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Biomedical Technologies in Practice

Biomedical technologies have histories that inevitably come into being with an idea often stimulated by a random or unexpected observation that then initiates a series of experimental procedures. Many technologies never progress beyond this initial phase, but others are put into production and eventually applied in medical care. However, the application of a biomedical technology does not simply depend on its medical use alone, but is deeply influenced by prevailing medical and political interests and cultural norms, as well as by overarching ideas about the most promising directions for progress and mastery of the condition of the human body. Biomedical technologies are not *merely* devices or machines, such as blood tests and neuroimaging scanners that permit the routinized application of scientific knowledge; neither are they ethically and morally neutral.

At the experimental stage, biomedical technologies enable manipulations that intervene in animal and human bodies revealing previously unknown or inaccessible 'objects', thus making them factually 'real'. At times chance intervenes in the creation of these material entities or 'technophenomena'. The improbable chain of events in 1928 that led the Scottish researcher Alexander Fleming to observe the antibiotic properties of the rare mould, *Penicillium notatum*, is a well-known example of the humble origins common to many biomedical technologies. Fleming rather carelessly left an open Petri dish smeared with *Staphylococcus* bacteria on his laboratory bench by an open window while he went away on a two-week holiday. When he returned, the yellow-green growth of the bacteria was surrounded by a clear halo produced by a mould that had accidentally drifted down from a mycology unit above into Fleming's London lab one floor below. Various unconfirmed reports about the effectiveness of the mould had already been reported prior to Fleming's 'discovery', but he was the first to grow a pure culture of *Penicillium* resulting in a new technophenomenon that he named 'penicillin'. However, it was not until 1942 that sufficient observations and experiments had been carried out and adequate quantities of penicillin produced for it to be put formally into production in the United States, and then initially only on a small scale. It took even longer for ordinary doctors to appreciate its value and learn that the drug should be administered intravenously to be effective.

Ludwig Fleck argued in the first half of the twentieth century that phenomena that scientists work with are the products of technologies, practices and preconditioned ways of seeing and understanding. Fleck's argument is that every scientific phenomenon exists only as a result of a technical intervention on the part of scientists,[1] and that creating a firm separation between the worlds of research and of application (such as is commonly done between the laboratory and the clinic) is entirely inappropriate. In other words, biomedical technologies are anchored as part of one or more 'sociotechnical systems' that straddle institutions including hospitals, laboratories, biotech companies and the state.[2] The phenomena that result from their application coalesce as the accepted biological, clinical and epidemiological facts of biomedical practice. Such routinized practices are transportable across vast distances and are capable of marshalling yet more phenomena as a result of systematic interventions into patient bodies or human populations, thus producing yet more facts. In other words, biomedical technologies bring about transformations, resulting in newly discovered knowledge about the material world that, in turn, influences subsequent interventions. This insight informs our position that the science of biomedicine is actively constructed by technology – biomedical technology. By extension this means that health-related matters are routinely 'objectified' as technical problems, to be solved through the application of technology and the conduct of science, and are, by definition, therefore, decontextualized in practice. Objectification tends to make opaque moral assumptions embedded in the actual application of any given technology as the following chapters will show.

This approach builds on and extends the work in the 1960s and 1970s of the French philosopher Michel Foucault. He argued that, commencing in the seventeenth century, management by the state began to be accomplished through the expansion of practices of regulation, discipline and surveillance directed at individuals. At the same time, government of 'populations' – of what Foucault termed *le vivant* ('the living') – was brought about through the use of technologies such as the census. Foucault coined the term 'biopower'[3] to describe the means by which government is exercised in the form of technologies that, although not machines, are nonetheless machine-like in their systematic and codified generation of objects for management as well as new knowledge. Foucault's formulation encourages an examination of a broad range of practices as biomedical technologies. Shortly before his death Foucault introduced a distinction between, on the one hand, technologies of bodily governance that he termed 'objectifying practices' and, on the other hand, technologies of the self used to transform one's own body and mind through, for instance, spiritual exercises, public acts of contrition and confession.[4] Together, these technologies have resulted in forms of embodiment, experiences and behaviours that many people assume are 'natural', resulting in the 'making up' of kinds of people that did not previously exist.[5]

We argue that two significant developments since Foucault's time make straightforward application of his categories to contemporary biomedical technologies problematic. The first is the advent of what we call 'techno/biologicals', technologies that are in part constituted from human biological material, thus troubling 'natural' categories about self and other and producing new forms of life. The second is the increasing deployment of biomedical technologies outside the parameters of the state, whether in the developing world or in industrialized economies, by non-governmental organizations (NGOs) and private actors who seek to achieve specific health goals independently of a systematic government-monitored approach to public health. In light of these developments, understanding emerging forms of biopower requires careful scrutiny of biomedical technologies in practice.

