Singapore Biopolis: Bare Life in the City State

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In late 2003, the Singaporean government launched *Biopolis*, its new hub for life sciences research. Biopolis is a technology park, a high-profile space that brings key Singaporean biomedical research institutes together with global and local biotechnology and pharmaceutical companies and national governance bodies. Adjacent to the National University Hospital and the National University of Singapore, it constitutes a third node in a biomedical knowledge corridor, mediating between academic biology and clinical applications. *Biopolis* is the biomedical component of a larger Technopole, *one-north*, a 200-hectare cluster of 'new economy' ventures that includes ICT companies and media industries. The name o*ne-north* refers to Singapore's location slightly north of the equator, and the Technopole has an urbane tropical ambience. Laboratories are located in buildings with names like *Proteos* and *Helios*, architectural structures that are simultaneously futuristic, East Asian and subtly organic. The complex is set in a garden of bougainvillea and hibiscus, the facilities scattered among art galleries and cafes linked by meandering pedestrian walkways. *One-north* is intended to be a space devoted to creativity, flexibility and intellectual play (Wong and Bunnell 2006). Its spatial organization is designed to both capture the mercurial effects of intensified interaction and inspire scientific musing on fundamental processes of life and matter, saturating the space with experimental energy[1]. *Biopolis*, then, is a garden of innovative Eden[2].

The complex houses five of Singapore's seven biomedical institutes; the BioInformatics Institute (BII), the Bioprocessing Technology Institute (BTI), the Genome Institute of Singapore (GIS), the Institute of Bioengineering & Nanotechnology (IBN) and the Institute of Molecular and Cell Biology (IMCB), and has dedicated space for commercial researchers. The Singapore Tissue Network, a central tissue banking facility is located here, along with the newly created Singapore stem cell bank. The global stem cell company ES Cell International and the multinational pharmaceutical company Novartis have their laboratories and offices here. They share the park with the national Bioethics Advisory Board and A*STAR, (Agency for Science, Technology and Research), which directs domestic Science and Technology Policy and includes the Biomedical Research Council (BMRC) a funding body for biomedical research and Bio*One Capital, the venture capital arm of the Singapore Economic Development Board. Since the announcement of the scheme in 2000, The Singaporean Government has allocated 2 billion US dollars to Life Sciences research, with a further 5 billion announced in 2007 for Science and Technology R & D, to 2010, under the aegis of the Biomedical Sciences Initiative (BMSI)(MTI 2006). The BMSI is the government's long-term plan for the development of public and private biomedical innovation and bioeconomic wealth in Singapore.

Biopolis, and the BMSI more generally, is designed both to stimulate local biomedical innovation and to attract life sciences experts and institutions from all over the world with the promise of generous funding and resources, liberal regulation and concessions. It is designed to foster cross-disciplinary research and collaboration and the sharing of state-of-the-art facilities. In his launching speech, the Deputy Prime Minister Dr Tony Tan Keng Yam stated:

> Biopolis has three principal objectives: First - to be a focal point for scientific talent. To attract top talent to do world-class research in Singapore, and to serve as fertile

> training ground for undergraduate and graduate students. This magnet of talent is the single most crucial element for the biomedical industry to grow. Second - to integrate and synergise the capabilities and resources of A*STAR's research institutes and to encourage cross-disciplinary research. And third - to bridge the private sector and public sector research work by creating an environment that fosters exchange of ideas and close collaboration. Such close interface between researchers from industry and scientists from research institutes will accelerate the translation of new discoveries to marketable products.

The ethos of *Biopolis* is one of public largesse and liberality rather than the stringent restrictions placed on public funds for embryonic stem cell research in the United States and parts of Western Europe for example.

The creation of *Biopolis* signals the Singaporean government's commitment to life sciences research as an economic activity. However, the facility is not only a strategy for internal economic development. It is also a platform from which to project Singaporean expertise into the region and the world. By creating *Biopolis,* Singapore itself hopes to become the 'Biopolis of Asia' the premier life sciences hub in a region where several more populous states, notably China[3], India, Taiwan and South Korea[4], are rapidly scaling up public investment in regenerative medicine and genomics (Wong 2006; Salter 2007). The success of *Biopolis* and the Life Sciences initiatives more generally, is 'a matter of life and death' for Singapore, according to Vivian Balakrishnau, the Minister for Trade and Industry[5]. In what follows I want to tease out what is at stake in the creation of *Biopolis* for the Singaporean state and population, and what it can tell us about SE Asian governmentality and its bioeconomic and biopolitical aspirations and anxieties.

