Human Genome Project: First scientific milestone of the twenty-first century

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The mapping of the human genome is a fundamental milestone in the development of science. The “letters” of this genetic code—3.1 billion DNA base pairs, equivalent to 200 telephone directories each of 500 pages—have now been listed in draft form. There are still some gaps and the human genome project will not be completely finished for another three years.

The project heralds huge advances for humanity in the twenty-first century, facilitating the understanding and ultimately the treatment of a vast range of diseases, including cancers. As a key step in understanding the complex functioning of human cells, it is part of scientific innovations that are unravelling the connection between chemistry and biology, between organic molecules and life forms.

This development is graphic confirmation of the fact that the most advanced life on our planet, *homo sapiens*, evolved from more primitive species of animals, sharing the same kind of genetic mechanisms. It has tremendous significance as a refutation of mystical and obscurantist views of man's place in the universe.

Some 99 percent of the code mapped on the 23 chromosomes in each of our cells are the same in all humans. No significant racial differences were revealed in the genetic mapping. In fact, 97 percent of the genome is termed “junk” insofar as it appears to serve no purpose in the cell's functioning. Only about 3 percent of the genome contains the sequences making up the 100,000 or so human genes (the actual number is still disputed), of which 38,000 genes have been discovered so far. These gene sequences provide the blueprints that a cell uses to construct the protein molecules that enable it to function. There are also genes whose function is to switch other genes on or off.

Other organisms whose genomes are known include the bacterium e. coli, yeast, the fruit fly and the nematode worm. Work is in progress to map the genomes of a range of other species such as the common mouse, cat, and so on. Understanding how the genes work in simpler organisms is helping scientists decipher the human genes. For example, 15 percent of our genes are the same as e. coli genes, and 30 percent are the same as yeast. Our evolutionary heritage is confirmed by the fact that 75 percent of our genes are the same as those of a mouse and we share 98.4 percent of the same genes as a chimpanzee.

Two things in particular have made this advance possible: the tremendous developments in technology and international collaboration.

The computer-controlled machines performing the DNA sequencing and “super-computers” used to process the huge amounts of information involved are a major feature of the project and, increasingly, the whole of biology.

The work to obtain the genome draft over the last 10 years was the result of international cooperation between teams of scientists. It included publicly funded researchers in the United States, led by the Human Genome Research Institute at the National Institutes of Health (NIH), Washington, headed by Francis Collins, but also a number of university teams. In the United Kingdom the research was conducted at the Sanger Centre in Cambridge, funded by the charity the Wellcome Trust, and headed by John Sulston. University researchers in Germany and Japan also contributed.

Despite much media hype, Craig Venter's privately owned Celera Genomics—which entered the field in 1998 claiming that could beat the publicly funded teams and finish the sequencing in three years—depended heavily on utilising the public work that is regularly published and updated on the Internet. Scientists were scathing about Venter's methods. James Watson, Nobel prize winner and co-discoverer of DNA, described them as “sloppy” and said that Venter's work was “not science”. Sulston said “We had to fight, I regret that, and it hasn't been easy.” Competition from Venter had, however, “only accelerated it [the project] by a year.”

Against this background the language with which US President Bill Clinton chooses to announce completion of the draft genome, was striking. The genetic code was “the language in which God created life,” Clinton said, inspiring awe and wonder for “God's most divine gift.”

Clinton was responding to the pressure of the religious right who increasingly dominate the political agenda of his administration. Faced with a scientific development that powerfully confirms the materialist outlook and refutes the insidious creationist theories of the fundamentalists, Clinton elected instead to thank God.

His remarks epitomise the political and intellectual backwardness that characterises the bourgeoisie today. Contrast this to the response of a former president, Thomas Jefferson, who used his presidency to promote scientific endeavours and to educate the population of the newly founded republic that was the first to allow liberty of conscience to its citizens.

The degree to which corporate business interests have muscled into genome research is indeed a disturbing feature. A host of new hi-tech companies have received millions of dollars in investment. Whilst only Venter's Celera Genomics has worked on the genome project itself, firms like Human Genome Sciences, Incyte Genomics and Millennium Pharmaceuticals have been created to sell their genetic-based knowledge on to the pharmaceutical giants such as SmithKline, Novartis, Glaxo, AstraZeneca, etc.

This is only the most acute manifestation of a general phenomenon; as state financed research has been squeezed, the proportion of research and development carried out by the private sector has expanded. One estimate for the United States reports that government

funding for research and development has fallen from more than 50 percent in the early 1960s to less than 16 percent today.