Technological Mastery of the Natural World and Human Development

A belief that mastery of the natural world could be achieved through scientific investigation and the application of 'machine power' was central to Enlightenment thinking.[6] By the nineteenth century, writers as different as Herbert Spencer and Auguste Comte explicitly associated developments in science and technology with progress and the advancement of human kind. Spencer argued that the degree to which people are able to control the natural world is an indication of the degree of their civilized status,[7] and the anthropologist Edward Tylor, in his book *Primitive Culture*, sought to rank cultures according to their ability in 'adapting nature to man's ends', with savages at the lowest end of the spectrum and educated peoples of Western Europe at the highest end.[8] Of course there were a good number of well-known dissenters to a position that celebrated the progress brought about by science and technology, but these people were in the minority.[9]

Signs of this 'honourable' and 'audacious' struggle against 'brute matter'[10] were evident in Europe from the fifteenth century on; the work of Leonardo da Vinci, Nicolaus Copernicus, Andreas Vesalius, followed later by Francis Bacon, Galileo Galilei, Isaac Newton and many others, provides evidence of an epistemological upheaval characterized today as the 'scientific revolution', one in which the world is made known through systematic investigation and transformed to what is assumed to be the better by means of the application of technologies. In the eighteenth and nineteenth centuries this approach was indispensable to the industrial revolution in northern Europe, one of the principal intentions of which was to improve the well-being of the masses, if only so that they might be better able to endure excessively hard work.[11] It also brought about worldwide exploration and colonization, including the systematic extraction of wealth in the form of natural materials of all kinds, both for building and engineering feats and for scientific investigation in laboratories and medical schools.[12]

One strand of early scientific thought that became extremely influential in both British and Continental thinking of the eighteenth century, and is particularly relevant for the argument that we make in this book, culminated in Isaac Newton's experiments on optics, mathematics and mechanics. Newton postulated a 'world machine' created by God, a machine that set the whole universe in motion, one governed by immutable laws subject to human investigation. This mechanistic view of nature is both causal and deterministic, and enabled Newton to argue provocatively that the force holding the planets in their orbits that can be expressed in a single mathematical equation is the same force governing matter on earth.[13] Newton has been described by many as a 'disembodied scholar', one who lived an otherworldly life of detachment, although this characterization is currently being questioned; nevertheless he was most certainly a man 'possessed by a love of truth',[14] one who exemplified a rational approach to understanding the world about us as a unified whole.

A good number of truth claims put forward during the Enlightenment, including those of Newton, are still with us today, and have a profound effect on the way in which science is conducted and biomedical technologies of all kinds are put into practice. Amongst them are the following: first, many people involved in the enterprise of 'development' argue with little reflection that further technological mastery of nature is essential to continued progress and improving the state of the world economically and with respect to health and well-being. Second, many researchers in the biological sciences assume that biology is subject to universal laws similar to those established for physics based on the insights of Newton. Third, it is commonly assumed in the medical sciences that the human body is readily standardized by means of systematic assessments, bringing about a further assumption that the material make-up of the body is, for all intents and purposes, universal. Fourth, the global dissemination of knowledge, biomedical technologies and ways of life and moral underpinnings associated with modern Western civilization are seen to be an essential part of an enlightened humanistic endeavour. Although people increasingly question these axioms, the dominant ideology holds firm.

Technology and Boundary Crossings

In common with technologies of all kinds, biomedical technologies have the prime function of enabling humans to act on the world and its inhabitants. But technologies are not mere objects or autonomous entities, as this observation might at first suggest. Marx noted the key corollary long ago: by changing the shape of material things we inevitably change ourselves. Biomedical technologies are, of course, designed expressly to facilitate human intervention into the workings of the body in health and illness; in implementation they change us, and, even as they themselves are constantly modified, they change the world in which we live.

The use of complex technology is integral to biomedicine today – and increasingly so as molecular biological knowledge and its associated computer technologies become ever more routinized.[15] Once technological interventions become the keys to diagnosis (very often of more importance today than the clinical examination per se) and to care, then inevitable changes result as to what counts as valid knowledge about the body, the doctor–patient relationship, and, indeed, the relationship amongst the body, culture and society.

As noted above, the history of technological innovation, at least from the time of the Enlightenment, is usually portrayed in Europe and North America as a narrative of progress and of the betterment of individual and social life. The anthropologist Brian Pfaffenberger[16] characterizes this history as the 'Standard View of Technology': tools, devices and artefacts permit us to lead an increasingly rational, autonomous and prosperous existence, liberated from constraints imposed by individual biology, oppressive human enemies and the environment. Embedded in this Standard View are two sets of tacit meanings that at first sight are contradictory. The first assumes that the relationship of humans to technology is too obvious to need examination. Organizations, industries, technicians, craftspeople and others simply make things that are in themselves neither good nor bad. This is what Langdon Winner[17] has described as 'technological somnambulism' – an unreflective acceptance of technological innovation. The second approach, which we might term 'technological determinism', conceives of technology as a powerful and autonomous agent, inherent to progress, and therefore by definition an unquestionable good, but one that inevitably dictates the forms that human social life will take.[18] The very idea of an autonomous technology raises an 'unsettling irony'.[19] We humans have apparently lost out but nevertheless rush eagerly ahead creating new devices in the belief that we will achieve yet more control and autonomy in our lives.