Bare Life in the City-State

The name *Biopolis* brings together two resonant ancient Greek terms. 'Bios' is one of the Greek words designating 'life', specifically the way of life of human collectives, as distinct from zōē, the simple, organism life or 'bare life' common to all living beings. This Aristotelian distinction in hierarchies of life has recently been made controversial by Giorgio Agamben's work (Agamben 1998), and we will return to the question of its appropriateness later in the paper. The second ancient Greek term is 'polis', the city, but more specifically the city-state considered as a utopia, an ideal community of citizens, the locus of perfectible social relations. 'Polis' also designates an ideal body politic (OED 2007), the ordering of both the population's bodies and the social structure according to an ideal organic unity, city-state as living being. *Biopolis* then appears as a biopolitical space where both the social and biological life of the citizenry are mobilized and ordered through the technical innovation of the new life sciences[6].

Singapore, a famously efficient, prosperous and authoritarian city-state, has arguably been organized along technotopian lines since its national creation in 1965. As a 'developmental' state, the Singaporean government has very effectively shaped society and economy according to ideas about modernity, technological progress and the perfectibility of social order, relying on vertical lines of authority and strictly limited democracy to implement its vision (Wong 2005). A malarial trading entrepôt in the first part of the twentieth century, Singapore is today a gleaming, air-conditioned high-rise city, and the population has a *per*

capita income only slightly lower than Australia's [7]. Education has played a central role in the shaping of ideal citizens, particularly techno-scientific education in the service of economic development and responsiveness to need for new industrial initiatives(Olds 2007). At the same time, education has played a strong normative role in creating citizens who subscribe to the State's interpretation of Singaporean history and politics, rather than engage in informed debate and dissent. As Yao argues, the control of opinion is also an aspect of Singapore's utopian aspiration. The State imposes a 'unitary vision of a good society' and projects a singular idea of the future, while denigrating other possible futures (Yao 2007).

Biopolis then acts as a synecdoche for Singapore itself, and recapitulates its constitutive utopian vision in the mode of biological innovation. It is a key site for the transformation of the Singaporean economy into a bioeconomy, a regenerative economy[8] which uses 'the latent value incumbent in biological products and processes to capture new growth and welfare benefits for citizens and nations' (OECD 2006). It brings together five elements – biological 'bare' life (embryos oöcytes, genetic material, blood, the raw materials of life sciences innovation), expert scientific community, regulatory oversight, capital investment and the biopolitical life of the population - in a utopian configuration. Like all utopias, it is concerned with the creation of a future imaginary world (Levitas 1990), in this case a utopia attained through a particular form of technological progress, spatial ordering and expert synergy. As Walker (2007) argues the history of industrialization contains a strong utopian strain, the idea that cutting-edge technology will bring about a golden age in the near future that will fundamentally improve the human condition. The rhetoric of bioeconomic development is saturated with this kind of technological optimism, as the apparently self-renewing ability of living processes are harnessed to overcome depleted resources (e.g. biofuels) and produce increased wealth and health. So for example, the OECD attributes bioeconomic development with the potential to overcome scarcity, to enable 'more eco-efficient and sustainable use of natural resources to provide goods and services to an ever growing global population' (OECD 2006: 1). This abolition of scarcity is a desire common to 'new economy' discourse more generally, as large claims are made for the self-generating and frictionless nature of informatic and vital technologies and commercial strategies (Walker 2007; Cooper 2008).

Biopolis offers a vision of biotechnological progress and self-renewing life that is also social progress, a future social order organized around the prosperity and health to be created by biotechnical innovation. Many commentators on Life Sciences research have observed its promissory value, its orientation towards future benefits that require current commitments (Rajan 2006; Cooper 2008). *Biopolis*, both as an idea and a practice, draws on this promissory value and makes more explicit its utopian nature. As I have argued elsewhere, biomedical science always involves a latent ideal social order, a scientifically perfectible body politic where social and ontological problems (poverty, sexual 'deviance', death) can be resolved through biotechnical progress (Waldby 1996) and the creation of *Biopolis* is highly informative about both contemporary social and political anxieties and their imagined solutions, projected into the future. In this register, then, I want to examine two related themes suggested by *Biopolis*. First, what can the enormous investment in life sciences research tell us about the way Singapore is trying to locate itself in the global (bio)economy? Second, what does it tell us about the contemporary biopolitics of population in Singapore?

Singapore in the Global Bioeconomy

Singaporean scholar Lai Si Tsui-Auch divides state investment in biotechnology into two eras – the first beginning in the late 1980s, the second in the late 1990s. In the 1980s, the Economic Development Board (EDB), the country's powerful economic planning agency, began to move the country's economic base away from manufacture and towards a knowledge economy. As Tsui-Auch argues,

> 'As a very small country with a population of just over 3 million, and lacking a natural hinterland for cheap labour and land supply … Singapore had few alternatives but to shift towards fostering higher value-added, knowledge intensive activities. Firmly believing in the positive relationship between scientific and technological advances and economic development, the western-educated ruling elite has been committed in investing in science and technology education, a path taken to upgrade its human capital and to leapfrog development (Tsui-Auch 2004) p. 456.

