a non-profit basis" and allows Member States to require "voluntary unpaid donation" as a condition for importing gametes from abroad (European Union 2004, L102/53–4).

[141] TWEB charges $16,500 for 6 mature, vitrified eggs and $1,600 for international shipping. Whereas donor compensation costs vary for fresh eggs, all frozen eggs are offered at this fixed price.

(over)stimulating the donor's ovaries to produce more eggs and the pregnancy chances of the recipient, but adds the dimension of profitability linked directly to the outcome of the cycle. As a result, TWEB's sales model commodifies the individual eggs rather than the "clinical labour" of the egg donor (Mitchell and Waldby 2010).

Taking up the UK's donor egg shortage as a business opportunity, TWEB's home page includes a prominent "Welcome UK" section, which links to a page explaining that a selection of TWEB donors comply with the UK's HFEA's Code of Practice, whose profiles may be accessed through the website. Accordingly, TWEB donors have to decide whether to become an international donor, which entails agreeing to the release of identifying information when the child turns 18 and receiving less financial compensation—a consideration to be made in a North-American cultural context that favours altruistic donations and encourages downplaying financial motivations (Almeling 2011). By catering to the HFEA requirements, TWEB demonstrates how the international movement of eggs affects local egg donation practices, thereby extending UK regulations to new territories.

Conversely, the movement of eggs into the UK imports at least two important aspects of US egg donation practices. Firstly, frozen egg banking changes the temporal dynamic of international egg procurement; whereas fresh egg donation is characterised by a degree of uncertainty about the outcome of the donor's treatment, which may take up to three months, cryopreserved eggs are available for immediate shipment and do not require synchronisation between the two women's cycles. Because there is no need to await a match between recipient and donor to start a stimulation cycle, egg banks can accommodate a continuous supply of eggs by donors and a continuous demand for "high quality" eggs in anticipation of a diverse group of future intended parents not limited to the local population. If there are enough donors and recipients available, egg banks can thus speed up the reproductive process of egg donation through the stalling of the eggs' cellular time. TWEB's specific transatlantic egg flows speed up UK egg donation procedures by making the more abundant availability and variety of donor eggs in the US accessible for local treatment of UK intended parents. For those patients seeking to avoid waiting lists, the speeding up of the reproductive process may be a key motivator to purchase eggs abroad.

The second key element that frozen US oocytes import into the UK is the particular discursive framing of the eggs by TWEB and the concomitant choice for a specific donor by the intended parents. While TWEB's frozen donor eggs cross a greater spatial distance for UK egg recipients, online profiles offer a closer encounter with the detailed discursive construction of donor. TWEB's online platform presents its goods—the eggs—in detailed donor profiles. Each profile shows a selection of photographs and donor statements about their talents, reasons for donating, favourite books, personal

goals for the future and exercise habits. The profiles also feature a detailed medical history, including birth control method, abortions, plastic surgery, and diagnosed conditions—from dwarfism to nearsightedness—of the donor and her family members. Further details about family members, including age, occupation, weight and skin type, are also included. TWEB's interface organises the profiles in lists of ten per page, showing a numeric ID, age, location and a small picture. Buttons for categories like "weight," "education" or "ethnicity" arrange the profiles in "ascending" or "descending" order, in anticipation of the potential recipients' selection process. Through the interactive juxtaposition of donor profiles, this online interface configures the various differences between donors as the basis for the profiles' arrangement on the webpage, which has the effect of presenting these particular categorisations as key considerations to potential egg recipients.[142]

In the UK, by contrast, the choice for an egg donor is more anonymised and either made by the fertility clinic, which seeks a donor with "similar physical characteristics to yourself," or, in the case of the London Egg Bank (TLEB), through an online catalogue (2014). This catalogue includes donor characteristics such as weight, height, eye, hair and skin colour, and categorisations of "race" and "religion" along with medical test results and keywords on "personality" and "hobbies." TLEB explicitly foregrounds its use of individualised—if anonymised—donor presentation in its marketing with slogans like "The choice is yours. You are in control."

TWEB nevertheless introduces a much more specific donor choice in the UK through its detailed online profiles. The donors' presentation with a selection of photographs and a self-description of talents, reasons for donating, favourite books and personal goals illustrates Jenny Payne's argument that not only bioavailability, but also "biodesirability" drives cross-border reproductive care. TWEB's profiles are carefully constructed to meet widespread preferences for physical resemblance to the intended parents, expected fertility and health, but also invite a selection based on traits like beauty and intelligence (Payne 2013, 7). One way in which the profiles convey the biodesirability of the gametes on offer is with photographs depicting graduations (intended to show intelligence and academic achievement); beauty pageants and school proms (as signs of attractiveness); and pictures in sports gear and cheerleading (as a testimony to athletic qualities). Significantly, all of these images also signal life phases associated with reproductive youth. Similarly, the textual self-descriptions convey gender-specific positive traits that intended parents are expected to be looking for, such as caring qualities, altruism or maternal solidarity with infertile people. Mediated by

[142] These profiles also present egg donation as a practice that not only requires providing eggs, but also a significant degree of public self-disclosure and self-presentation.

TWEB and its specific interface, the self-presentation in these profiles approximates "impression management" in online social networks, which is shaped by expectations of the imagined reference group and "the values associated with 'the ideal self'" (Ellison, Heino, and Gibbs 2006; Siibak 2009). Recipients in Payne's study of European cross-border fresh egg donation signalled biodesirable qualities were of key importance in their donor selection (2013, 7). By extension, the introduction of these biodesirability markers to people receiving donor-egg IVF treatment in the UK may be a driving factor for transnational egg movements.[143]

Besides the egg donor, the potential future child also figures in these profiles. Much like blogger Eggfreezer described her cryopreserved egg as an early version of her future child as I discussed in Chapter 4, a link between the egg and the potential offspring is also established in TWEB donor profiles. To a degree, this goes for all the donor profiles, which make an implicit claim to heritability by suggesting that the future child may embody the donor's biodesirability. More explicitly, some donors expressly refer to their eggs as future children: "I would love to know that 18 years from now my egg grew up in a wonderful and amazing environment with great people who cherish their child and family. I know my egg will be an amazing person!!" (TWEB 2015a). The profiles' inclusion of pictures of children makes a further claim to heritability by suggesting that they may bear a degree of resemblance to future children born from these eggs. These children's pictures, however, are often ambiguous as they could be the donor's own childhood photographs or those of her children; in some profiles the distinction can only be deduced from the changing aesthetics of imaging technologies in the last three decades. As Marieke Schellart, whose documentary *Eggs for Later* I discuss in Chapter 3, used home videos to imagine reproductive futures, these ambiguous portraits suggest a heritable continuity between mother and child that may be transferred through the egg on offer.