Of course, utopian visions about the freedom that technologies will bring have not been entirely hegemonic, and all along they have been opposed by a counter-discourse depicting dystopias, replete with warnings about the consequences for society of technology gone wild. From the Frankenstein story of Mary Wollstonecraft Shelley, to Charles Dickens's *Hard Times*, H. G. Wells's *The Island of Dr Moreau*, Aldous Huxley's *Brave New World*, George Orwell's *Nineteen Eighty-Four*, and Margaret Atwood's *The Handmaiden's Tale* and her more recent *Oryx and Crake trilogy*, amongst many others, we read in novels and science fiction and see at the movies and on television the havoc and misery that technologies can potentially create. Inevitably it is at the technologically manipulated margins – between what is assumed to be the unassailable natural world and the encroaching boundaries of culture – where concern and moral outrage is most evident in these dystopian accounts. Towards the end of the twentieth century, Pfaffenberger concluded that the modernist lens persistently envisions technology as both creator and destroyer, an agent of future promise and at the same time of culture's destruction.[20] Emerging technologies that enable us to 'see into' the living body and to manipulate bodily boundaries and molecular formations long assumed to be absolutely inviolable exacerbate this tension.

Amongst those who in the early part of the twentieth century perceived the effects of technological innovation principally as a form of dystopia was Lewis Mumford. In his extensive writings he was one of the first to sow the seeds of a more complex understanding of the relationship amongst technology, society and culture and, with fascism very much in mind, he wrote critically about technology. Mumford referred to 'our over-mechanized culture', a condition that he feared would lead to a 'final totalitarian structure'. He believed that the new international competitiveness associated with globalization would eventually produce a 'dominant minority' who would manipulate the majority through the creation of depersonalized organizations together constituting a 'megamachine', something visualized by Mumford as an inclusive but 'invisible' entity, embracing not only technical and scientific expertise and artefacts, but also the bureaucratic structures designed to organize and control the whole enterprise.[21] In an era of technologized and globalized neoliberalism, bordering today on nihilism, Mumford's writing reads as prophetic.

A tacit assumption embedded in both the somnambulist and deterministic visions of technology is that material artefacts are things-in-themselves, and therefore ethically and morally neutral – a premise that Mumford so ably exposed, and one that today a good number of philosophers, sociologists and anthropologists of science, ourselves included, argue against.[22] Biomedical technologies, ranging from embryos created by means of *in vitro* fertilization (IVF), tissue cultures and genetic engineering, permit us to radically reconstruct what are assumed to be 'natural' boundaries between culture and nature, often creating new entities – hybrids of what was formerly thought of as belonging distinctly in the domain of either nature or culture. A body diagnosed as brain dead continues to breathe with the assistance of a mechanical ventilator; it is warm, urinates and defecates – such a 'dead' body must be alive if organs for transplant are to be procured from it. The technological ability to determine the sex of a foetus prior to birth has brought about a significant demographic imbalance between the sexes in some locations. The implementation of biomedical technologies also challenges what has generally been regarded in any one location as 'normal' and morally 'right': resorting to sperm donors to accomplish pregnancy, for example, is often forbidden; buying organs for transplant is illegal in most parts of the world; and making use of psychopharmacological agents such as Prozac to 'enhance' personality may be frowned upon.

Furthermore, what counts as normal and abnormal is open to interpretation on the basis of statistically calculated estimations of risk that can be subject to periodic recalculation as a result of new research findings. An example of this is the use of blood cholesterol levels to assess the risk of heart attack based on epidemiological studies of large populations that have demonstrated the association between cholesterol and heart disease. Recent research, much of it funded by drug companies that make cholesterol-lowering 'statin' drugs, shows that even lowering a 'normal' cholesterol level can decrease the risk. The implication that everyone should be on cholesterol-lowering drugs, physicians have pointed out, discounts the increasing risk of drug side effects outweighing any benefit in reducing the already low risk of heart attacks in those with a normal cholesterol.[23] At these nodes of uncertainty it becomes most apparent that moral and scientific judgements are intertwined.[24] We return to this point repeatedly throughout the following chapters.

Biomedicine as Technology: Some Implications

By focusing on biomedical technologies, our purpose is to draw empirical and analytic scrutiny to the practical and everyday implications of biomedicine and the biosciences in the lives of people around the world. In so doing, we are in agreement with practitioners and anthropologists who view biomedicine neither as a monolithic, universal, static enterprise, nor simply as a particularistic and personalized practice. Wherever it is used, biomedicine, although standardized for universal application, must be individualized in actual clinical practice and adapted for public health interventions around the world. It is this twofold dimension we wish to illuminate from the outset, by drawing attention to the enterprise of biomedicine as itself a technology, in the application of which judgements and adjustments are constantly made.

