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Human origins, natural selection and the evolution of ethics

> Bioethics can serve no useful ends if it is to be merely a watered-down version of contemporary biology . . . Bioethics must be based on modern concepts of biology and not on unsupported introspection.[1]

Technologies, all byproducts of science, have redefined how we live, work, fight, relax and communicate with one another. They have not only given us knowledge and provided a previously unimaginable technologically based standard of living, but also unprecedented coercive powers. Humans can now choose to command forces in the service of differing social, economic and political goals, and also, predictably, any potential consequences of their choices. Paradoxically, it's not the science but the use or abuse of science's gifts that challenge and demand mature intellectual appraisal. By commanding technological powers way in excess of our Stone Age brain's emotional capabilities to responsibly contain that power, we find ourselves at odds with our evolutionary heritage. We seem uncertain in which direction to head and how to achieve the behavioural goals that provide the adaptability requisite for survival and future wellbeing.

Our predicament may reflect that we are, in essence, essentially the same animal that evolved approximately 30 000–35 000 years ago. Within a comparatively short evolutionary period, we have successfully adjusted from a nomadic lifestyle living in small, closely genetically related groups, to living within settled villages and have weathered, more or less, the stresses of nationally based industrial societies. Now we need to negotiate a complicated,

[1] Potter, V. R. (1971). *Bioethics: Bridge to the Future*. Englewood Cliffs, New Jersey: Prentice-Hall, p. 4.

interconnected, information-based global society. In addition, there are definite environmental warnings that our very destiny may be on the line – the choice between responsible survival and biological extinction is ours to make. We can no longer refute that the way we are multiplying, consuming natural resources, using energy, condoning institutionalized violence and producing waste has fundamentally changed the balance of our global environment. Significantly, the 'naked ape' is now forced to calculate the likely odds of the species' survival within differing future scenarios. Fortunately, well-developed human instincts are already embodied in our genes as we place special value on social attributes such as caring and sharing. These important qualities gave our ancestors strong survival values as we evolved socially. Beyond the powers of the rational mind, our remarkable brains house faculties that embrace love, compassion, solidarity and a sense of fair play. Caring survival skills can be easily observed even in the desperately deprived, such as among destitute homeless kids who routinely share their meagre food and drink – as well as their drugs of comfort. However, it is hard to fundamentally appreciate how dramatically different our socioecological environment is today compared to that in which we adaptively evolved.

This book is about caring and sharing knowledge; it is about people, kids, scientific achievements and monumental scientific failures. Its purpose is to provide a practical interface spanning knowledge gained from modern scientific endeavours and existing bioethical discourse. Before ethical and moral philosophy can be of leading assistance, a good working knowledge of biological systems is essential. My hope is that, by vitalizing interests which facilitate the acquirement of wisdom based on biological understanding, new social values, based on such discernment, can be developed.

Modern science, ethics and evolving bioscience ethics

Science is descriptive, dealing with facts and requiring verification, whereas ethics (formally a part of philosophy) is prescriptive, dealing with what ought to be and depending upon justification. It follows, therefore, that science is ethically neutral while its application is not; that is, the ethics in science do not reside in the science itself but in its conduct and application. When science was in its infancy there was little contradiction between the science and the ethics; that is, 'science ethics' differed little from any other kind of ethics. Modern science, however, is a disseminated resource that is changing the way we live and so can no longer be claimed to be in effect neutral. Although it is now established that scientists can no longer claim that science is neutral but must consider the ethical and social aspects of their work, there still remains the need to bridge essential differences between science and its technology on the one hand, and its social consequences on the other. The bridging process is the province of bioethics. Bioethics refers literally to 'life ethics' and grew out of a vast scholarly literature which had accumulated over centuries in the philosophical and theological traditions. The ever-present risk is that in the process of bioethical/philosophical discourse, crucial scientific knowledge may be inadvertently left out, misunderstood, distorted or subsequently lost because, clearly, speed of change is not of the essence when formulating and justifying human values. To illustrate – compare the discussion of a specific ethical issue such as stem cell research in, for example, a medical journal, a theology journal and a philosophy journal, and note the strikingly different processes of ethical argument. These differences present real barriers to the individual who is concerned with influencing practical decisions, to decide how bioethics should be applied, or even whether it should be applied at all. These differences also present real problems in national politics where questions of how much consensus must exist on an ethical principle before its enforcement becomes a responsibility of the state. How large must a minority be before tax funds collected from all ought to be denied to uses that the minority finds ethically reprehensible? Logic dictates that it stands to reason that scientific evidence should be taken into account when making socially important decisions, but is it? Could it be that to protect the corruption of scientific understanding is the reason why the discipline of bioethics has fragmented into several areas of concentration, such as gender-specific ethics, medical ethics, environmental ethics, forensic ethics, to name but a few? A related difficulty has been that some scholars draw distinctions between ethics and morals as concepts, while others use the terms interchangeably. From the historical perspective, morality is a body of specific rules or guides to human behaviour, whereas ethics is the intellectual justification and organization of those rules – some of which are in agreement with modern scientific insights, while others are not.