Otherwise unavailable to British intended parents, the particular presentation of the egg through visual and textual representations of donors and children introduces a dimension of (consumer) choice on the part of the recipients. Through the mechanisms of the filter, which allows recipients to only show blue-eyed or French-ancestry donors, and organising categories like "weight" and "height," the juxtaposition of profiles invites a comparison. As a result, the intended parents do not choose *whether* they would like to receive a donor egg pre-selected by a medical team, but *which* donor egg would suit them best. This choice introduces a higher degree of patient agency over the reproductive process that may reposition conventional anonymous egg donation as

[143] Although TWEB only arranges egg donation, it is common practice among US sperm banks to include donor profiles of sperm donors. However, in sperm donation, "photos of the donor as a child rather than an adult are the most common visual representation" (Thompson 2009, 135).

lacking in comparison. In choosing, intended parents may balance a preference for donors that look like themselves to successfully perform "resemblance talk" and donors that "compensate for any of their own self-perceived shortcomings" (Becker et al. 2005; Payne 2013, 7). Especially given the high prices and high stakes involved, egg donation requires a particular type of risk management. On the one hand, the assessment of eggs on the basis of donor profiles increases the responsibility of the intended parents over the reproductive process, while on the other it encourages an enactment of biodesirability on the part of the donors.

While the speedy bioavailability and the choice for biodesirability drive these US-UK egg movements, the underlying demand for egg donation—both for donors and recipients—emerges from age-specific social realities. In a majority of cases, eggs move from fertile younger women to older women with age-related infertility. TWEB donors only qualify if they are between 18 and 29 years old, while UK women seeking donor eggs abroad are on average around 40 years old (Culley et al. 2011, 1; Shenfield et al. 2010, 3). Furthermore, reproductive youth tends to have an inverse relation with financial means and many young women—especially those who bear the expenses associated with their "proven fertility"—are attracted to egg donation for the financial compensation (Almeling 2011, 68). As described on their "Eggs without Borders" blog, TWEB specifically focuses on recruiting students by targeting campus newspapers and handing out TWEB flip-flops and sunglasses, given that they are typically young and their education levels are a selling point: "ASU's Spring Semester will soon be underway […]. With thousands upon thousands of qualified young women moving back into the area, The World Egg Bank is giving them the resources they need to learn more about egg donation" (2015c). US students are in an increasingly precarious financial situation as university tuition and living costs at public institutions have risen 40% in a decade (2001-02 to 2011-12), while in 2012 available grants and scholarships fell by 15% (Snyder and Dillow 2013, 310; Ensign and Korn 2012). In the context of the most recent financial recession, young US women who are not students may deal with unemployment, which affects young adults disproportionately by a factor of approximately 2,4 and rose from 10,6% in 2001 to 16,2% in 2012 (United Nations 2014a; United Nations 2014b).

By contrast, British women approaching 40 are relatively well-to-do compared to younger age groups as wealth accumulation reaches a peak in the 45-64 group (Prothero 2013). Often a second option after failed treatments with one's own eggs, women seeking donor-egg treatment abroad are typically older than those women who try IVF for the first time—averaging around 40 years compared to 35 (Culley et al. 2011, 1; Shenfield et al. 2010, 3). As the practice of TWEB exemplifies, these intersections of age, gender, fertility and economic means drive the international movements of eggs.

In relation to OC, I have suggested that egg freezing creates a "distributed" type of reproductive ageing located both in the body and in the frozen egg. In transnational egg donation, the distribution of reproductive ageing similarly happens in a heterologous fashion between different bodies and eggs. Now spanning a much larger spatial scale, it intersects the physicality of cellular and physical reproductive age with broader political and economic structures. If egg donation may be considered as a form of distributed ageing, reproductive youth becomes a transferable quality that may be "outsourced" to women across the world.

While CBRC for egg donation has been geographically limited by the distances intended parents are willing to travel, the mobility of frozen eggs allows the extension of international egg donation networks, which are currently primarily situated in Europe and North America, to the global South. Although the discussed egg transfer of TWEB occurs between two relatively privileged national contexts, future flows of eggs—following the logic of the existing cross-border trade of fresh eggs—may follow a trajectory from poor donors to wealthy intended parents, from less regulated national contexts to more restrictive health systems, and from younger to older women. As the fertility industry has expanded beyond Europe, North America and Oceania to the Middle East, Asia, Africa and Latin America, where clinics predominantly operate on a private basis, institutional infrastructures are in existence that could be employed in transnational transfers of cryopreserved eggs (Ryan 2009, 811–2). As numerous Asian and Latin-American countries, including India, Cuba, Malaysia and Thailand, actively encourage medical tourism, government policies could further encourage the growth of a more globalised ART circuit for egg donation (Pande 2011, 619). In India, for example, international trade agreements, a large private health care sector and a national health policy that overtly seeks to "encourage the supply of services to patients of foreign origin on payment" have played an important role in stimulating the medical and fertility tourism market through measures including "low import duty on medical equipment" and arrangements for special "medical visas" (Mukherjee and Nadimipally 2006, 129–130; Ramírez de Arellano 2007, 197).