Initially the state agencies took a broad approach to biotechnology development focusing on food and agricultural biotechnology as well as pharmaceutical and diagnostics, and offering financial incentives to attract global corporations to set up local R & D facilities in collaboration with Singaporean expertise. The current phase of biotechnology development, encapsulated in Biopolis, is much more focused on biomedical innovation and health science, and funding is dedicated to the development of all stages in the biomedical value chain, from basic research through to commercialisation and manufacture. It also involves a much larger sector of the economy, and much more generous public investment

The current phase has its origins in the Asian financial crisis of 1997-8. The crisis devastated regional banks and currencies, and contributed to serious political instability in neighbouring Indonesia, while leaving the burgeoning Chinese economy untouched. At the same time, Singapore, like the other developmental states in East Asia was under increasing pressure to neo-liberalise its economy, moving away from national protectionist policies to more globally competitive, borderless economic strategies and a weakening of the state-driven approach to economic development (Wong 2005, Salter 2007). The events of 1997-8 then represented a significant crisis for the Singaporean state, both in the management of its economy and more broadly in its own status as a post-colonial 'developmental' state.

At the same time, 'crisis' is the metier of the Singaporean state. Singapore, like many postcolonial Asian states, had a traumatic birth, amid regional instability, anti-colonial struggle, labour rioting and the expulsion of Singapore from federation with Malaysia. The Singaporean nation was close to disintegration or destruction at several key points during the 1950s and 1960s, and this sense of fragility and narrowly averted crisis permeates the ethos of government and civil society (Yao 2007). As Heng and Devan argue, the sense of impending crisis has been incorporated into the style and legitimation practices of Singaporean government.

> [By] focusing anxiety on the fragility of the new nation, its ostensible vulnerability to every kind of exigency, the state's originating agency is periodically evoked and ratified, its access to wide-ranging instruments of power in the service of national protection continually consolidated. If a postcolonial government remains

> continuously in office for decades beyond its early responsibility for the nation's emergence, as is the case in the Republic of Singapore, the habit of generating narratives of crisis at intervals becomes an entrenched, dependable practice (Heng and Devan 1992) p. 343-4.

The People's Action Party (PAP) has formed the government of Singapore since independence from Britain in 1959, led first by Lee Kuan Yew until 1990, then by Goh Chok Tong, and now by Lee's son, Lee Hsien Loong. The contemporary Singaporean state has unbroken continuity with the moment of colonial liberation. It can claim to be the creators almost *ex nihilo*, of modern Singapore and its continuous protectors from disaster. The PAP thus has a surplus of legitimacy over and above the governments of most western nations, a legitimacy entwined with a constant sense of threat and proness to moral panics. At the same time, this legitimacy depends on the state's continuing ability to maintain very high levels of economic prosperity and distribute it through the supply-side socialism (public housing, transport and ethnic communal funding) that has characterised the post-colonial economy (Chua 1995).

This configuration of legitimacy gives the Singaporean state the ability to mobilise rapidly its population for nation-building projects. Yao argues that it helps to create a particular kind of responsive loyalty among citizens, who are constantly solicited to 'imagine the nation's collapse as an ever-present likelihood' and take on this burden of anxiety as an individual and collective responsibility (Yao 2007: 41). A state-fostered anti-individualist, communitarian ethic also lends the population to ready mobilisation. The 1991 White paper on *Shared Values* states that citizens should place 'nation before community and society above the self, honouring the family as the basic building block of society' (Chua 1999) p. 575. Yao comments that this communitarianism,

> Enables the Singaporean State to continuously fashion itself anew. The process gives life to the idea of the State as a moral order …Communitarianism allows the State to take on a political ambition for comprehensive rule, as it assumes for itself the role of the final arbitrator of all things in society (Yao 2007: 6).

Moreover, Singapore's extensive and efficient economic and educational bureaucracies can implement policy changes rapidly and thoroughly, with a high degree of uniformity throughout the tiny, highly urbanised nation. In the words of one commentator, Singapore has 'the political capacity and legitimacy to mobilize strategic resources to achieve (national) objectives that are otherwise unimaginable in non-city-state global cities' (Olds 2007: 7).

