



ESSAYS ON SCIENCE AND SOCIETY: Is the Genome the Secular Equivalent of the Soul?

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The sequencing of genomes from organisms as diverse as bacteria, yeast, worms, flies, and, of course, ourselves, has moved biology beyond the study of individual genes to the study of all genes, making the genome an explicit object of investigation and representation. With the imminent publication of the complete sequence of the human genome, often seen as a decisive Promethean step in self-knowledge, the societal and cultural effects of genomics are at the forefront of public awareness.

The human genome sequence has become central to ethical and policy debates about the application of gene transfer to biomedicine and biotechnology. In addition, it is also shaping contemporary ideas about how our genes dictate our humanness. Scholars have discussed the powerful appeal of the scriptural metaphor in describing how the genome is viewed in popular culture.* The human genome has been labeled the "Book of Man" and its decoding likened to the search for the Holy Grail.

With the complete human genome sequence now at hand, the notion that our genome is synonymous with our humanness is gaining strength. This view is a kind of "genomic metaphysics": the genome[†] is viewed as the core of our nature, determining both our individuality and our species identity. According to this view, the genome is seen as the true essence of human nature, with external influences considered as accidental events. The notion that the genome contains the blueprint of human nature is akin to an important outlook within Western metaphysics that interprets all living organisms as having "souls," which determine their characteristic traits. From this perspective, the human soul is viewed as encapsulating the human essence. This convergence of ideas is perhaps not so surprising. Max Delbrück, a 20th-century pioneer of molecular biology, noted how the notion of a genetic program (borrowed by molecular biologists from the fledgling computer sciences) had an uncanny kinship with the Aristotelian concept of *eidōs*, the organizing principle inherent in every living thing.[‡] Aristotle and medieval philosophers such as Thomas Aquinas regarded the concept of *eidōs* as closely connected with the notion of a *forma* or "soul," which was believed to shape matter into the recognizable form of a living organism. *Forma* was seen as imbuing an organism with individual characteristics, as well as the essence of that species. Thus, plants were viewed as having a vegetative soul, animals a sensitive soul, and humans an intellectual soul. This concept of form still operates in contemporary bioethical debates about when a human embryo achieves personhood.

Part of the *prima facie* plausibility of our genome as the definition of our humanness comes from the blending of ideas of nature, stability, immutability, and genes--if a trait is in the genes, there is nothing that can be done about it. This notion was already evident in the 1960s during the nature-versus-nurture controversies about human intelligence--those siding with nature were skeptical of special educational efforts for the underprivileged, because low intelligence was supposed to be part of nature, that is, "in the genes" and therefore immutable. The rapid succession of discoveries and speculations about the genetic basis of psychiatric disease, alcoholism, and violence, and such recurring

conundrums as the "homosexuality gene" have left their mark on the public consciousness. For many, it is a given that the genome is closer to one's true nature and destiny than other individual properties, which are acquired and thus considered more flexible and amenable to external influences.

One of the ethical issues (mis)informed by "genomic metaphysics" is the question of when a human being becomes a person equipped with basic human rights. Most of us would agree that a newborn baby has basic human rights, whereas a sperm does not. So when does personhood originate? For most of those opposed to abortion, embryo research, and the like, the obvious answer is that personhood originates when an egg is fertilized by a sperm. This conclusion is initially compelling, because it is at fertilization that the zygote with a diploid genome arises from the fusion of two gametes with separate and distinct genomes. The new diploid genome coincides with the emergence of a new individual organism and contains the genetic program that will direct the development of that organism. From this perspective, the genome can easily be viewed as the material marker of personhood. In addition, the fact that the new genome remains (nearly) stable during the life of a person reinforces the intuition that the genome is synonymous with personal identity.

For the many defenders of the zygote-as-person thesis, the traditional scholastic notion of *forma* poses a dilemma. The Scholastics postulated "delayed animation," namely, that the human embryo does not receive a rational (that is, distinctively human) soul at conception, but only when it is "sufficiently formed" (purportedly, 40 days postconception for boys and 90 days for girls). Some modern Thomists have therefore reinterpreted the concept of "form" in genomic terms, in order to make it compatible with the zygote-as-person thesis (which depends on "immediate animation"):

"...form is not appearance, quite the contrary: form defines essence. But medieval biology is no longer valid today and we know that "human" form gives structure to human "matter" as soon as the genetic information (in-forma-tion) required to define a particular genetic patrimony is put together."[§] [my translation]

