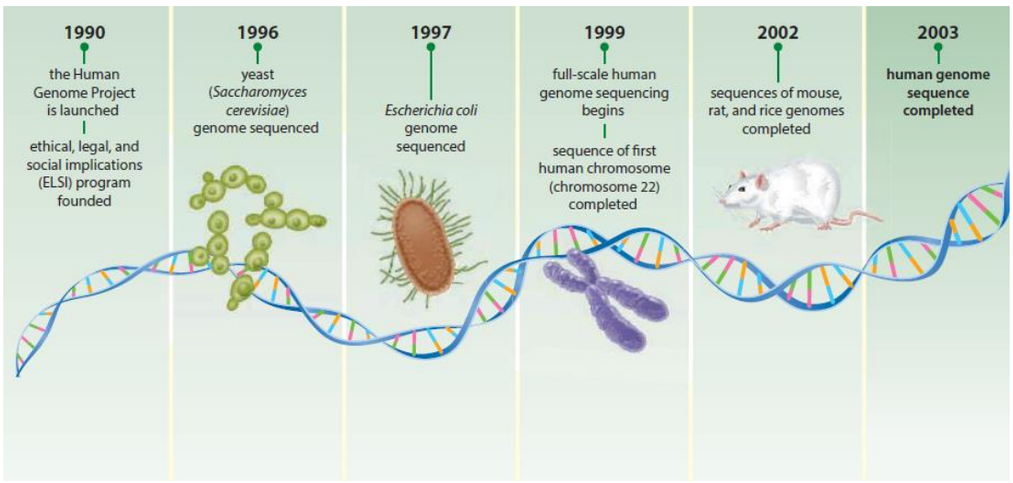
One of the most important scientific achievements in history was made possible by advancements in techniques for analyzing DNA. This was the determination of the DNA sequence of the human genome.

The international Human Genome Project (HGP) was completed in 2003. The main goals of the HGP were to determine, nucleotide by nucleotide, the complete sequence of the human genome and to identify all of the genes.

This genetic blueprint for a human has shown us that

- the human genome consists of about 3 billion base pairs of DNA.
- humans have about 21 000 genes, which is much fewer than scientists had predicted.
- our genes are only about 1.5% of our DNA. Scientists still do not know what most of the remainder of our DNA is used for.



The HGP is complete, but there's still work to do

Though the HGP is finished, analysis of the data from this project will continue for many decades. To complete this huge task, researchers have also studied the genomes of other organisms, including the fruit fly, the mouse, and Escherichia coli—a bacterium present in human intestines.

The DNA sequences of the genomes of thousands of organisms have also now been determined. Studies in non-human organisms help to develop the technology required to handle the large amounts of data produced by the Human Genome Project. These technologies help to interpret the function of newly identified human genes.

Although the Human Genome Project represents a huge advancement in science and technology, its completion has raised many social, legal, and ethical issues.

The original issues identified were: questions of fairness in the use of genetic information; the impact of genetic information on individuals; privacy and confidentiality of genetic information; the impact of the HGP on genetic counseling; the impact of genetic information on reproductive decision-making; the impact of genetic information on medical practice; the uses and misuses of genetics in the past; questions of commercialization; and conceptual and philosophical implications raised by the HGP.

Public Benefits

Some of the most important benefits of these technologies are in the area of human medicine. Studying the human genome, as a whole, offers the potential for developing drugs that are tailored not only to the expression of individual genes associated with particular disorders, but also to the unique genome of a patient and their **genetic profile**.

Studying the differences in gene expression among individuals can help medical researchers understand why certain drugs work better in some people than in others, and why certain people experience side effects from medications. The findings support the development of new techniques for predicting risks and diagnosing medical conditions.

All the research gathered through the Human Genome Project is publicly available. By making this a condition of the project, the scientists were able to share much of what they learned about human genetics. In other areas of genetic research, however, the relationship between public and private information is more complex.

Ownership of Genetic Information

In 2005, the National Geographic Society and the company IBM jointly launched the Genographic Project, a five-year venture to use DNA samples provided by volunteers around the world as a tool to learn more about the migrations of ancient peoples. Projects such as this can contribute valuable information to researchers in many fields. Who owns the genetic information, however? For example, should companies have the right to sell DNA information to other companies without the permission of the people who provided the samples? Should companies that use DNA in medical

research be required to share the results of their work with the individuals or communities whose genetic information was used?

Many people argue that genetic information is a natural resource that belongs to everyone. Other people believe that an individual's genetic information belongs only to this individual. On the other hand, if companies cannot earn a profit from their research, there is little incentive for them to invest in genetic studies. In the world of genetics, where is the boundary between public and private property?

Patenting Organisms and Genes

When Saskatchewan farmer Percy Schmeizer met the international biotechnology corporation Monsanto in court, the case revolved around Monsanto's right to control how farmers use its products. Monsanto is the developer of Roundup-Ready™ Canola, a genetically engineered form of canola that is resistant to the herbicide Roundup™ (also produced by Monsanto). This genetically modified plant, has helped farmers increase their crop yields and save money on herbicide applications. Its use is also changing farming practices, however. Traditionally, farmers save seeds from one year's crop to plant the following year. Farmers also exchange seeds with one another. When plants appear by chance in a farmer's field—for example, as a result of seeds blown by the wind or dropped by passing birds—the farmer has had the opportunity to decide whether to keep or remove them. Farmers who buy seeds from Monsanto must agree not to save any seeds from their crop, but to buy fresh seeds every year. The farmers are not permitted to exchange Monsanto seeds with other farmers. If Roundup-Ready™ Canola appears by accident in their fields, they must remove and destroy the plants. These regulations provide a way for Monsanto to earn a profit from its work.

In the end, the Canadian courts upheld Monsanto's right to patent the Roundup-Ready™ gene and to control the use and distribution of its seeds. Many people remain skeptical about the growing role of global biotechnology companies in the production of crop plants. Some people are concerned about the loss of traditional ways of life and the increasing dependence of farmers on the corporations that patent seeds. Others are concerned about world food production becoming concentrated in the hands of private companies. These companies, however, play an important role in genetics research and in the development of gene technologies and products that have important public benefits. Gene patents offer a way to reward their investment and innovation. The issue of gene patents extends to other fields, including medicine. For example, imagine that a company has identified the location and function of a gene associated with breast cancer. Should the company be allowed to patent the gene? What if this means that the company then has control over all the treatments that affect the function of the gene? Governments, companies, and individuals around the world are grappling with the legal and ethical questions associated with the ownership of genetic information.

1.) What is the current status of the data analysis from the Human Genome Project and what we have learned from it?

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2.) What are some of the social and ethical issues related to the Human Genome Project?

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3.) What is a person's genetic profile? Why are there concerns over ownership of and access to this information?

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