The 1997 crisis thus became an occasion for the Singapore government to reorient dramatically both the economy and the population, to again 'reinvent' the nation, this time around the imperatives of a global knowledge economy, particularly life sciences innovation. In 1999, the EDB announced that human health-related life sciences were to be the new foci of economic development. Singapore was to become Asia's premier biomedical research nation, with 'world-class capabilities … across the entire value chain, from basic research, clinical development, product and process development, manufacturing to healthcare services' (BioMed-Singapore 2007). Life sciences are now taught at all levels of the education system, with massive investment in university level training and international consortia to

produce a larger cohort of local life scientists. Singapore has also moved to a strong IP protection in notable contrast to China and India, a factor that brings it into line with the larger bioeconomies Britain and the USA (Finegold, Wong et al. 2004). From this point on Singapore's utopian ambitions were to be realized through a new capacity to engineer living systems and reorder its urban spaces, 'in the context of intense interurban competition to hold down global flows of capital and talent' (Wong and Bunnell 2006: 69). *Biopolis* demonstrates in microcosm the global reorientation of the Singaporean *polis*, creating a zone of biocapitalist innovation that can compete with other urban Technopoles. As one Singaporean-based life scientist comments, 'You've got these biocorridors in Southern California and Massachusetts… of companies that are start-ups or in various stages of development…they're much larger, but I think the way it is developing here so rapidly, and the ability of [biotech companies] to grow here, its really been very impressive, on a par with anything else in the world'[9].

Stem Cell Research

The move to a global knowledge economy involves a radical internationalisation of Singaporean science, an increased emphasis on global collaboration and the importation of foreign expertise. Ong (2007) notes that Singapore has been exceptionally strategic in its use of its geographical position and its traditional role as transport hub and point of international exchange between east and west, north and south, development and under-development.

> The city-state has displayed flair in its experiments with an elastic sense of the scale of the nation and the possibilities for configuring an 'effervescent ecosystem,' a far-flung informational network that links disparate sites of intellectual and creative production. Planners assembled foreign institutions, global companies, mobile experts, and authoritarian politics to create a milieu of intellectual upgrading, accumulation, and production (Ong 2007) p. 6.

This global flair is evident in the approach to human embryonic stem cell science, for example. The government has managed to develop a highly coordinated approach that has seen the development of Singapore into a significant hESC research hub. In addition to the funding and facilities represented by Biopolis and the BMSI, the regulatory environment is highly conducive to internationalised hESC research. The state effectively invented a bioethical institutional process in response to the regulatory challenges created by hESC research, with the aim of harmonising the local population's views on the topic with the demands of international science.

In 2000, the Cabinet appointed a national Bioethics Advisory Committee (BAC), whose first task was to develop a regulatory framework for embryonic stem cell research. hESC research was already active in Singapore by this date – notably Professor Ariff Bongso of the National University of Singapore was amongst the first to derive embryonic stem cells from human embryos and to grow human embryonic stem cells on human feeder rather than animal cells. (Pattison report p. 36). Existing research using human embryos had been governed by clinical regulations, which allowed the use of excess IVF embryos for research up to 14 days. The BAC was charged with producing a much more comprehensive regulatory system through the international standards of community and expert consultation and high-level bioethical deliberation. In particular, the committee was charged with harmonizing the

attitudes of Singapore's many ethnic/religious communities towards the status of the embryo. The BAC made clear from the start its in principle support for hESC research, so consultation was aimed at finding a regulatory system that would moderate or exclude anti-hESC opinion and build on a moderate majority opinion.

> For its deliberation, the BAC recognized the need to moderate extreme views at the outset. As a multi-racial, multi-religious and pluralistic society, Singapore's bioethical position should not be characterised by a single norm, perspective or persuasion. Rather, its position should reflect the diversity of opinions directed at promoting the common good of all (Lim and Ho 2003) p. 22.

Consultations were carried out with Buddhist, Islamic Hindu, Sikh, Jewish, Tao and Christian religious leaders, and with patient groups and peak science bodies. The majority Buddhist and Islamic groups, representing about 60% of the population, came out as pro-hESC research and in particular pro-SCNT research, while Christian groups, representing 15%, were resolutely opposed, as were Sikh and Taoist groups. Ong (2007) notes that debate was not heated, and that the issue in Singapore lacks the kind of inflammatory energy evident in the United States and Germany, although at the same time, Christian groups generally wield more social power and are associated with elite sectors of the population.[10] The BAC also considered the international regulatory situation. The final recommendations however are strongly modeled on the British regulatory system. They permit SCNT, the creation of research embryos, derivation of stem cells from fetal tissue, the banning of commerce or sale of donated materials combined with the right of researchers to commercialize, stipulations around informed consent and recommend the creation of a statutory body to license and control stem cell research in accordance with legislation.

Through this process, Singapore has developed a liberal but well regulated regime, highly compatible with British, Swedish, South Korean and Australian regulatory systems, and well suited to facilitate international collaboration and compliance with future therapeutic requirements. So, for example, the US National Institutes of Health permits US federal funding that uses Singaporean-derived stem cells, a major facilitator of collaborative research. Moreover it has invented a bioethical deliberative *process* which is seen to be compatible with European and North American governance norms, which gives it a well-regarded place in the global moral economy of stem cell science (Salter 2007), and helps to reassure venture capital and international biomedical firms of the social sustainability of Singaporean stem cell research. The well entrenched quality assurance ethos typical of Singapore also reassure interested parties that regulations will be uniformly implemented, unlike the much more disparate and uneven regulatory landscapes of Indian and mainland Chinese stem cell science (Salter 2007; Salter et al. 2007). At time of writing the BAC is in the midst of conducting public consultations about research oöcyte donation and the creation of cybrids for SCNT research, two highly controversial areas that will require regulation if Singaporean scientists are to work at the cutting edge of stem cell science according to cosmopolitan bioethical norms.