All scientific knowledge and applied technology requires ethical consideration to ensure that it is used appropriately and responsibly. However, the question of whether we have adequately identified our bioethical responsibilities relative to our scientific understanding is dependent on whether we have access to current scientific research. At the 1997 American Association for the Advancement of Science held in Seattle, my colleague Steven Gilbert and I launched 'bioscience ethics' – a term I had previously coined and used informally. Bioscience ethics has taken off since and has developed into the accepted interface bridging applied science and applied bioethics. Bioscience ethics assists by promoting biological understanding useful in the development of ethically responsible decision-making in tune with present-day reality; or, if preferred, by combining the 'normative' with the 'informative' in the scientific context. Bioscience ethics[2] facilitates this bridging process by dismantling present-day restrictive subject boundaries that curtail full and clear information transfer across relevant disciplines. The major elements of bioscience ethics are increased understanding of biological systems, responsible use of technology, and reassessment of ethnocentric debate more consistent with new ecological and sociomedical insights. Bioscience ethics does not replace bioethics in any shape or form; rather it facilitates informed decision-making in matters of science and its applications.

In its most basic respect, bioscience ethics aims to democratize esoteric science by making it comprehensible to the scientifically untrained but socially concerned individual. Rightly, it is up to society to decide whether a technological application is ethically acceptable; however, appealing to scholarly philosophical and/or theological discourse, distanced from the scientific workbench, is not always the most efficient way to bargain with the realities created by modern scientific innovations. Likewise, the solution to modern ethical problems cannot always be found within an abstract system of principles to be chosen, or rejected, or even imposed from above. In the final analysis, the sum of us must decide which bioethical principles, values and beliefs are most appropriately applied to a particular biological problem. To this end, accurate, updated biological understanding must be provided if responsible ethical positions are to be reached, especially when judgements are to be made about scientific matters. To this end, the minds of scientists trained to utilize their analytical, logical skills to investigate natural phenomena can usefully be of practical service. More importantly, scientists socialized to see and interpret the world around them in ways that their training demands have an ethical obligation to contribute to the social discourse from which bioethical values are derived. Although scientists at work ask fundamental, ethically neutral questions devoid of value judgements, it cannot be assumed that science lacks emotion. Evidently, science's application must be judged and evaluated before deriving new values from scientific insights; therefore, scientists (being human) experience exhilaration at a discovery, grief at an inappropriate application, and otherwise engage their minds in matters of passion and ethics. In truth, scientists are prone to be over-burdened with a personal and collective responsibility because many of the present-day problems were created by the misapplication of the science to which they are so dedicated. Ironically,

[2] Bioscience-bioethics education portal at www.bioscience-bioethics.org/.

many of the solutions to our technologically based predicaments again lie in the scientists' practical skills and biological understanding.