In this global flow of frozen eggs, the "cold chain" may start to function like the "global care chain." The latter references "the international transfer of caretaking" by the commodification of care work through the employment of lower-waged migrant women (Arlie Hochschild 2001, 357; Parreñas 2000, 561). Rather than the migratory displacement of women as a result of the marketisation of domestic care work, the marketisation of technologically-assisted reproduction may result in the displacement of the cryopreserved gametes of lower-waged egg donors. From the example of TWEB, it may be extrapolated that this global cold chain of distributed ageing would flow from sites in which women's reproductive youth intersects with financial need in a national

context of high biotechnological development and permissive regulations to the places where an increased age of reproduction—or reduced fertility for other reasons—meets relative wealth, high biotechnological development and limited or expensive supplies of eggs. Biodesirability plays a key role in shaping these reproflows, as became apparent in the discursive constructions of TWEB's eggs. In contrast, the political implications of the irrelevance of biodesirability in the procurement of eggs for research are a central concern in the next section.

Transnational Egg Procurement for Human Embryonic Stem Cell Research

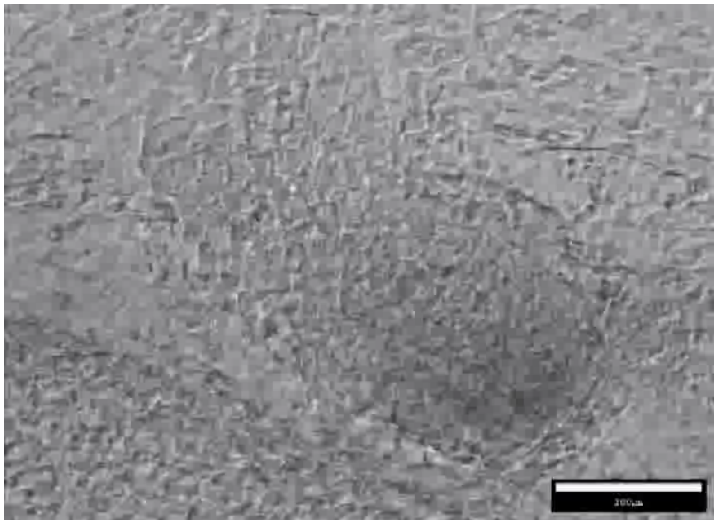

Figure 5: Still from video "Contracting Cardiomyocytes Differentiated from NT-ESCs" (Tachibana et al. 2013).

In 2013, Shoukhrat Mitalipov's research group at Oregon Health and Science University (OHSU) made a historic announcement: they managed, for the first time, to derive stem cells from human embryos produced through somatic cell nuclear transfer (SCNT), popularly known as "cloning" technology (Tachibana et al. 2013).[144] In their *Cell* article, they included a video as evidence for the successful differentiation of the derived pluripotent human embryonic stem cells (hESCs), in this case into heart muscle cells. The image shows a blurred figure made up of two round shapes positioned diagonally above one another, which contract roughly every two seconds. The symbolism and dramatic visual impact of heart muscle cells pulsing *in vitro* was recognised as early as a century prior to Mitalipov's publication by the famous biologist Alexis Carrel, who specifically cultured the contracting cells of an embryonic chicken heart given the "connotation of the heart [and its beat] as the seat and sign of life" (Landecker 2007, 69). Carrel used the visibly contracting muscle cells, which were kept alive in culture for over 30 years and ended up outliving him, to make a claim about the nature of bodily time *in*

[144] The publication of Mitalipov's research group counts 23 authors, of which Tachibana is listed as first author and Mitalipov as last.

vitro. For Carrel, they demonstrated "permanent life," or the possibility for life outside the body to become immortal under the right tissue culturing conditions—thereby suggesting cellular ageing is contingent and medium-specific (Landecker 2007, 71, 106). In Mitalipov's parallel visual strategy, the heart cells visualise a type of ageing that does not extend indefinitely, but regenerates and begins anew *in vitro*. Underlining this point, these contracting cardiomyocytes are reminiscent of the quintessential first encounter with a new life in the image of the heartbeat in a fetal ultrasound, but instead of the fetus *in utero*, they present the *in vitro* gestation of a new type of cellular human life that may be conceived from oocytes.

As the recent successes in SCNT have renewed interest in the technology and its clinical potential, they are also likely to increase demand for eggs (Boiani 2013, 629). In this section I will extend the previous discussion of the transnational mobility of frozen eggs for reproductive purposes to a consideration of its relevance for research egg procurement practices. I use the first three scientific studies that successfully obtained SCNT-derived hESCs as case studies: Mitalipov's (Tachibana et al. 2013), Chung et al.'s (2014) and Yamada et al.'s (2014). These studies may not only set a precedent for future stem cell derivation protocols, but also for methods of acquiring the required eggs; I therefore use them as starting-points in considering a potential future of transnational research egg procurement. I will do so by situating these studies within the regulatory, infrastructural and discursive contexts of their emergence and exploring the various factors that may drive the movement of eggs across state and national borders. I will also reflect on the differences between reproductive and research egg procurement practices, and consider their implications for egg donors. Reading SCNT research as a rearrangement of bodily time, my analysis of these studies will lead to a discussion of the new role of the egg in a global politics of ageing, in which age is conceptualised at the cellular and molecular level, and its regeneration becomes dependent on the reproductivity of young women.

Fifteen years after James Thomson's first isolation and *in vitro* growth of human embryonic stem cells (hESCs), Mitalipov's research group managed to derive hESCs from embryos created through the SCNT technique (Cyranoski 2013a). This technique entails the replacement of the egg's original nucleus with the nucleus of a fully differentiated somatic donor cell. The resulting egg, which now has the same genetic make-up as the donor, is subsequently activated to divide into a cloned embryo. The inner cell lines of this embryo contain pluripotent embryonic stem cells, which may be extracted and can be programmed to differentiate into the desired cell type.[145] The

[145] In animal experiments, both stem cells and offspring have been created through SCNT (Winter et al. 2012, 190–1). Reproductive cloning of large mammals like pigs is now performed routinely in so-called "cloning factories" like the Chinese BGI, which produces up to 500 animals a year (Shukman 2014).