Such liberal regulation is also calculated to appeal to international stem cell scientists who feel hampered by their national regulations, and Singapore has succeeded in attracting international stem cell expertise. The most high profile scientist is Alan Coleman, formally associated with the UK Roslin Institute and its mammal cloning program (notably Dolly the

sheep) who moved to Singapore in 2002 to head up ES Cell International, a regenerative medicine company that began life in Australia but relocated to *Biopolis*. The company has received significant subsidies from the EDB and a number of Singaporean project grants, including a SG$2.6 million small business award. Coleman cites the inadequacy of European funding for his research on diabetes as his reason for relocating (Arnold 2006). ES Cell International had an ambitious development strategy for hES cell-derived pancreatic islets and cardiomyocytes, aiming for FDA approval by 2010. However in July 2007 the company announced its abandonment of therapeutically oriented hESC work, while continuing its development of hESCs for *in vitro* drug testing and other intermediate range revenue-earning research (Normile 2007). The therapeutic program transferred to the basic research environment of the Institute of Medical Biology, also in *Biopolis*, a move singled out by some of the stem cell scientists interviewed as indicative of the supportive nature of the environment at *Biopolis* and its exceptional level of flexibility. Professor Coleman has subsequently been appointed Executive Director of the Singapore Stem Cell Consortium (SSCC) and Principal Investigator at the Institute of Medical Biology (IMB), effectively giving him scientific leadership of the national stem cell research effort. The SSCC provides extramural funding for stem cell research across Singapore, coordinates professional networks, meetings, and public education campaigns, infrastructure provision and is in the throes of developing a stem cell bank at *Biopolis*[11]. Other notable international recruits to Singaporean stem cell science include American cancer researchers Edison Liu Tak-bun, Neal Copeland and Nancy Jenkins, who previously worked at the U.S. National Cancer Institute, and who cite the Bush administration's funding restrictions and regulatory conservatism as the reason for their relocation (Arnold 2006).

The formulation of cosmopolitan bioethical standards has clearly facilitated the internationalization of Singaporean life sciences research. The actual protection of individual autonomy afforded to patients by these bioethical endeavors is arguably a secondary consideration, particularly given the apparent clash between the local communitarian discourse and the emphasis on individual autonomy enshrined in western bioethics (Holden and Demeritt forthcoming). At the same time, it is arguable that the function of bioethical deliberation around stem cell research globally has been to facilitate the science and coordinate public attitudes accordingly, rather than engage in a fully articulated and democratic public debate (Gotweiss, Salter and Waldby 2008).

Expertise and Citizenship

This influx of stem cell expertise and other kinds of biomedical expertise in genomics, infectious disease and nanotechnology is part of a more general Singaporean experiment with the accumulation of foreign knowledge and the relocation of the national economy within a global knowledge network. Kristopher Olds documents the policy changes that have seen Singapore '[open] up its territory to new forms of foreign educational knowledge, institutional structures, practices, and technologies' (Olds 2007: 1) since 1998. The Asian fiscal crisis saw a reorientation of the existing Singaporean emphasis on education towards a more dynamic and entrepreneurial version, an approach considered more appropriate to the generation of commercial wealth from basic science.

> A particular conception of the [knowledge-based economy] was developed, one that elevated principles of life-long learning, creativity, innovation, competition,

> entrepreneurialism, critical thinking, and talent. In other words the need for ...enhanced and diversified services and high valued added manufacturing sectors, as well as better educated and more skilled citizen-subjects; creative "souls" that would contribute to contemporary and especially future development (Olds 2007: 10).

This approach involves the importation of both international education institutions, notably MIT, Duke, Johns Hopkins, Chicago, Cornell and Carnegie Mellon who have set up outpost campuses, and the recruitment of international scientists and scholars, as well as a massive expansion of higher education capacity to improve the scale and quality of indigenous scientists. The Singaporean knowledge economy generally, and its bioeconomy in particular, hence rely heavily on expatriate expertise, as a way to leaven the allegedly conservative Singaporean scientific culture with the adventurous spirit of global technoscience. As Ong puts it,

> By forming partnerships with American and European institutions, Singaporean policy makers hope to shake up the complacent, academic by-the-book approach to knowledge, and to ignite a sense of knowledge as an exciting thing that can be converted, with the right amount of entrepreneurial zeal, into intellectual capital…. through propinquity and interactions between foreign experts and citizens, administrators hope that a culture of 'techno-entrepreneurialism' will blossom among Asian students more accustomed to being told what to do (Ong 2006) p. 181.