The business of human survival has always been, and still is, one of mature ethical debate within science-based endeavours involving decisions of life and death. Thus, the business of bioethics is well placed to decide whether any specific scientific innovation has anything to say about ethical imperatives and, in true democratic spirit, provide methodical justification in tune with the demands of present-day survival. In this context, a new bold bioethics argues that scientific evidence is to be taken into account when making socially important decisions. Self-evidently, bioscience ethics and bioethics (colloquially dubbed bioscience-bioethics) may seriously challenge traditional (human-centred) ethical and moral theory, but that can only be of advantage because challenge generates energy which, in turn, fuels cultural evolution in diverse and unexpected directions. It would, therefore, be inappropriate for this book to espouse theological or doctrinal assumptions, and it does not, although there may be a confluence of ideas in many instances. Paradoxically, bioscience ethics builds on biological imperatives but is driven by social, psychological, secular and theological predicaments. The book's chapters link a series of interrelated topics concerned with procreation, health and the environment – issues particularly suitable when emphasizing science's power over our individual lives. For example, chapters sorted under the overall heading 'human-dominated ecosystems' rework environmental priorities by adjusting ethical boundaries distanced from their ethnocentric roots. The chapters concerned with procreative biology highlight the personal and the transgenerational issues.

As long as our culture continues to reflect advances in science and technology, there is an obligation to make science accessible to everyone. Many of us have no clear sense of the wholeness of scientific practice, despite the fact that we are living through an explosion of science education made suitable for those with little or no background in the sciences. I would like to begin by briefly examining our origins and what is known about the evolution of human ethical consciousness. A better understanding of our past improves understanding of our present selves and highlights major areas for thought.

The hunter–gatherer *Homo sapiens*

The human brain's evolution can be divided into three distinct ancestral stages (the 'triune' brain – a term popularized by Paul MacLean, 1990), in which each evolutionary stage solved different physical survival functions and behavioural environmental problems. These are the primitive (or reptilian) brain, the early mammalian (or limbic) brain and the new mammalian brain (or neocortex). The primitive brain (also called the basal ganglia) is largely controlled by the unconscious autonomic nervous system, and embodies a significant core of automatic survival functions, including sentiments of which we are not necessarily aware. Basic functions relating to instinctive behaviour patterns of self-preservation include the desire for pleasure, choosing a mate, breeding, fighting, fleeing, territorialism, social hierarchy ('pecking order'), selection of leaders, status maintenance, tendency to follow precedent, resistance to change, awe for authority, compulsiveness, ritualism, prejudice and deception. It may seem puzzling, but behaviours such as dominance displays, flocking, schooling, herding and associated instinctive behaviours are socially effective lifestyle functions that reduce violent interactions between members of a species and are life-enhancing behaviours under most circumstances. We carry our primitive reptilian brain, consisting in the main of the brainstem, basal ganglia, reticular activating system and the midbrain, around with us largely unchanged.

The early mammalian or limbic brain that arose in the transition from reptiles to mammals about 150 million years ago embodies the first layer of the cortex responsible for our social and family behaviours as mammals. It underlies the subjective experience of emotional feelings that guide functions bordering on defence, food and sex, as well as activities related to the expression of the semi-conscious emotions and feelings linked to attachment and care of offspring – obligatory functions for the preservation of the species. Accordingly, the limbic brain's primal activities (such as the 'fight or flight' fear response) relate to the production of powerful emotions that incite further the objectives derived from the primitive portions of the brain. Limbic-generated emotions and their corresponding reactions are, typically, immediately independent of thought reactions to perceptions as relayed by the senses. This may explain why certain judgements, such as political or religious dogmas or any other strongly felt inspirations, may be so overwhelming that they remain in the face of logic and contradiction.

The latest evolutionary development is the new mammalian brain or neocortex, which evolved over the last 60 million years and is most notable in primates, particularly humans. Its extensive neocortical development encompasses conscious mental activity, and this made reasoning, abstract intelligence, mathematical thinking and decoding of sensory information possible, as well as many other new talents such as music, language, meditation, dreaming and expanded memory. Substantial brain reorganization occurred during the evolution of the neocortex, where flexing and packing against the cranium made possible the development of new pathways connecting midbrain regions

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to the neocortex and providing many new evolutionary opportunities. That music, for example, is the product of natural selection is not debated despite the existence of conflicting ideas as to its precise purpose. Popular hypotheses include that music promotes social cohesion in group activities such as war or religion, and that its evolution is driven by the pacifying effect it has on infants. Effectively, then, portions of the triune brain handle functions and behaviours that are common to the animal ancestors that share it, but these functions have also evolved together to produce collective agreement in thought and emotion to insure good quality survival of the species (see section on Neuroethics below, p. 16).