OHSU research team used the SCNT technique with donor eggs and infant and fetal donor skin cells to create embryos, from which it derived human embryonic stem cells (hESC), which the team then reprogrammed into contracting heart muscle cells (Tachibana et al. 2013, 1234).[146] This achievement has revived interest in a technique that was on its "death bed" after earlier attempts failed and after the Nobel-prize winning induction of pluripotent stem cells (iPSCs) from somatic cells provided an alternative way of producing stem cells (Boiani 2013, 629).[147] Alongside the OHSU research, the two other case studies are the subsequent work of two international research groups—one based in Los Angeles and Korea and another in New York and Israel—that derived human embryonic stem cell lines using the somatic cells from, respectively, a 75-year old man and a woman with type-1 diabetes (Chung et al. 2014; Yamada et al. 2014).

These three studies all emphasise the clinical potential of their work, which follows from the possibility of differentiating hESCs into specialised cell types like skin, nerve or muscle cells. HESCs hold the potential to regenerate specific histocompatible cells and tissues that could be transplanted into the somatic cell donor's body without the risk of immune rejection. Not simply supplementing the body, these stem cells also hold the promise of "reawaken[ing]" the body's latent self-generating capacities (Bell qtd. in Cooper 2006, 10). SCNT could then become a key technology in regenerative medicine, which is an umbrella term for "therapeutic interventions intended to repair or replace human tissue damaged either in accidents or by degenerative disease" (Petit-Zeman qtd. in Lafontaine 2009, 54).

As the recent achievements provide an incentive for further research and potential future clinical application, they also cause an increasing demand for human eggs, and for women to provide them. Self-admittedly characterised as "inefficient processes," the creation of hESCs requires a significant amount of oocytes—the Oregon research used 122 embryos to derive 6 stem cell lines (Tachibana et al. 213, 1232). Yamada et al.'s study in the following year was more efficient, creating 4 stem cell lines out of 77 eggs, although they received a total of 512 mature oocytes to do the experiments detailed in the report (Landau 2014; Yamada et al. 2014, 537). More efficient procedures may nevertheless entail a *de facto* increase in the demand for oocytes because they could raise interest and investment in this type of research.

[146] Noggle et al. also generated hESCs after SNCT, but Mitalipov's case is the first in which the resultant cell lines perfectly matched the donor's DNA (Noggle et al. 2011; Boiani 2013, 629)

[147] The importance of the successful derivation with the SCNT method when iPSC reprogramming is already available follows in part from the possibility to study these two types of stem cells comparatively. Some studies suggest that SCNT stem cells may be superior in reprogramming somatic cells with specific defects for research into genetic pathologies. SCNT can also be used to study oocyte factors in order to refine iPSC reprogramming procedures and gain more insight into human developmental biology (Le et al. 2014, 37; Boiani 2013, 631; Thompson 2013, 38–9).

If, as SCNT research on oocytes of other mammals suggests, human frozen eggs could also be used for stem cell studies, the effects of this demand may be felt far away from the lab.[148] Given that a limited egg supply is one of the key practical constraints for SCNT research, the logistic advantages of banking eggs have been recognised by the biomedical research community (Chang et al. 2011, 310). The possibility of shipping eggs could fundamentally shift the dynamics of egg procurement globally in ways that intersect with local gender- and age-specific social realities, as is now starting to happen in reproductive egg procurement.

The importance of the egg procurement aspect in these three SCNT studies follows from the fact that they provide evidence for a claim that was previously falsely made by the South-Korean scientist Hwang Woo-Suk in two *Science* publications (2004; 2005). Not only was the evidence of Hwang's hESCs fabricated, he reported to have worked with only 242 and 185 eggs. However, the Korean National Bioethics Committee found over 2000 eggs were sourced from 119 women, of which over half were paid and which included some of Hwang's female junior colleagues (Gottweis and Kim 2010, 513).[149] Following the Hwang scandal, a backlash against stem cell research resulted in a prohibition on awarding any financial reward in exchange for eggs in Korea (D. Spar 2007, 1291).[150]

From the Hwang case emerge two important aspects that inform the relation between stem cell research and the geopolitics of transnational egg mobility. Firstly, the current establishment of international cold chain structures for the movement of donor eggs to fertility clinics should be considered in the light of their potential use to supply ova to research labs. Hwang's team sourced a significant proportion of its oocytes from the international for-profit egg broker DNA Bank, which procured eggs from Korean women for intended parents from Japan, where commercial egg donation was prohibited (Dickenson and Idiakez 2008, 128; Paik 2010, 82). DNA Bank allegedly recruited not only Korean, but also Chinese and Malaysian women to provide eggs (Widdows 2009, 12). As Catherine Waldby notes, DNA Bank's role in Hwang's research demonstrates that

[148] Although cryopreserved human eggs have not yet yielded hESCs after SCNT, this has been achieved with mice and cow eggs (Luster 2004; Chang et al. 2009; Sung et al. 2010). In Korea, the tightening of egg procurement regulations after the Hwang scandal (see below) has become a driving force for stem cell research with cryopreserved eggs because researchers working on SCNT are only allowed to use frozen eggs left over from fertility treatment. They are nevertheless optimistic about deriving hESCs within several years (Dickenson 2013a, 20).

[149] Local feminist organisations played a key role in exposing the quantities and methods of egg sourcing, while a coalition of 35 women's groups assisted the women who suffered serious complications like ovarian hyperstimulation syndrome after the egg extraction (Dickenson and Idiakez 2008, 127–8; Widdows 2009, 10–1).

[150] Laws against payments for egg donors were also adopted in other Asian countries including Singapore and China (D. Spar 2007, 1291; Cai et al. 2012, 189).

existing transnational reproductive egg donation networks can easily be employed to enable a supply of eggs for research purposes (2008, 24).