Biopolis, with its mixture of international and indigenous expertise, global biotechnology companies and Singapore research institutes, is part of a wider social experiment in finding the right mix of global and local knowledge, commercial and scholarly innovation, and short, medium and long-term outcomes. It is also part of an experiment in the transformation of Singaporean citizenship and the triage of the national population according to their individual and collective usefulness in a neo-liberalised knowledge economy. As Ong (2006) notes, neoliberal governance 'centres on the capacities and potential of individuals and the population as living resources that may be harnessed and managed by governing regimes'(Ong 2006: 6). The entitlements of citizenship are increasingly marketized and hierarchized according to the citizen's ability to contribute value to the economy, so that some modes of citizenship involve more privileges and benefits than others.

In Singapore, the advantages and rights of citizenship are increasingly tied to the capacity of the citizen to embrace the risky experimentality of neo-liberalised life in the global city-state. As Wong and Bunnell (2006) note, the creation of *one-north*, and the surrounding 'bohemian' neighbourhoods of Holland Village and Portsdown Road, is also the creation of zones of privileged access to personal freedom and expressive life that have historically been denied to the Singaporean population, in part through the detailed government management of behaviour in the publicly funded housing estates. Such privileges are now being proffered to an internationalised class of mobile scientists and entrepreneurs to recruit and retain them in otherwise straight-laced Singapore. They may not be citizens in a technical sense, yet they have taken on the emblematic qualities of innovation, technocratic rationality and higher education that characterise the new ideal citizen. In a symptomatic move, in 2003 the inaugural *Singaporean Honorary Citizen Award* was conferred upon Sydney Brenner, both a Nobel Prize laureate in Medicine and founding member of the Institute of Molecular and

Cell Biology at *Biopolis*, for his 'pioneering efforts to establish Singapore as a hub for biomedical sciences'.

This privileging of the global life scientist as the emblematic citizen brings us back to the question of the body politic suggested by the name *Biopolis*. How does this site of expert biomedical innovation articulate with the broader Singaporean population, who cannot participate as scientific experts? On what terms are non-scientific citizens, the so-called heartland Singaporeans[12], integrated into the promised regenerative economy and in what ways are they valued or devalued?

Biopolis, Biobanking and the Body Politic

As I noted above, the term 'polis' connotes not only the utopian city-state but also the body politic, both social order understood as organism and the citizen's body as site of social order (Waldby 1996). The Singaporean body politic is, as Yao (2007) observes, intensively cultivated; citizens are entreated to identify closely with the nation, to align their identities and anxieties with the economic and political endeavours of the state. The extensive life sciences education effort in primary and secondary schools is clearly one way to orient the general population to the biotechnical future. Bioeconomic development however requires much more direct and embodied forms of participation from populations. As the biomedical research effort is scaled up, medical researchers require proprietary control of high volumes of human tissue – donated embryos, oöcytes, sperm, cadaveric foetal material, peripheral and cord blood, cancerous and infected tissue, organs and cellular matter. They also require more access to research subjects to test new drugs and treatments. That is, human populations are essential sources of biological value for biotechnical innovation and bioeconomic development cannot proceed without access to the regenerative and experimental capacities of living human bodies. Hence the citizens of Singapore, 'the *Biopolis* of Asia' will be required to act as tissue donors and research subjects, to align the regenerative and experimental capacities of their *in vivo* biology, their 'bare life' with the *in vitro* requirements of an expanding life sciences industry. A number of Biopolis projects are designed to facilitate this alignment.

The Singapore Tissue Network, located in *Biopolis*, was set up to in 2002 to centralise tissue collection and organise it at a national level, in place of the ad hoc clinical collections scattered around the country's hospitals. The STN is designed to standardise collection procedures and improve storage and access for researchers, and particularly to manage the DNA information available in a range of tissues to make them more useful for biotechnical research[13]. While the network can improve technical tissue banking conditions, it cannot influence donation rates, and there is evidence to suggest that the rapidity of biomedicalization (Clarke et al. 2002) in Singapore has created something of a lag between the needs of the *Biopolis* laboratories and the readiness of the population to act as a biological resource base. Donation of spare IVF embryos for stem cell research is uncommon and there are as yet no protocols for consent or derivation, leading ES Cell International for example to use embryonic stem cell lines derived in Australia[14]. Oöcyte donation, necessary for Somatic Cell Nuclear Transfer research, is also at low levels, as it is in all countries that rely on gifting, leading some bioethicists to call for egg-sharing incentives similar to those now used in the UK (Heng 2006). Moreover, recent empirical research among Singapore's three main ethnic groups (Chinese, Malay and Indian) indicates a lower level of willingness

to donate blood for genetic research than is found among North Americans of Europeans, and a lower general awareness of genetic research(Wong, Chia et al. 2004).