What readily springs to mind when thinking about biomedical technologies are machines such as mechanical ventilators, imaging technologies including X-ray machines and CT scans, as well as devices such as prosthetic limbs, cardiac pacemakers, tooth implants and so on. However, our lives are filled with far more mundane biomedical devices and technologies, including the basic physical examination, patient history taking (including self-examination and self-history taking), the administration of injections and the prescription of medications. These technologies are ubiquitous and affect everyone including many of the millions of people today designated as the 'super poor'. In practice, such 'simple' technologies have a number of features in common. Most important, they are highly portable and can easily be applied anywhere and used with little or no training, and often at relatively little cost. Furthermore, the undoubted efficacy of many pharmaceuticals, when appropriately prescribed and applied, makes them powerful tools, sometimes invested with magical qualities. Not surprising, then, the lives and hopes of people in virtually all parts of the world are touched to some extent by the promise of biomedicine, even when the majority of its medications and more expensive technologies remain largely beyond the reach of most.

As Mumford argued, biomedical technologies can be viewed as the products of rationally ordered sociotechnical complexes in which they are inevitably embedded in order to function. Nikolas Rose refers to 'hybrid assemblages of knowledges, instruments, persons, systems of judgement, buildings and spaces, underpinned at the programmatic level by certain presuppositions and assumptions about human beings'.[25] Applying the genealogical method of Michel Foucault, Rose is explicit that technologies have histories, and this simple recognition makes it evident that their application changes what it is to be human. In her study of the development of tissue culture, Hannah Landecker shows how biomedical technologies, particularly those that have emerged over the past century as a result of advances in molecular biology, transform, first of all, 'what it is to be biological' and thence what it is to be human.[26] We draw on these formulations to argue that technologies should be understood as both produced through culture and as productive of culture.[27] This approach highlights the way in which meanings and moral imperatives are differentially attributed to the production of technologies over time and to the interventions into human life made possible by them. In other words, unexamined ideologies are often associated with the implementation of technologies. That new scientific insights and new technologies facilitate change and innovation in ways never before possible, frequently for the better, only facilitates the dissemination of moral assumptions. We do not subscribe to technological determinism because the consequences of technological applications are unpredictable due to differing local moral economies, evidentiary disputes and political struggles.

Legitimation of biomedical technologies involves the dissemination of rhetoric about their value; at the most fundamental level, it is assumed that they contribute to scientific progress and, further, that they fulfil human 'needs'. Mary-Jo DelVecchio Good argues that clinicians and patients alike are 'energized by enthusiasm, albeit tempered with irony' in response to 'nascent technologies' and the hope they inspire,[28] an impression frequently given by the media. However, Marilyn Strathern[29] notes that opposition that surrounds the introduction of many new biomedical technologies makes it clear that these hybrid entities often appear as a threat to moral order. This is especially evident at times in countries that were formerly colonized. Hence, to justify such practices and damp down vented anxiety, legal constraints or, at a minimum, professional guidelines are everywhere produced to govern conduct in research laboratories, clinics and consulting rooms. Such constraints include, for example, rules about who is 'eligible' for assisted reproduction, organ transplants or medications that can be used not only to treat 'deficiencies' but also to enhance performance.

Citizens of democratic societies learn that they have a 'right' to have access to a range of biomedical technologies in the name of health. A few individuals extend this 'right' to include personal enhancement and lobby government for unhampered access to a range of technologies, including genetic testing, genetic engineering, reproductive technologies, organ transplants and even cosmetic surgery. Contradictions between what are thought of by some as rights, and what authorities see as experimental or available only on a restricted basis are not easily resolved. For example, couples apparently unable to conceive may wish to resort to the use of donor sperm, a practice that is not acceptable in many countries. Certain individuals on a list to receive an organ transplant may be told they have little time left to live and decide to go abroad to buy an organ even though a market for the sale of organs is illegal in virtually every country in the world. A further problem arises because transplant recipients must receive follow-up treatment when they return to their home country if the transplanted organ is to function adequately, putting physicians and governments in an awkward position of moral ambiguity. Furthermore, because technologies are in constant evolution, the practices they make possible inevitably change and hence the social and ethical aspects of the situation also change. For example, until relatively recently it was not possible to freeze and store human eggs. Now that this can be done, questions arise about the conditions under which eggs should be retrieved from women for storage and for what purposes. Furthermore, as moves are increasingly made worldwide towards the privatization of medical services, the question of national and international control over the implementation of technologies, and their growing economic cost, has become exceedingly acute. The above issues are further expounded upon in Section 3.

Technologies of Bodily Governance

Biomedical technologies are not only found in clinics and hospitals. Indeed, it is the articulation of clinical practice with what we term, following Foucault, 'technologies of bodily governance' that makes the dissemination of biomedicine particularly effective. Such technologies allow representative sampling, statistical assessment and the application of probability to target entire social bodies – communities, nations and, at times, the whole world. Foucault, writing about 'techniques of power', charted the gradual emergence and regularization from the eighteenth and nineteenth centuries onward of state-controlled, systematically organized institutions – schools, the army, prisons, the family, hospitals, clinics and other units for the administration of collective bodies. He described these changes in social organization as the formation of 'biopower', central both to the emergence of capitalism and to the 'controlled insertion of bodies into the machinery of production'. For Foucault, biopower literally means having power over other bodies: 'an explosion of numerous and diverse techniques for achieving the subjugation of bodies and the control of populations'.[30] Foucault envisioned biopower as having two 'poles': the first, 'anato-mopolitics', refers to increasing objectification and manipulation of the human body by means of medical examinations and drills, exercises and techniques used in education, the workplace and policing. The second pole is the 'biopolitics of population' in which groups constituted as named populations and subpopulations come to be defined as entities for management by the state. Foucault coined the term 'governmentality' to refer to the way in which the exercise of power by the modern state came increasingly to include the active management of the population to stimulate its 'vitality', and the adoption of codes and techniques by individuals to govern their own lives such as, for example, following a 'healthy' lifestyle.[31]