Secondly, in contrast with paid international egg donations, the unpaid "altruistic" egg donations for Hwang's stem cell research were publicly motivated with a highly bionationalist discourse. Hwang's stem cell research was recognised as a way of securing "prestige" and "symbolic and economic capital," while asserting independence from—if not global scientific leadership over—former Western colonial powers (Thompson 2013, 123). Hwang asserted that "science knows no border, but a scientist has his homeland" and with his stem cell research he "stuck the Korean national flag into the heights of biotechnology, America" (Gottweis and Kim 2010, 9). With the research framed in an "ethos of competitive nationalism," egg donation became "an act of 'good citizenry'"; Hwang claimed in public media that the egg donors were "not paid and were motivated by a desire to help sick people and national pride" (Kim 2008, 407; Cyranoski 2004, 14). In December 2005, hundreds of women supporting Hwang held a ceremony, opened by singing the national anthem, in which they declared their intention to donate eggs and left a trail of azalea flowers leading to Hwang's laboratory (Gottweis and Kim 2010, 14). Egg donors also wrote on www.ilovehwang.net, where some motivated their donation as a "sacrifice" to the nation: "I'm very happy that I can add my tiny self to support him. […] Please give me a chance to be patriot" (Kim 2008, 407–8). A variation on the traditionally politicised relation between women's reproductivity and the reproduction of the nation, this bionationalist framing of egg donation positions eggs, rather than children, as symbols of the nation's successful future.[151] Hwang's case illustrates how, in the face of increasingly international research collaborations, the notion of the nation may be mobilised in framing both the scientific breakthroughs and the bodily sacrifices to promote stem cell research (Neilson 2003, 166).

Both aspects, the approximation of research and reproductive egg procurement and the employment of nationalist discourses on stem cell research, also played a central role in the US regulatory context of the three abovementioned 2013 and 2014 SCNT studies (Tachibana et al. 2013; Chung et al. 2014; Yamada et al. 2014). The United States has had a relatively discouraging approach to stem cell research, notably through the restriction of federal funding for SCNT research during the Bush administration in 2001 (Streiffer 2008, 40). The limitations on stem cell research triggered fears about a "brain drain" of scientists to other, more permissive regulatory contexts—including those that came to be known as the "Asian Tigers" like Singapore and South-Korea—thereby

[151] In South-Korean news media, altruistic egg donors were praised while women receiving payment for their eggs were dismissed as "frivolous" for using their reproductivity to pay for things like "ski holidays" (Kim 2008, 408). See Chapter 1 on similar accusations of frivolity in egg freezing and abortion discourses.

"fuel[ling] nationalisms" in the US and elsewhere (Thompson 2013, 115, 123).[152] Although the primary ethical concern lay with the embryo created and destroyed in the production of stem cells—informed by the embryo's politicised status in the politics of abortion—the US stance on paying women for eggs was also restrictive. While the reproductive egg procurement industry flourished and routinely offered donors between $2,500-$10,000 per cycle, influential national bodies like the US National Research Council and National Academy of Sciences recommended against paid research egg donation—a position that was also adopted in various state laws, including Massachusetts' and California's (National Research Council 2005; Klitzman and Sauer 2009, 604; D. Spar 2007, 1290).

However, later that decade, President Obama removed Bush's restrictions on federal funding of stem cell research, referencing concerns with national competition in statements like "we will ensure America's continued global leadership in scientific discoveries and technological breakthroughs" (qtd. in Thompson 2013, 116). Prior to Obama's order, in 2007, the American Society for Reproductive Medicine (ASRM) and the International Society for Stem Cell Research (ISSCR) adopted the position that reimbursement for research egg procurement may be acceptable (Klitzman and Sauer 2009, 604). Indeed the three SCNT studies' account of egg procurement reference these guidelines and set the precedent for $5,000 (Oregon) to $8,000 (New York) compensation per cycle—in line with the ASRM's compensation guidelines for its reproductive counterpart (Yamada et al. 2014, 537).

The last decade's quick shifts in US regulation of SCNT and the resultant differing state regulations of egg procurement also opened up a "new stem cell geopolitics where not only other countries, but some individual states […], claimed or were feared to have a new competitive edge" (Thompson 2013, 116; Maher 2008). While paid egg procurement within permissive states functioned as one of the conditions of possibility for research projects like Mitalipov's, its successes, in turn, increased pressure on other states and research institutes to reconsider its egg procurement regulations (Schubert 2013). For example, in the year that Mitalipov's study was published, California sought to follow Oregon's and New York's precedent with Assembly Bill 926 "Reproductive Health and Research" for lifting the prohibition on paid research egg procurement, which passed the Senate but was vetoed by Governor Jerry Brown (Bonilla 2013; Thompson 2013, 35). The differing state-specific regulations are moreover instrumental in shaping flows of cellular material across the nation and beyond, as is the case in negotiations of "material transfer agreements" for shipping the Oregon stem cell

[152] The interest in regenerative medicine in these Asian countries may not be unrelated to the ageing of its populations, which occurs twice as rapidly in this region as it does in Western European countries like France (Neilson 2003, 165).

lines between Mitalipov's and other research labs, which may be governed by conflicting egg procurement regulations (Cyranoski 2013a). International regulatory differences could similarly play a role in directing the global flow of frozen eggs for research purposes.

At this specific historical moment, the concurrent geographically-asymmetrical relaxing of restrictions on financial compensation for egg procurement, popularisation of OC technology, mushrooming of egg banks within a general trend of bio-banking and the availability of cryo-shipping infrastructures paves the way for a transnational flow of eggs for research. The possibility of shipping eggs could fundamentally shift the spatial dynamics of egg procurement for a research sector that is both characterised by intensive cross-border cooperation in what Thompson calls "stem cell internationalism" and strong pressures of scientific competition and commercial research investments linked to local and national identity (2013, 138).