Despite this apparent recalcitrance, one major project is currently seeking to enrol 250,000 Singaporeans (12% of the population) into a national research program that requires both tissue donation and a lifelong commitment to regular, detailed clinical assessments. This project, the Singapore Consortium for Cohort Studies (SCCS), in many ways exemplifies the issues of both global economic positioning and biopolitical ordering that concern this paper, and I will devote the remaining discussion to its analysis. The cohort is designed to track gene environment interactions in metabolic disease, specifically type two diabetes and ischemic heart disease, diseases that have developed in the Singaporean population due to rapid modernization. According to the chief investigators, this study will be of supranational interest because of Singapore's capacity to act as both the *Biopolis of* Asia and an ethnic surrogate *for* Asia. According to the SCCS protocol,

> Singapore is a multiethnic population with three main ethnic groups, Chinese (76%), Malays (14%), and Indians (9%)[1]. Singapore is unique in that it consists of three ethnic groups that have relatively same [sic] exposure levels. As such, Singapore has developed a biomedical sciences (BMS) initiative to exploit its unique position as a country that can represent more than 60% of Asia's peoples. Singapore currently hosts six of the top ten pharmaceutical conglomerates, key industry players and a growing base of medical technology companies …. Singapore also features a dedicated Research & Development complex, the Biopolis, … a "plug and play" infrastructure for pharmaceutical and biotechnology companies to share scientific facilities and services, facilitating cross-disciplinary research and public-private collaborations for the advancement of the field and enhancement of business. Singapore, therefore, has much to offer by the development of a cohort study to study the interaction between genes and environment in disease development among Chinese, Malays, and Indians. Information obtained from the study could be applicable to India, China and much of South East Asia (Singapore Consortium for Cohort Studies 2007) p. 3

The study is also being benchmarked against a large-scale cohort study planned by the Karolinska Institute that will enroll 500,000 members of the Swedish population, 'a rather homogeneous Caucasian population'[15]. Using similar protocols and instruments, the two studies will help in the identification of genetic biomarkers and clinical guidelines specific to South and East Asian populations[16]. The results from the study will be applicable, the researchers claim, to the largest emerging health markets in the world, the growing middle class Indian and Chinese populations now suffering the diseases of western affluence. To put it another way, the Singaporean population can be transformed into an exemplary resource for biomedical innovation addressed to Asian health markets, both because its ethnic composition is an Asian microcosm and because that population is available for the high throughput genomic analysis made possible by *Biopolis*. Biopolis and its high technology biomedical expertise are finding new ways to render the biological qualities of the population as national assets and forms of regional or global value.

At the same time, the study will only be possible if a significant proportion of the population participate. While the scientific arm of the study is located at *Biopolis*, the study also has a

community clinic and works through household visits to the apartments of heartland Singaporeans. Recruitment is as much as possible focused on family rather than individual participation, as family linkage studies provide additional genetic information. If the family consents, a nurse visits the household and takes a detailed questionnaire regarding diet, smoking history, family history of diabetes and other factors that influence metabolic disease, and the family gives permission for the study to be linked to their medical records, national disease registries, and the use of their blood and other biological samples. Participants must then attend a clinic after an eight-hour fast for blood samples, retinal photographs, anthropologic measurements (weight, height, and waist circumference), blood pressure (sitting arm, prone arms and ankles), and foot sensation measurements. Participants will then be followed up every 3 to 5 years for the rest of their lives to track the emergence of metabolic and other kinds of disease.

Enrollment in the study thus involves commitment, both in seeing through the initial data gathering and blood donation, in giving lifetime access to their medical records and in attending follow up consultations. At time of writing, about 50% of potential participants approached agree to be involved[17]. I would argue that this kind of research participation is an exemplary moment when the body of the citizen and the collective biology of the population acts *for* the body politic described by *Biopolis*. Participants effectively volunteer their *in vivo*, biological life to a national *in vitro* project, the analysis of the Singaporean genome and its translation into regional therapies and guidelines. The cohort assembled by the study agrees to link the everyday biological life of their bodies, their individual processes of genetic susceptibility, metabolism, illness and mortality, with the analytic activity of the national genetic biobank. Crucially, they align the temporality of their bodies, their trajectory towards morbidity and death, with the temporality of database development. Genetic databases have a cumulative logic, building research power over time. The longer the period of participation, the more valuable the data. The biobank tracks the accumulation of morbidity and mortality in its generational cohorts, as they move through aging and death. The data only becomes valuable as large numbers of cases of particular disease develop among its participants, creating enough statistical power for genomic studies to be meaningful. Beyond the lifetime of participants, the biological samples themselves can be retained and repeatedly mined for a variety of research. Hence participants coordinate the temporality of their biology with the temporality of biomedical innovation, contributing to the promissory value created by bioeconomic investment. In this way, they make their biological life available for the techno-social future promised by *Biopolis*, and the BMSI more generally, a future whose success 'is a matter of life and death' for Singapore.