In the case of the human genome project it is notable that Celera Genomics—whose clients include Pfizer, Pharmacia and Novartis—had investments worth $900 million this year whereas the public US National Human Genome Research Institute received $112.5 million in 260 separate grants.

The consequence of this huge involvement of private finance will emerge in the soaring costs of health care. The transnational drug corporations will seek to use all the advantages in medicine arising from genome research to boost their already massive profits. It will increase the social divide between the wealthy minority, who will be able to afford these benefits and whose lives will be extended as a result, and the vast majority of working people unable to pay ever increasing health care costs. This will also be the case in countries with state health services, where governments increasingly ration the more expensive treatments.

The recent World Health Organisation (WHO) *World Health Report 2000* concluded that "inequalities in life expectancy persist, and are strongly associated with socio-economic class, even in countries that enjoy an average of quite good health." A recent example of the massive profiteering the global biotech companies indulge in was provided by figures on the cost of anti-retroviral therapy drugs used to treat AIDS. World prices for a year's treatment currently lie between $10,000 and $15,000, whereas the cost in Brazil, where a generic version of the drug is produced, is just $1,000.

Most scientists stress that the work on understanding the human cell is still in its infancy. The human body is made up of 75 trillion cells, each like an enormously complex chemical factory with thousands of proteins whose interactions are controlled by the genes. Identifying and understanding the function of the proteins in diseases is only at the earliest stages of research.

Diseases that arise from a single gene malfunction, such as cystic fibrosis and haemophilia, are quite rare. It is generally accepted that the conception of one gene giving rise to one malfunction (like the notorious "criminal gene" theory) is a crude oversimplification **.** Most diseases will require an understanding of the complex interactions between genes, proteins and cells, as well as wider environmental factors.

Earlier this year, work on the alteration of a single gene that gives rise to the rare inherited disease X-linked SCID has been carried out in the Necker Hospital for Sick Children in Paris. An 11-month-old baby boy faced certain death from this disorder, which stops the immune system from working. His life was saved by means of so-called gene therapy—replacing the defective genes in the boy's bone marrow with healthy genes. The treatment has been used, apparently successfully, with three other children since then. Gene therapy is now under trial in three different types of anti-cancer treatment as well as in methods to deal with haemophilia and cystic fibrosis.

Using computers, drug companies are hoping to employ the knowledge gained about the genetic code to predict which protein a particular gene sequence produces and which drugs or diagnostic tests may be effective. Whilst this is still largely guesswork it is what has stimulated the millions of dollars of investment and is why biotech companies are now patenting genes and their knowledge of how the genome functions.

Celera Genomics sells its knowledge of the genome to corporate subscribers at $5 million to $15 million a year. Incyte Genomics has won 500 patents on full-length genes and applied for about 7,000 more. Human Genome Sciences has won patents on 100 genes and filed applications for more than 7,500. Altogether private companies have between them taken out a total of some 1,500 patents.

In March this year President Clinton and UK Prime Minister Tony Blair released a vacuous statement calling for open access to raw gene data. This was followed by a sharp fall in the value of biotech stocks, by as much as 20 percent. It is said that this fall was what persuaded Venter's private Celera Genomics to collaborate with the publicly funded teams headed by Collins and agree to jointly announce completion of the draft genome. Equally disturbed by the share price fall, the Clinton administration has since clarified their position on patents. While raw data will be publicly available, patents on "new gene-based health care products" are entirely acceptable. This means that the widespread patenting of gene sequences and their functions will go ahead—guaranteeing the profits of the biotech companies.

This unprecedented move to prevent the free dissemination of scientific knowledge has incensed the publicly funded teams who have worked on the human genome for the last 10 years. Although Watson grudgingly admitted that Venter had made a contribution to the project, he said, "As for gene patenting? I hate it." John Sulston has declared that he opposes the patenting of genes from a socialist standpoint. He is quoted in the British *Guardian* newspaper saying, "Global capitalism is raping the earth, it's raping us. If it gets hold of complete control of the human genome, that is very bad news indeed. That is something we should fight against." He added, "I believe our basic information, our 'software', should be free and open for everyone to play with, to compete with, to try and make products from."

The reaction by many scientists like Sulston to the unbridled attempt to carve up and privatise vital biological knowledge is laudable. If the present degree of corporate intervention proceeds it will ultimately result in the strangulation of all scientific inquiry. The free development of science, and with it the productive potential of society, is impossible without unimpeded access to knowledge. It is entirely incompatible with the domination of unaccountable private companies that seek to monopolise knowledge in the interests of their own profits.

The huge scientific and technological resources which modern research has produced must be taken out of the hands of the tiny minority of wealthy individuals. They must be placed under public control so that the medical advances that the genome project promises can be made equally available to all.