One shift in these dynamics that could be hypothesised from the three SCNT studies is the further regulatory, discursive and infrastructural approximation of research egg procurement and its more transnationalised reproductive counterpart. Firstly, in the US regulatory context of the studies under scrutiny, research egg donation begins to resemble its reproductive counterpart in the state-specific increase of donors' financial compensation to comparable levels. As these regulations become more permissive, they may also remove compensation-related barriers to importing eggs that have been obtained by payment elsewhere. By extension, the regulatory approximation of research and reproductive egg donation could open up further possibilities of using "spare" eggs that are no longer needed in the reproductive context—particularly if that includes unclaimed frozen ova from OC—for research purposes (Sung et al. 2010, 203–4).[153] In the context of the increasing popularity of elective egg freezing, this paves the way for a model in which those who provide eggs for research studies also pay for the stimulation, extraction and cryopreservation procedures.[154]

Secondly, because the mobility of frozen eggs removes the need for spatial proximity between research labs and egg procurement sites, existing infrastructures of (cross-border) reproductive health care could be employed for research purposes. Already the Mitalipov and Yamada et al. studies sourced their eggs through university centres that specialise in female reproductive and sexual health. The Hwang case offered an example of how CBRC networks could be employed to meet egg demands. Given the

[153] In conventional IVF procedures good-quality eggs usually do not become spare because intended parents "often want to deploy all of them for reproductive bids" (Waldby and Cooper 2010, 7).

[154] When the frozen eggs that once embodied promissory value of bioprepared fertility become "spare," they are rendered into "a form of waste" that has the potential to become "a valuable surplus" in the research context (Waldby and Cooper 2010, 6). In keeping with this logic, there is typically no financial compensation for donating "spare" eggs.

potential of rerouting transnational reproductive networks in global capitalism, TWEB, and its advanced infrastructure for handling large egg repositories and creating a transatlantic flow of oocytes, could give an indication of how similar biomedical and logistic technologies could be used to move eggs for research purposes.

Thirdly, the employment of reproductive health care infrastructures has effects on the discursive framing of research egg donation. For example, the OHSU Women's Health Research Unit, which "recruited" the egg donors for Mitalipov's study, frames its research with reference to notions of altruism and women's solidarity: "OHSU research has begun to illuminate some of the vast overlooked difference between the genders that influence a women's overall health" and "This research is vital to the women of Oregon and to women everywhere. You can help" (2015a; 2015b). Its Facebook page juxtaposes announcements of clinical trials with quasi-feminist links to Buzzfeed posts on #doublestandards. Ironically, as many feminist scholars and activists have objected to paid research egg procurement out of concern with women's exposure to significant health risks in the stimulation and extraction procedures, precisely an identity politics of female solidarity is employed when egg donors are mobilised by an appeal to a "pro-cures" narrative that frames the stem cell research as a contribution to women's health (Dickenson 2006; Pfeffer 2011; Thompson 2013). The discursive framework through which the recent shift in attitudes to paid research egg donation is mitigated thus appeals to a familiar combination of identity politics of "sisterhood" and the notion of altruism, which also characterises discourses of reproductive egg donation and surrogacy (Pande 2011, 619; Almeling 2011, 36).

Notwithstanding their approximation, a key difference between research and reproductive egg procurement that would impact transnational egg movements is the fact that the donor's socio-cultural biodesirability is irrelevant in donor selection for research. As a result, research egg procurement may target a much broader group of women. As Widdows contends, this may lead to a situation in which "women from lower socioeconomic strata would be more likely to become the providers of eggs […] because the genetic content of the enucleated egg […] is irrelevant" (2009, 13). This is particularly pertinent once eggs become moveable between different national and economic contexts. Here the concerns raised in scholarship on CBRC with "international economic imbalances [that] make underprivileged women in poorer countries an especially vulnerable population" become especially relevant for SCNT egg procurement (Franklin 2011, 811).

Moreover, although research and reproductive egg donation are often presented as identical processes, SCNT research makes its own specific demands on eggs and the women who provide them. Firstly, Chung et al.'s study suggests that the genetic make-up of a donor is not entirely irrelevant: "genetic variation between egg donors may play an

important role in the developmental potential of cloned embryos" because particular individual's eggs yielded a disproportionately high amount of embryos that developed to the blastocyst stage (5 days), at which point stem cells could be extracted (2014, 780). More insight into the specificities of this inter-donor genetic variation may result in a more selective targeting of egg donors. Secondly, in these studies, only eggs by women in the 21-26 age range resulted in hESCs. If this result is reproduced consistently, egg donation for SCNT research may work with even lower age limits than the 29-year limit that TWEB uses and would specifically impact relatively young adult women.

Lastly, SCNT-specific treatment may start prior to egg extraction through its particular hormonal stimulation of the eggs inside the donor's body. Yamada et al., for example, scrutinised the effect of different stimulation protocols on the viability of the resulting *in vitro* eggs for SCNT. In this sense, the woman's body is the medium, analogous to the cell medium in tissue culturing, through which the cell may be manipulated. Should a particular protocol prove more successful than another, this could lead to different stimulation processes for research and reproductive egg donors. Together, these three initial studies suggest that future egg donation for this research may take on the form of SCNT-specific hormonal protocols in groups of relatively young women with specific genetic characteristics for SCNT-compatible eggs. In a global context, the transnational flows of eggs would connect the relative youth of these egg donors with the contrasting age group of the envisaged patients for regenerative medicine in age-specific relations of socio-economic and cellular dependency within a broader biopolitics of ageing, which I discuss in the next section.

Cytoplasm Politics: The Egg in the Global Biopolitics of Ageing

As egg freezing for fertility preservation was in part motivated by changing societal trends in timing reproduction and biopreparation for future (in)fertility, so the interest and investment in regenerative medicine emerges in relation to issues of ageing in which global political-economic, cultural and cellular scales meet. Most obviously, SCNT research for regenerative medicine must be positioned in the context of profound changes in the age distribution globally, though most dramatically in the so-called "ageing societies" of Europe, North America, Japan and Australasia (United Nations 2007; Virpi 2008). These populations are characterised by a relative large proportion of older people—in Western Europe, for example, by 2030 half the population will be over 50 years old and will have a life expectancy of another 40 years (Harper 2013, xiii). These population shifts result from a decrease in birth rates—global fertility almost halved from 5 to 2.6 average lifetime births per woman in the 1960s-1990s period—along with the last century's increase in life expectancy of about 30 years (Neilson 2003,

164; Christensen et al. 2009, 1196). Along with these age-related demographic shifts emerge changing notions of self-responsibility for "successful ageing" at different points in the life course. In this context, SCNT studies suggest that the "aging body could partake of the embryonic vitality of the very young body indefinitely reproducing itself" and, in doing so, implicate women's reproductive bodies within a globalised "biopolitics of ageing" (Neilson 2003, 181). In this section I position the three abovementioned SCNT studies in relation to this global biopolitics of ageing to highlight the role of the egg's cytoplasm—rather than its nucleus—in political-economic, cultural and cellular reconfigurations of what it means to age.