Despite our appreciation of our brain's deep evolutionary history, we are still unsure as to when in prehistory our ancestors negotiated the divide from ape to human. Until recently, most researchers believed that the transition took place when humankind systematically started to make stone tools for immediate and future use. Such behaviour implies a capacity for human-like conceptual and abstract thought, contrasting with the thinking processes of the other primates which seem to be mainly perceptual (i.e. limited to the experience of the immediate senses). The first tools were simple, sharp stone flakes and shaped cobbles, known as Oldowan technology, and appeared around 2.5 million years ago in East Africa. The age of these flakes closely matched those of the then earliest known fossils of the genus *Homo*, to which modern humans belong. Recent fossil discoveries in Kenya have, however, pushed back the record of upright-walking hominids to about 4.2 to 3.9 million years ago. Another difficulty in using stone tools as a mark of humanness is that pygmy chimpanzees, or bonobos, also make and use similar tools. Nevertheless, the emergence of the first good evidence for a species closely resembling us seems to be at least 2 million years old.

Genetic anthropologists have identified a trend of accelerating change in the evolutionary lineage leading to modern humans from ape-like ancestors – a trend that is ongoing. Following the emergence of the first ancestors of the *Homo* species, the ape-sized brain began to experience a 40–50% enlargement, which was repeated three times. It may have been that mutational benefits acquired through the evolution of binocular vision, necessary for the hunting lifestyle, subsequently led to the selection of a larger brain whose excess potential was advantageously redirected towards abstract thought, mathematical ability and so on. This interesting hypothesis, of course, is debatable; however, scientists have recently discovered a region of overlapping genes that evolved extremely quickly in our ancestors and that may explain why human brains are dramatically larger than those of other mammalian lineages. The genes in question are active in cells that appear early in embryonic

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development and assist in forming the cerebral cortex and its connections to other parts of the developing brain. Whatever the aetiology, radical brain expansion did open up new evolutionary potentials in intellect and culture. It has been suggested that the era of tool making also saw the emergence of the elements of social organization seen in modern hunter–gatherer societies, including division of labour, sharing food resources and sophisticated language. In this scenario, the Oldowan tools (approximately 1.4 million years old) were made by a protohuman hunter–gatherer society whereas the species *Homo sapiens* used to define humans with fully enlarged brains and sophisticated culture appeared in the fossil record some 60 000 years ago. Fully modern humans are typified by forms prevalent since the last interglacial period about 35 000 years ago.

Modern humans are the only surviving species of a more diverse family of hominids and are now most closely related to the living African apes as determined by the common ancestor from which humans and chimpanzees evolved. At the outset, two species descended from a common ancestor start out with identical DNA but, as the generations go by, random changes accumulate and the longer the two species have been separated, the greater the difference in their DNA. Differences in DNA are expressed as a percentage rate and are referred to as the 'molecular clock'. Comparing human and chimpanzee DNA gene sequences reveals that the DNA of humans and chimpanzees corresponds more closely (1.6% difference or 98.4% similarity in DNA sequences) than would be expected, given the considerable morphological differences between the two species. Then again, this small 2% difference still leaves the equivalent of 14 million nucleotide differences, distinguishing the 20–25 000 protein-coding genes of humans from those of chimpanzees. As any geneticist knows well, a small number of nucleotides can make a very big difference. For example, one wrong base pair can give you sickle-cell disease; one malfunctioning gene can make all the difference (Chapter 10). It is apparent that subtle reshuffling of DNA was sufficient to have given us, over an estimated 5 million years – or ~250 000 generations – a species capacity that has never existed before, and that has transformed the world.

We also know, from DNA studies measuring the frequency of certain genetic markers in populations, that *Homo sapiens* has great variation in local form (demonstrating polymorphism of many genetic characters) but remarkably low overall genetic difference, even between geographically distant human populations. This means that within its single gene pool there could be more variability within one population than between individuals from different populations or races. Such genetic data lend support to the notion that all modern human populations are descended from a recent single ancestral population (the 'out of Africa' and 'mitochondrial Eve' models), and confirms the scientific reality that we are all members of the same race of people. Mitochondrial DNA clones itself rather than recombining, so is passed to the next generation only by the mother. Since mitochondrial DNA also evolves 10 times faster than nuclear DNA, it conveniently provides an independent molecular clock to reveal an individual's maternal ancestry.