Although Foucault argued for two distinct poles of power, in practice they are inseparable: statistical compilations used in conjunction with the concept of risk are the tools made most use of in the fields of epidemiology and public health, and these compilations in turn profoundly influence clinical practice. Reciprocally, the raw data of these compilations originates in the clinic.[32] Emphasis is often given in epidemiology to what is known as the 'social determinants' of health and illness, that is, to measures of poverty, inequality, discrimination and stressors of various kinds, in order to explain why some people are more liable to become sick and die early deaths than others.[33] The proliferation of estimations of 'risk' derived largely from epidemiological data means that we all are subject to warnings, primarily in the media and secondarily from our physicians, about any number of conditions to which we may be vulnerable, ranging from sexual dysfunction to obesity.

In his book, *The Taming of Chance*, Ian Hacking argues that with the founding of the biometrical school of statistical research by Francis Galton in 1889 (who was also the founder of the 'science' of eugenics) 'the stage was set for ultimate indeterminism.'[34] Hacking insists that the 'imperialism of probabilities' with which we live today could only have come about in conjunction with a massive expansion of literacy, computation, bookkeeping, the invention of the census and the idea that people can be divided into different groups of populations. At first these populations consisted of deviant groups who did not 'fit' with society, but were later expanded to include citizens as a whole, for whose governance the state was responsible. Together, these activities constitute 'technologies of data collection' that are intimately associated with the growth of a 'research mentality' evident in Europe and North America in the late nineteenth and early twentieth centuries which gradually fused with the political technologies of rule deployed in the European colonies.[35] Law-like regularities that can be observed statistically amongst groups of people provide a means of setting off 'normal' from that which is considered deviant or 'abnormal.' Madness, disease, vagrancy, births and deaths must all be counted and categorized, in order that they may be – as it were – managed. Furthermore, individuals exhibit governmentality when they change their activities, consciously or otherwise, to those thought to be best suited to continued health and well-being.[36] Of course, many people do not respond in a way that either the government or the medical professional might wish.

We have more to say below and in the following chapters about Hacking's idea of 'making up people,'[37] that is, how people are classified into groups by authorities of one kind and another, and how these classifications in turn affect the subjectivity and lives of the people so classified. Of particular interest is how these individual effects may bring about changes in the original classifications (notably through the interventions of involved advocacy groups). Hacking argues that people subject to classification (and in contemporary society this includes us all in one way or another) are moving targets because by being assigned to a class – abused child, single mother, refugee, senior citizen – individuals are changed and do not experience themselves as the same person as they were prior to classification. Hacking named this the 'looping effect' – the manner in which science and bureaucracies 'create kinds of people that in a certain sense did not exist before.'[38] Statistical modelling of troubling and threatening events, including maternal death during labour, projected HIV infections, estimations of future disease based on genetic testing and so on, informs policies, and in so doing contributes to the looping effect and hence fashions identities; individuals are made into 'at-risk mothers,' 'vulnerable to HIV,' 'at risk for prostate cancer' and so on.

Statistical methods made use of in epidemiology are sophisticated technologies designed to calculate individual risk for illness based on standardized estimates derived from population studies. Such estimates are made possible with the emergence of a state apparatus for enumerating populations through the census and making them available for study. Such an approach differs from classical divinatory technologies (consulting oracles or soothsayers and reading omens) in which accounts provided by experts about unfortunate events in the past and predictions of future danger are contextualized in the client's own life circumstances, resulting in highly individualized predictions. In contrast, population-derived epidemiological forecasts produce decontextualized probabilities about whether or not a breast cancer gene increases risk for breast cancer in the future, or an elevated cholesterol level is likely to lead to a heart attack. Such probabilities are of great value to insurance companies and health planners whose work depends upon reliable knowledge about populations. For example, actuarial and epidemiological data can predict with considerable certainty how many individuals in any given population will die in a year; however, these estimates cannot say *who* will die. Thus, risk estimates actually produce uncertainty when given to individuals, who are often baffled by or disbelieving of probabilistic calculations. The 'tyranny of numbers' has often been criticized because their use is designed to create an objectivity and produce truth claims that must inevitably decontextualize and efface the reality of everyday life and experience; calculations of future risk for disease are a ubiquitous example of technologies of bodily governance.

In an article published in 1985, entitled 'The Median Isn't the Message',[39] the renowned biologist Stephen J. Gould recounted how he had dealt with the acute anxiety experienced on being diagnosed with abdominal mesothelioma, a deadly cancer. His first response was to go to a library and read up on the available literature that, once he had absorbed the import of the information, 'stunned him' for about 15 minutes. But Gould's rational brain soon took over, producing knowledge that, when combined with what he describes as his naturally optimistic outlook, permitted him to emerge from the library feeling reasonably encouraged.