Writing on population ageing as "surely one of the most profound and sustained revolutions marking the history of humanity," sociologist Céline Lafontaine argues that it "is totally redefining our relationship with time and death, […] which now appears in relatively new forms, as the rapid increase in degenerative diseases such as cancer, Parkinson's disease and Alzheimer's illustrates" (2009, 54–5). Rather than the relatively quick major causes of death prior to the 1950s, namely war, childbirth, and infectious diseases, contemporary deaths occur more slowly and typically follow a stage of prolonged illnesses requiring medical treatment and care (Lafontaine 2009, 54–5). Precisely this last stage of life is the focus of SCNT research for regenerative medicine, which suggests that the egg has the potential to reconfigure the linearity of ageing and may be used to treat age-related diseases and physical changes.

Yet rather than simply meeting an increased demand, Melinda Cooper positions the rise of regenerative medicine as an effect of a 20th-century social transformation from a welfare to a neoliberal state model, which are founded on contrasting approaches to ageing. While the former sought to guarantee stability throughout the life course, the neoliberal state withdraws from public health care programmes for "the extremes of childhood (education, child care, child protection) and old age" (2006, 17n4). Cooper describes how US cuts in health care services were accompanied by government and private investments in biotechnological innovations resulting in medical products that are speculative, individualised and may only be affordable to a section of the public (Cooper 2006, 17n4). Propelled by the promise of future applications and highly expensive in execution, SCNT-based stem cell studies appear as a case in point of this approach, in which the potential of future patient-specific cures manifests the speculative and individuating qualities of the neoliberal project.[155]

Rather than constituting a welfare crisis, ageing and age-related pathologies thus become the occasion for creating "new demands" in markets for technologies that

[155] For a discussion of the politics of individualised and public health care, or "me vs we medicine," see Dickenson (2013b).

"retard or obscure the effects of ageing," which are growing both "in size and overall share of the economy." [156] SCNT creates such new demands through a reconceptualisation of ageing away from a model of homogenous and irreversible decline towards a view of the body as an unevenly ageing entity in which "cells and tissues in certain sites" may be replenished and rejuvenated (Neilson 2003, 181). The potential profitability of this reconceptualisation is reflected in the funding of Chung et al.'s study by the Massachusetts biotechnology company Advanced Cell Technology (ACT). ACT seeks multi-million dollar investments in "research and development" to secure its "intellectual property position in the drive towards commercialization of embryonic stem cell and SCNT technology" (2005). Through the lens of the biotechnology industry, SCNT research provides the means of acquiring "ownership rights to critical technologies in regenerative medicine" through patents, of which ACT alone now has 30 and another 280 pending in the field of stem cell and SCNT technology.[157]

This commercialisation of stem cell research is situated within dominant cultural narratives of "successful ageing" that animate "anti-ageing medicine" as a tool to "address the anxieties of growing old in Western societies and […] exercise the ethos of [individual] 'responsibility'" (Cardona 2008, 475). Irrespective of whether clinical applications will emerge from this research, the financial stakes of biotechnology companies in SCNT reflect an investment in the profitability of cultural ideas of "successful ageing" and self-responsibility for growing older through consumer engagement with the growing anti-ageing industries.[158] Crucially, a situation in which the driving factor for funding medical research is the marketability of the resulting product is conducive to blurring the lines between treating age-related pathologies and treating ageing itself as a pathology.

Underlying SCNT research into regenerative medicine, and the commercial investments into this technology, is a reconceptualisation of the ageing process that is not without political consequences. In relation to the practice of OC, I have argued that egg freezing is based on a decline model of reproductive ageing, which associates ageing with decreasing egg quality and quantity. OC offers an alternative to this negative progression through what I have called "distributed ageing," in which the reproductive temporality is split into the age of the body and the age of the egg. OC does not prevent

[156] For example, Chung et al.'s study, a Korean-US collaboration, was funded by the South-Korean ministry of Science, ICT and Future Planning, which views SCNT as a step in overall goal to "create new industries" and "new demands" (Korea IT Times 2013).

[157] ACT (renamed Ocata in 2014) currently focuses on regenerative ophthalmology and aims to commercialise treatments of age-related eye diseases; it is motivated by the "potential size of this market and its projected growth rate largely as a consequence of an increasing aged population" (2015).

[158] Prior to the clinical applications of these technologies, some biotechnology companies that invest in regenerative medicine generate revenue by selling anti-ageing cosmetics with stem cells to women (Neilson 2003, 181; Thompson 2013, 157).

or counteract ageing, but preserves the oocytes' age at the time of freezing until the time of intended pregnancy. In this way, reproductive ageing is counteracted by introducing *in vitro*-cultured embryonic tissue into the body once a pregnancy is desired. Similarly, SCNT-based regenerative medicine aims to interrupt the temporal logic of progressive decline through the expulsion of aged cells to sites outside of the body and the subsequent re-introduction of differently-aged histocompatible cells and tissues into the body. However, rather than preserving cellular youth, SCNT technology generates it *in vitro* prior to transplanting it back into the body.

Significantly, in this approach to ageing as heterogeneously distributed across tissues within and without the body, the egg takes on the central role in "reset[ting] the clock of aging." This idea is expressly stated in ACT's press release on studies with cows that were concerned with

> the feasibility of reversing the aging of cells by SCNT and transplanting young cells back into the old animal. […] [T]hese studies suggest that medicine may one day be able to reset the clock of aging in aged human cells by SCNT and then use the resulting young cells to regenerate the immune and vascular system of older patients. (2005)

Reminiscent of the language of the "stopping the biological clock" in OC news discourses, the clock now does not denote time running out, but rather symbolises the human agency that may be exerted over the passage of bodily time via the egg. As the egg fulfils a central role in circumventing the limitations of reproductive ageing in OC, so SCNT research positions the egg as the key component in human ageing. Contrasting with the rather passive role that has traditionally been ascribed to the egg in reproduction, the report on the first successful SCNT-hESC derivation describes the egg's cytoplasm's "unique ability to reset the identity of transplanted somatic cell nuclei to the embryonic state" (2013, 1228). This approach foregrounds the egg's cytoplasm as "the only system that can reprogram a somatic nucleus to a full extent," thereby shifting an adult cell nucleus into the embryonic state (Boiani 2013, 631).