The way the word "information" is dissected in this quote shows how the genome can be seen to provide the correct modern equivalent of medieval *forma*. For this author, Thomas Aquinas was wrong only about the timing of the conferring of humanness, and his timing was wrong because he did not have access to the correct science. So, the dilemma is over--the diploid genome of the zygote defines human nature, right? Well, not quite. The problem is that personal identity does not necessarily exactly overlap with genomic identity, the identity established by the formation of a new diploid genome at fertilization. For example, monozygotic twins may come from the same embryo and have identical genomes but they are unquestionably distinct persons. Even if they share many physical and psychological traits, they necessarily have separate biographies. "Sameness-of-persons" and "sameness-of-genomes" are clearly distinct relationships with incomplete overlap. The relation between genomes and persons appears to be even more complicated with the advent of cloning, in which new progeny are produced by reprogramming the genome of somatic cells from an adult donor. Some ethicists committed to the zygote-as-person view have acknowledged this problem.[¶] Others have tried to solve the dilemma by redefining the formation of twins as a type of "parthenogenesis" (a phenomenon in certain organisms in which progeny are formed from gametes without fertilization). They view fertilization as producing a new person (the zygote), which occasionally gives rise to a second person through "parthenogenesis." But this contorted interpretation of twin formation does not help the zygote-as-person view. It merely provides further evidence that, whatever it is that gives

rise to a new person, it is not necessarily synonymous with the generation of a new genome.

Clearly, there are problems with the "genomic metaphysics" idea that the genome is the sole determinant of our human individuality--but what about the notion that the genome confers on us our species identity. That such a belief informs strongly held intuitions about the wrongs of genetic manipulation was made clear to me in public debates preceding the Swiss referendum on genetic engineering in 1998. In discussions on engineering transgenic animals such as pigs to provide organs for xenotransplantation to human patients, I often heard the question of how many human genes one would have to introduce into a pig to make it noticeably human. Of course, the purpose of gene transfer, in this case, is indeed to make the pig more "human," albeit in the very limited sense of removing certain surface proteins, rendering the pig tissue more immunologically compatible with human tissue. This question, however, may well express a more basic concern that "pig-nature" is underpinned by pig genes and "human-nature" by human genes. In other words, the question reflects a pre-Darwinian understanding of species as unchanging and sharply distinct entities, each defined by its own specific genome. If one sees nature as structured by sharp borders between species, by clear-cut differences between specific genomes (each genome being the *eidos* that cleanly defines the species), then it is easy to see how mixing genes from different species would be considered a suspicious and unclean hybridization. The very existence of recombinant DNA technology thus provides a kind of cognitive dissonance around taxonomic borders that could and has resulted in moral disapproval. This clear-cut definition of species also explains why, for instance, the small degree of sequence divergence between the human and chimpanzee genomes (1.3%) has come as something of a shock to scientists, philosophers, and the general public alike.

The idea that different species are distinct types is usually taken as obvious by the public and by bioethicists, yet it is largely a foreign notion to the post-Darwinian world of modern biologists.⁴ The philosophical basis of the notion of species is still a matter of debate. A biological species can roughly be defined as a historically situated entity that includes potentially interfertile populations of individual organisms. Given the multiplicity of reproductive isolation mechanisms that prevent cross-species breeding, there is no reason why there should be a predefined quantity of genetic divergence (independent of the actual biological consequences of specific genetic differences) to mark the distinction of a species from its closest relatives. There is more to belonging to a species than membership in a group that shares a similar genome. Nevertheless, this is how species is understood in framing many bioethical dilemmas involving gene transfer and genetic engineering. For instance, the Swiss Federal Ethics Commission on Genetic Engineering had to discuss and reject the notion that producing transgenic animals is inherently against "the dignity of creatures" (a notion enshrined in the Swiss Constitution).

The view that the genome contains the essence of human nature raises several problems. One problem is exemplified by the recent storm-in-a-teacup raised in Central Europe by the German philosopher Peter Sloterdijk, who speculates that "anthropo-technologies"--such as, genetics-based programs to breed a more docile human race--will replace traditional humanistic education as the force shaping future generations. A similar problem arises out of discussions about genetic enhancement of human traits. In both cases, the genomic perspective brings a rather artificial pathos to the debate as it makes too absolute the division between genetic modification and external influences. Likewise, rationalizing all human behavior in terms of genes--a gene for violence, a gene for depression, a gene for impulsiveness--tends to trap the field of behavioral genetics between the opposing forces of genetic reductionism and the politically correct impulse to de-emphasize genes.

By placing all our hopes (and fears) in our genes, we are fueling the expectation that the human genome will be the last word about human nature. But this expectation is an

illusion. True, genetics and biology enable us to wield increasing power over our destiny, but that does not mean that more traditional forms of enquiry about ourselves have been superseded by our greater understanding of human biology. More than ever, we need a richer account of the human condition. To be a human person means more than having a human genome, it means having a narrative identity of one's own. Likewise, membership in the human family involves a rich nexus of cultural links that cannot be reduced to taxonomy. On the question of human nature, we need a philosophical fresh start that cannot be provided by genomics alone.

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