Our close extinct relative, *Homo neanderthalensis* (Neanderthal man), who flourished in Europe and western Asia between about 200 000 and 30 000 years ago, possessed many similarities to humans and had a brain volume greater than that of modern humans. The archaeological evidence also points to a uniquely advanced Neanderthal culture, including sophisticated burial practices. Certain genetic evidence indicates that the population that left Africa some 100 000 years ago interacted with another early human group that had been in Europe for much longer. DNA sequencing of fossil remains may in future reveal whether or not modern humans harbour an archaic Neanderthal imprint.

We still don't really understand some vital periods in our own past. Why did human creativity shown in art, music, sophisticated tools and spirituality suddenly flourish 35 000 years ago when our brains had evolved to the modern size some 65 000 years earlier? Human anatomy and physiology has changed little in the past 35 000 years, yet human culture has changed dramatically. Cultural change represents a recent kind of evolution to support the transmission of learned knowledge across generations in the least possible time. Whatever one generation learns can now be passed onto the next by guidance, instruction, education, ritual, tradition and even indoctrination; all of which ensure continuity in culture. Richard Dawkins, in *The Selfish Gene* (1989), suggested that we are no longer only shaped by our selfish genes but also by ideas which he called 'memes'. The concept of the meme, analogous to the gene, is now known as 'dual inheritance theory' or 'gene-culture co-evolution theory'. In the case of culture, the inheritance mechanism is social learning where members of a particular community learn ways to think and behave from influential members of their community acting as role models. Different thinking processes have different consequences for the patterning of cultural change through time. Peter Singer, in *The Expanding Circle* (1981), suggested how culture may have genetically selected for compassion as tribal society expanded beyond its original bounds of the family. On the other hand, cultural preferences, such as attitudes and styles, are not specifically encoded in the genes, so these attitudes and fashions can readily be reversed. It seems that social flexibility may well have become our greatest asset in the struggle for survival.

While bipedal walking, cooperation in family and tribal units, long education, self-consciousness and sophisticated language were evolutionary prerequisites, the essential characteristic of *Homo sapiens*' intelligence was, and still is, creativity. Many believe that our species' creativity, more than any other element, gave rise to artistic expression and ethical rules. That is, in biological terms, human uniqueness resides primarily in our brains with one of its products being culture. Our brain size has more than doubled in the past 2 million years to a volume of some 1500 cubic centimetres. This steady growth in brain size and complexity made possible a steady growth in intelligence, and an increasing mastery of the world. But size isn't everything. What also matters is how the brain is structured, with the human brain's uniqueness lying in its flexibility. Flexibility and intelligence is demonstrated by the ability to face problems in an unprogrammed and creative manner. But the full, transgenerational benefits of a good solution to a particular dilemma can only be reaped by communicating and sharing the knowledge with the rest of the tribe.

It is believed that the key change depended on some fine-tuning of the larynx, making sophisticated languages possible. Before this vital structural change evolved, human groups spoke a protolanguage that linked items in the environment to words which could be linked to one another in simple series. But the simple chain of words could not allow the expression of complex ideas such as cause-and-effect relationships. Such ideas became possible only when a grammar emerged to organize words into sentences. Grammar offered huge benefits, such as a comprehensive modelling of the world and abstract thinking that was not tied to immediate action. As a consequence, planning became possible once humans could contemplate the choice of options most likely to be successful. We became empowered to anticipate a wide range of behaviours in different environmental situations relating to the need for aggressive self-preservation, or peaceful cooperative living. It is believed that the analytical, conscious mind was born out of intellectual flexibility together with an innate lifelong love for learning, exploring and playing. So the early hallmark of human evolution was that this exceptional species had the capacity to reason, to reflect on its actions and to discourse with each other. During the brain's subsequent evolution, consciousness opened up other unique possibilities of conscience, perchance favourable to the expansion of ethics.

Among human evolutionary theorists it is popularly believed that human development was advanced not just by the enlargement of the neocortex but, in particular, that part known as the frontal lobes. The frontal lobe is the largest of the four lobes constituting each of the two cerebral hemispheres. It is responsible for voluntary control over most skeletal muscles and significantly