This reconceptualisation of the hitherto irreversible process of ageing as newly plastic at the molecular and cellular level entails a key shift in perspective in which the egg is not valued for its genetic content—as it was in autologous and third-party egg donation—but for its cytoplasmic reprogramming factors, which interact with the nucleus of the donated somatic cell. Although the nucleus' genome is key to the desired histocompatibility, the egg's cytoplasmic factors replenish the genome with embryonic youth. In order words, the egg's cytoplasm is the "biological tool" that holds the potential to return the adult cell to the youngest pluripotent state (Franklin 2013a, 28). The

cytoplasm is thus the medium through which the link between biological ageing and historical time may be severed.

The employment of the egg's cytoplasm, rather than its genome, is not without political consequences. The distributed ageing model of SCNT—whether scientific or clinical—implicates both the ageing bodies from which the somatic cell's nucleus is taken and the young adult female bodies, which provide the egg cytoplasm. When eggs become as mobile as somatic cells in frozen state, the two donating bodies, as well as the researching bodies in the laboratory, may be positioned across increasingly large distances. Within the context of the internationalisation of stem cell research, the global regulatory and economic disparities pertaining to egg procurement, increasing demands on egg supplies, and the neoliberalisation of both biomedicine and "successful ageing," the possibility of freezing eggs may enlist new groups of young women in donating their eggs to benefit other people later in life. Once eggs become frozen and, thereby, mobile, the global biopolitics of SCNT research and regenerative medicine are thus, on the one hand, driven and organised by shifting realities and ideologies of ageing, and, on the other, susceptible to a profound respatialisation in accordance with local regulatory, economic, logistic and cultural specificities.

In the distributed ageing model of SCNT research, the eggs do not provide reproductive youth to ageing bodies, as was the case for TWEB, but redistribute regenerative potential between people. As Waldby and Cooper have argued, stem cell industries divert women's generative capacity "away from the generation of new individuals and toward the regeneration of existing populations" (2010, 6). In this way, young women's reproductive bodies would provide not only the medium for the creation of the new generation of human beings, but hold the foundation for the (development of) medicine for existing and ageing generations. As the financialisation of the development of biomedical anti-ageing interventions co-emerges with a neoliberal notion of autonomous citizenship measured by the "ability to provide for [one's] own needs," potential clinical applications resulting from SCNT research could impact individual experiences of ageing, making them more dependent on consumption power and thereby exacerbating existing disparities in longevity (Brown 2006, 694; Neilson 2003, 182). The reliance on eggs in SCNT-based model of regenerative medicine has the potential political effect of creating new physical and economic relations of dependency that place uneven demands on those bodies rendered vulnerable through "institutionalised gender inequality and structural economic stratification" (Franklin 2011, 815). As global care chains create "a series of personal links between people across the globe based on the paid or unpaid work of caring" for both children and the elderly, so global cold chains of eggs may develop to redistribute both reproductive youth and

regenerative potential across borders and bodies, creating new relations of dependency that shift what it means to age globally (Hochschild 2000, 131).

Conclusion

Once frozen, eggs become mobile and thereby change the dynamics of egg donation for reproductive and research purposes. In this chapter I discussed the World Egg Bank's flow of frozen oocytes from the US to the UK, which is limited to those eggs that meet the HFEA restrictions on donor payment. Although the HFEA regulations seek to protect women from "financial inducement," the focus on the payment of egg donors does not address the wider marketisation of reproduction through practices of procuring and transporting eggs by commercial parties within a neoliberal political rationality. TWEB's transatlantic movement of eggs introduces new discursive practices in UK donor-egg IVF through the online donor profiles and the form of (consumer) choice they represent. TWEB thus illustrates the feasibility of creating transnational egg flows motivated by the speedy availability and detailed discursive framing of the eggs. The price of eggs could also be a driving force in future transnational egg donation. By analogy to the global care chain, a global cold chain could develop in which eggs, and the reproductive youth they represent, could travel from lower-resource areas to intended parents worldwide.

The recent breakthroughs of SCNT-hESC derivation are likely to increase interest in a technology that positions the egg at the centre of regenerative approaches to health care. In the last decade, US attitudes to payment for research egg donation have shifted dramatically, thus paving the way to meet the increased demand on eggs for further SCNT studies driven by Mitalipov's success and potential future clinical applications. The studies I discussed suggested that future SCNT research may require even younger donors than reproductive egg donation and could involve SCNT-specific hormonal stimulation courses, while the lack of specific biodesirability requirements open this type of donation up to a broader group of young women. If frozen eggs may be used for this type of research (Sung et al. 2010), the economic advantages of outsourcing egg procurement may be particularly pertinent for a research sector that receives much of its financing through capital-intensive biotechnology companies seeking to generate return on investment. Both in reproductive egg donation and in this particular type of SCNT research, eggs are cast as the medium through which age may be reconfigured—whether through the transfer of reproductive youth to women with age-related infertility or through the regeneration of older cells to counteract age-related pathologies. Oocyte cryopreservation may be considered the condition of possibility for a respatialisation of reproductive and research egg donation, characterised by an increasing geographical distance between the young women that provide the eggs and the intended parents and researchers that receive them. Distributed ageing with OC thus has a temporal

dimension, as the frozen egg allows the anticipation of bodily futurity in autologous donation and the non-synchronous timing heterologous egg donation, and a spatial dimension, as cryopreservation renders the egg—and the reproductive youth and regenerative potential it represents—transferable between people across the globe.