In Gould's words, the literature could not have been more 'brutally clear', in that the disease is incurable and has a median mortality of about eight months after diagnosis. However, he set about questioning what a median mortality of eight months actually signified in his case. He suggests that to most people it would mean, 'I will probably be dead in eight months', but insists that this is exactly the conclusion that should be avoided. We tend to view medians and means as hard 'realities', Gould points out, and forget the most important thing, the variation that permits their calculation. Thus, if the median is the reality and variation around the median just a device for its calculation, then 'I will probably be dead in eight months' may pass as a reasonable interpretation. But, Gould goes on, it is the medians and means that are the abstractions and the variation that is the reality. He then figured out where in all probability he should be located amidst the variation on the basis of his age (relatively young), his diagnosis at an early stage in the disease process, his access to the best possible medical treatment and his strong desire to keep living. Gould then found himself in the 'right skewed tail' around the median, indicating that he was amongst that group of diagnosed individuals who remain alive, often many years after diagnosis. In fact, Gould's calculations proved to be correct and he continued to live for a good number of years after his diagnosis.

Gould's case makes it very clear that the concept of risk is not at all self-evident because all such predictions have to be translated from statistical probabilities to 'fit' the circumstances of individual lives. Moreover, health care professionals, patients and involved families may weigh contextual variables quite differently, added to which media reporting of risk estimates is often inaccurate.[40]

In geographical locations where material and financial resources to set up and sustain the massive apparatus needed to document, classify and store population-based data are sparse, probabilistic technologies of governance raise yet other very serious difficulties. This is because in such locations the collection of statistics is patchy and often disproportionately culled from certain 'kinds' of people (pregnant women and urban dwellers, for example) who are the most readily available as sources for data collection – leading to enormous bias. Because such numbers, however they are obtained, are crucial in mobilizing financial and technical resources, the collection of population-based data in resource-poor countries has special implications. In contrast to wealthy countries, choices are rarely made locally today about the way in which numbers will be mobilized with the objective of improving health; instead, such choices are the result of technocratic decision-making at a distance, carried out largely by donor organizations and other international agencies. A similar situation applies very often to poor and isolated parts of well-off countries, including the rural southern United States and the Canadian Arctic where life expectancy rates are up to seven years lower than in these countries as a whole.

Technologies of the Self

Foucault introduced the notion of technologies of the self when writing about Greek and Roman philosophy and early Christianity. He pointed out how, in classical times, philosophy extended beyond a system of thought to comprise a series of practices, including spiritual exercises, dietetics and forms of self-control. Foucault defined these 'technologies of the self' as practices that 'permit individuals to effect by their own means or with the help of others a certain number of operations on their own bodies and souls, thoughts, conduct, and way of being', with the purpose of transforming the self in order to attain 'happiness, purity, wisdom, perfection, or immortality'.[41] Foucault's point is not simply that individuals have long sought out ways to thrive and better themselves, but that the situation changed dramatically with modernity, when state bureaucracies, supported strongly by professional disciplines (notably medical specialties), began to be systematically involved in projects to govern life, no longer leaving matters up to individual whim. Some scholars argue that these disciplinary practices are indispensable to the success of modern governance and that 'the production of a biopolitical body is the original activity of sovereign power'.[42]

The idea that individuals themselves should manage their health gained prominence with the support of governments and members of the medical profession, including some deeply religious practitioners. In the nineteenth century, organizations such as the 'crusaders for fitness' associated personal salvation and health with correct living, diet and exercise.[43] The doctrine of these 'hygienic religions' was that, rather than simply praying for health, one should work for it. In North America, physician activists such as John Henry Kellogg and Horace Fletcher were explicit that changes in lifestyle would reinvigorate both body and spirit and promote a healthy nation.[44] The sociologist Peter Conrad argues that today 'wellness' – the avoidance of disease and illness – has become a 'virtue', for some, a secular path to salvation.[45] Obviously many people choose not to participate in activities purported to sustain health and enhance their body image for a variety of reasons, but equally it cannot be denied that media and television reporting, self-help groups, exercise facilities, and government and corporate initiatives of many kinds relentlessly target individuals about the importance of 'working' at one's health. The promotion of biomedical concepts of health can be reckoned, following Foucault, as a technology of self.