In this respect I would argue that the 'bare life' of the population, at least in this form, is not the boundary of exception proposed by Agamben (1998), the point to which populations can be excluded from human rights and livable life by sovereign power. Rather *in vivo* biological life has become a highly animate point of inclusion through which populations are integrated into the body politic in Singapore and other burgeoning bioeconomies. This is not to suggest the terms of this integration do not have a politics, or that they are separable from human rights issues. As I suggested at the outset, the future promised by *Biopolis* is highly speculative, and the risk of speculation will be borne by the population, at the same time as they are asked to act as an experimental site for new biomedical innovation. However, as a form of biopolitical governance, *Biopolis* and similar ventures will only succeed to the extent that they can continue to secure mass research participation and deliver therapeutic and

economic benefits. Consequently, populations have the opportunity to set collective conditions on scientific access to their biological life, an opportunity now being taken up around the world, for example in benefit sharing negotiations. The globalization of west European bioethical norms (informed consent, right of refusal to participate) to countries with more authoritarian traditions is another point of potential biopolitical contestation. As one Singaporean SCCS scientist noted wryly, the younger recruits to the cohort are both more familiar with the genetic science and more assertive of their civil rights. In other words, the value and valorization of *in vivo* biology may itself become a contestation point around human rights and equity, as bioeconomic activity extends itself to more and more members of populations.

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[1] Thrift (2006) suggests that the bioscience buildings recently built on university campuses all over the world are exemplary of the ways that innovation capital is using space to increase the valorization of scientific knowledge. These buildings are performative in that they are designed to foster interdisciplinary and a certain notion of interactive knowledge (Thrift 2006: 293).

[2] Halliday demonstrates the utopian qualities of botanical gardens, their early attempts to recreate an ideal Eden. I am using the idea of Eden here in that register

[3] China recently launched a fifteen-year *Plan for medium and long term science and technology development (2006-2020)* with the goals of increasing R & D investment from the current 1.4 per cent of economic output to 2.0 per cent by 2010 and 2.5 per cent by 2020.

[4] Between 2000 and 2007, it is estimated that the South Korean government has invested about 5.2 trillion South Korean Won ($4.4 billion) in the biomedical technology R & D field (Wong et al 2004).

[5] A comment made at the October 2005 Keystone symposium on stem cells, senescence, and cancer, Singapore.

[6] See Rabinow and Rose (2006) and Waldby (2008) for analyses of the extent to which contemporary biopolitics is imbricated with contemporary life sciences.

[7] In 2006 Singapore's Gross National Income per capita was $US 29,320, while Australia's was US$35,990 (World Bank Atlas http://web.worldbank.org/, accessed 7 March 2008).

[8] In a much more wide-ranging argument, Cooper (2006) argues that the whole project of postfordist economies is the reanimation and revaluation of both organic and inorganic matter, by putting them into speculative play through the technical reconfigurations and market deregulation of the 1970s and 1980s.

> The biotechnological solution to economic limits seems to encapsulate the speculative euphoria of revalorisation at the most intimate of material levels. At the same time that it writes off the inorganic matter consumed and left over by industrial production, post-fordism attempts to reanimate the whole of matter – the garbage heap of industrial waste, from cadavers to fossil fuels – within the process of its own self-valorization (Cooper 2006: 7-8).

[9] Interview, stem cell scientist, Biopolis, Singapore, 8th October 2007.

[10] Personal communication, Yao Souchou.

[11] The Singaporean stem cell bank will distribute the four Good Manufacturing Practice (GMP) embryonic stem cell lines created by ES Cell International with Sydney IVF in 2006, clinically compliant lines that could be used in the future for human therapies. While the lines will be distributed worldwide to scientists without intellectual property restrictions on preclinical research, their use for clinical applications will require license payments to ES Cell International. In other words, the Singaporean Stem Cell Bank will have a much closer relationship to business than the UK stem cell bank.

[12] A term used by the government to designate the presumed socially conservative general population, the beneficiaries of rather than participants in the 'new economy' (Wong and Burrell 2006).

[13] Interview with STN life scientist.

[14] Interview with stem cell scientist.

[15] Interview with SCCS scientist.

[16] So for example, current evidence suggests that guidelines related to body mass index (BMI) and central obesity measurements should vary for different populations. South Asians appear to be more susceptible to developing metabolic disease at lower BMI ratios than north Europeans.

[17] Interview with SCCS scientist.