A very different picture emerges when efforts to encourage individual responsibility for health are examined in a global context where the apparatus of the state is often weak, dependent on outside aid or essentially non-existent. Today, private foundations, NGOs, churches and other religious bodies and a host of other non-governmental actors increasingly promote technologies of the self globally. Consistent with neoliberal ideas that frown on state intervention, these self-help practices incite individuals to take responsibility for their own health and illness, even in situations where people are malnourished and where living conditions result in repeated assaults of infectious and parasitic diseases and where chronic disease is on the increase. In response to neoliberal initiatives, there is diminishing access to state-sponsored health care, and, where the economic means are lacking, little access to the private clinics that have opened up to replace clinics formerly run by the state. Quite simply, as World Health Organization (WHO) figures show all too clearly,[46] the bodies of the poor are increasingly under threat and their health is inevitably fragile. In the absence of a well-functioning medical system, self-help groups are often the most readily accessible – at times the only – means to conjure up a potential for well-being in situations where people have little opportunity to change the demeaning and often violent circumstances in which they live. Chapter 12 explores how, in such settings, where outside interventions are designed to assist primarily with economic development and secondarily with humanitarian assistance, self-help groups sponsored by NGOs and religious organizations have become vehicles for injecting ideas about personal responsibility for individual health; in these contexts, the notion that individuals can exercise control over their health is glaringly inappropriate.

In the chapters that follow we repeatedly find that people everywhere resist, circumvent, reinvent and pragmatically adapt and adjust to the various biomedical technologies that appear in their communities. Theoretical arguments about biopower, including the assumed role of the state in the management of individual bodies and populations and the idea of technologies of the self, are inspired almost exclusively by the experience of modernization in Europe, in particular France. Their mechanical application to settings where state power takes very different forms, and may be corrupt – or where 'government' is exercised to some degree by NGOs and humanitarian interventions – may conceal more than it reveals. As we will show, theories of biopower must be reworked if they are to be of global relevance.

We turn now to another set of practices that has been made possible only recently as a result of technological developments that came about in the latter half of the twentieth century.

The Power of Biological Reductionism

The foundations of what would become scientific medicine were gradually set in place commencing in the fifteenth century in Europe, when the practice of anatomical dissection, much of it carried out as public spectacle, became customary practice. Early European anatomists were 'consumed with disease and death'[47] because they were certain that knowledge obtained from the dissection of corpses (and on occasion from vivisection) would enable them to determine the causes of pathology lurking in the body. The organization of clinical medical training and practice continues to take place today largely on the basis of anatomical divisions of the body.

Beginning in the eighteenth century a major conceptual shift gradually took place in medicine that brought about a 'vitalist' approach to the body focused on 'life itself'.[48] This approach was consolidated by a style of reasoning that drew on the emerging basic sciences of biology, notably physiology, and the gradual acceptance of the theory of evolution.[49] Emphasis began to be given to the body as an organically unified whole – a living, integrated system that could be examined in the clinic by means of standardized techniques and procedures. By extension, the notion of a social body was recognized: 'made up of extracorporeal systems – of environment, of culture – also conceptualized in terms of large scale flows – of air, water, sewage, germs, contagion, familial influences, moral climates, and the like'.[50]

Towards the middle of the twentieth century, under the influence of the 'father of quantum mechanics', physicist/philosopher Erwin Schrödinger, another major conceptual move took place. As a result, a molecularized approach to medicine emerged that overshadowed, but by no means entirely displaced, the vitalist approach. It opened the door to an era of genetic determinism that remained dominant until the beginning of the twenty-first century. Schrödinger, following in Newton's footsteps, was convinced that the laws of physics, notably the second law of thermodynamics, must apply to the natural world, and he came to the conclusion that chromosomes could best be conceptualized as 'some kind of code-script'.[51] But Schrödinger went on to argue with himself, commenting that the term 'code-script' is too narrow because it does not account for continuity between generations. In contrast to the inert matter of the physical world one must account for how the living world is able to resist decay and 'keep going'.

Schrödinger's answer to this problem was to endow chromosomes not only with a 'law-code' but also with 'executive power'; a second metaphor he used was to describe chromosomes as being both 'architect's plan and builder's craft – in one'.[52] Evelyn Fox Keller characterizes Schrödinger's effort as a 'two-sided image of the gene, part physicist's atom and part Plato's soul', an image that was 'immensely productive for geneticists, both technically and politically',[53] and one that has had enormous social repercussions. Although subjected to criticism by influential scientists for several decades, this reductionist, determinist approach is only now undergoing some major rethinking, in large part due to surprising findings in the world of molecular biology that came to light during the mapping of the human genome that are restoring, in some respects, an appreciation of vitalism in medicine[54] (see Chapter 15).

Techno/Biologicals

Over the past four decades it has become increasingly possible to manipulate the boundaries and demarcations of biological entities. Emerging technologies that we term 'techno/biologicals' have the potential to challenge boundaries assumed to be unassailable – to perform 'border crossings'[55] – between what is normatively accepted as nature or as culture, self or other, life or death. The application of such technologies inevitably results in hybrid entities, and questions are brought to the fore about what is normal or abnormal, what is moral and just, and what should be the limits, if any, of human intervention into the 'natural world'. In other words, techno/biologicals reconfigure life itself. Donna Haraway, focusing specifically on the biotechnology industry, argues that 'bodies as objects of knowledge are material-semiotic-generative nodes'; their boundaries materialize in social interaction, and through this interaction bodies and body parts are constituted as objects, as sites for manipulation.[56] In the genetic laboratory such manipulation often results in 'rigorous couplings across taxonomic kingdoms (not to mention nations and companies)'.[57]

Amongst their many key applications, techno/biologicals enable the transformation of living cells, tissues and organs into agents that facilitate research, or else substitute or replace faulty, inadequate or failed body parts and mechanisms. Examples of techno/biologicals are 'immortalized cell lines' kept 'alive' in nutritive media, the creation of transgenic and synthetic organisms, organs readied for transplant, the extraction and preparation of stem cells procured from embryonic tissue for research purposes, and research into gene editing that is currently being practised on animals, plants and discarded human embryos. We can detect similarities in the effects brought about by techno/biologicals to those in non-literate medical traditions where substances are trafficked between humans in order to enhance well-being and provide protection from danger. Practices of witchcraft, spirit possession, shamanism and initiation rites, to name a few, often involve grafting, or hybridizing humans, with entities taken from the material and spiritual worlds. And while many researchers argue that the effects of these practices are symbolic, evidence suggests that in certain cases 'real' changes take place to the condition of the body (usually interpreted by outside observers as a placebo effect).[58] Such activities thereby transform body and society, and effectively challenge locally understood boundaries between self and other, and nature and culture. A ubiquitous example has been the case of the use of hallucinogenic plants by indigenous people in South America, certain parts of North America and Africa in spiritual and healing ceremonies directed by shamans or a medicine man.[59] However, such indigenous practices cannot have the same portability as do techno/biologicals because the efficacy of healing ceremonies, witchcraft practices, and so on, cannot be isolated from the specific contexts where they are applied.[60]

Techno/biologicals of all kinds are quite different from earlier, non-biomedical hybrids (for example, spirit possession). This is because they rely on procedures of standardization and normalization that facilitate the treatment or transformation of bodies deliberately decontextualized from history, society and social relationships. It is this ability to treat bodies-out-of-context – on the twin assumptions that all bodies are essentially the same and that taxonomies of diseases and conditions are applicable anywhere – that gives these technologies great portability and translocal effectiveness in connection with many medical conditions. For example, in discussing the procurement and preparation of organs for transplant, Linda Hogle describes what she terms 'donor enhancement'.[61] Pharmaceutical agents are injected into brain-dead donors in order to preserve cell integrity and inhibit certain functions while enhancing others. Hogle notes that due to these interventions, organs and tissues lose any particular or unusual features they may have had while functioning in the now deceased body, and are transformed into the equivalent of '"off-the-shelf" reagents' – they become, in Hogle's words, donor-cyborgs.[62] Once removed from the donor body, the surgeon takes the organ to one side in the operating room and quietly works on it further, striving for easy insertion into another body.

Techno/biologicals clearly have the potential to intervene worldwide and refigure life everywhere. Eugene Thacker, a specialist in communication and culture who has written extensively on the biotech industry and genomics, asks in what way Foucaultian biopolitics might be relevant with respect to this particular industry. He notes – as have we done above in connection with the management of populations and individuals deemed at risk – that Foucault never made an explicit link between the poles of biopower (the pole of anatomo-politics and the pole of population). Foucault made only the 'general inference that both the science of statistics and the science of life (bio-logy) constitute a biopolitics, that is, a bioscience of the state'.[63] Thacker argues that this nascent relationship noted by Foucault is magnified and developed in the biotech industry with the 'integration and management of the relationships between biology and computers', that is, between 'genetics and informatics'.[64] He writes that information generated from this relationship 'is the point of mediation through which biopolitics regulates genetics and informatics into a sophisticated mode of governmentality or control'.[65] Thacker points out that genome databases, biological 'libraries' of cell lines, patient databases, online medical services and a host of other innovations have resulted in an informatic understanding of 'life itself' which is now recognized as 'both material and informatic'.[66] This 'upgrading', as Thacker puts it, of Foucault's argument for biopower is on a vastly different scale from that which took place in the nineteenth and twentieth centuries. It must also be kept in mind how fragmentary at present is the penetration of such informatic-based medical care into many parts of the world. Most of the pills, therapies, diagnostic measures and insurance practices noted by Thacker as the material output of this new informatic approach simply do not exist for the world's poor, even when they reside in countries such as India or China, where good health care exists for many, but continues to be poorly distributed throughout the population.

The relationship amongst governments, medical establishments, emerging biomedical technologies, biotech industries, cultural values – often deeply associated with religious precepts – and the everyday lives of people living in most parts of the world today does not resemble that of twentieth-century Europe. Furthermore, this is now a world where the massive accumulation of wealth by a few is on the increase, while inequality and poverty are strikingly worse than in the twentieth century, and where social security is largely non-existent. A recent Oxfam report estimates that half of the entire global wealth is held by one per cent of the population. This means that 80 people own the same amount of wealth as more than 3.5 billion of the world's poorest people. The holdings of these rich individuals have increased 44 per cent over the past five years, by about half a trillion dollars. During the same period, the available cash of those at the bottom of the scale has dropped by 41 per cent, that is, over a trillion dollars. Women are particularly badly hit by this imbalance. The call is to tackle, above all else, tax havens.[67] It is in light of this reality that emerging forms of biopower and of ill health demand attention, and contributions made by social scientists to this task are presented in detail in the chapters that follow.