**Biotechnology**

**Definitions, Key Figures, and Major Historical Developments**

**Definitions:**

* **Autoimmune disorders** - A condition which occurs when the immune system mistakenly attacks and destroys healthy body tissue.
* **Biotechnology** - The application of technology to the study or manipulation of living things.
* **Chemical bases** - Adenine (A), Guanine (G), Cytosine (C) and Thymine (T). The genes that make up your body by stringing together to form DNA.
* **Cloning** - To generate a population of genetically identical molecules, cells, plants or animals.
* **Diamond vs. Chakrabarty** - A United States Supreme Court case dealing with whether genetically modified organisms can be patented.
* **DNA (deoxyribonucleic acid)** - The genetic material of most living organisms.
* **DNA fingerprinting** - A test to identify and evaluate the genetic information called DNA in a person's cells.
* **Fermentation** - The anaerobic conversion of sugar to carbon dioxide and alcohol by yeast.
* **Genes** - A region of DNA that controls a hereditary characteristic.
* **Genetics** - The branch of biology that deals with heredity, especially the mechanisms of hereditary transmission and the variation of inherited characteristics among similar or related organisms.
* **Genetic engineering** - A laboratory technique used by scientists to change the DNA of living organisms.
* **Gene therapy** - A technique for correcting defective genes responsible for disease development.
* **Human genome map** - The finished sequence of the human genome.
* **Human Genome Project** - An international scientific research project with a primary goal to determine the sequence of chemical base pairs which make up DNA and to identify and map the approximately 20,000–25,000 genes of the human genome from both a physical and functional standpoint.
* **Immunology** - The study of our protection from foreign macromolecules or invading organisms and our body’s responses to them.
* **Interferon** - A naturally occurring substance that interferes with the ability of viruses to reproduce.
* **Molecular biology** - The study of biology at a molecular level. It chiefly concerns itself with understanding the interactions between the various systems of a cell.
* **Nucleotide** - A nucleotide is the monomer structural unit of nucleotide chains that form the nucleic acids RNA and DNA; in other words, the building blocks for DNA and RNA.
* **Proteins** - Any of a group of complex organic macromolecules that are composed of one or more chains of amino acids.
* **Recombinant DNA** - The joining — or recombining — of two pieces of DNA from different sources, such as from two different organisms.
* **RNA (ribonucleic acid)** - One of the two main types of nucleic acid (the other being DNA), that consists of strands of repeating nucleotides joined in chainlike fashion, but the strands are single (except in certain viruses), and it has the nucleotide uracil (U) where DNA has thymine (T).
* **Somatic cell nuclear transfer** - Or therapeutic cloning involves removing the nucleus of an unfertilized egg cell, replacing it with the material from the nucleus of a "somatic cell" (a skin, heart, or nerve cell, for example), and stimulating this cell to begin dividing.
* **Stem cells** - A class of undifferentiated cells that are able to differentiate into specialized cell types.
* **Thalidomide** - introduced as a sedative drug in the late 1950s, then banned in the early 1960s after it was found to cause deformed limbs in the children of women who took it early in pregnancy.
* **Transgenic** - An organism whose genetic material has been altered using genetic engineering techniques.
* **Xenotransplantation** - The transplantation of living cells, tissues or organs from one species to another, such as from pigs to humans.

**Key Figures:**

**Stanley Cohen and Herbert Boyer** invented the technique of DNA cloning, whichallowed genes to be transplanted between different biological species. Their discovery signaled the birth of genetic engineering.

**Robert Hooke** developed inventions including the spring control of the balance wheel inwatches, and the first reflecting telescope. The first to apply the word "cell" to describe the basic unit of life.

**Edward Jenner** discovered in 1796 that inoculation with cowpox gave immunity tosmallpox, an immense medical breakthrough that has saved countless lives.

**Louis Pasteur** invented pasteurization and discovered the germ theory of disease.

**Walther Flemming** developed a new staining technique in 1879, using synthesizedaniline dyes to identify chromosomes, the structures of the cell nucleus. This allowed observation of *mitosis*, a term first used by Flemming for cell division.

**George Washington Carver** worked on improving soils, growing crops with low inputs,and using species that fixed nitrogen as alternative crops to cotton.

**Peyton Rous** was involved in the discovery of the role of viruses in the transmission ofcertain types of cancer.

**Alexander Fleming** was the bacteriologist who discovered penicillin.

**Henry Wallace** experimented with breeding high-yielding strains of corn (maize), anddeveloped a breed of chicken that at one point accounted for the overwhelming majority of all egg-laying chickens sold across the globe.

**Oswald Avery** proved that DNA — not protein, as many believed at the time — is theagent of heredity.

**Linus Pauling** is the only person who has won two undivided Nobel Prizes, studied andpublished papers on the effects of certain blood cell abnormalities, the relationship between molecular abnormality and heredity, the possible chemical basis of mental retardation, and the functioning of anesthetics.

**James Watson** and **Francis Crick** were discoverers of the DNA molecular structure.

**Norman Borlaug** helped to develop the high-yield, low-pesticide dwarf wheat uponwhich a substantial portion of the world's population now depends for sustenance.

**Paul Berg** performed pioneering work involving recombinant DNA, leading to thedevelopment of modern genetic engineering.

**Kary Mullis** received the Nobel Prize for his development of the Polymerase ChainReaction (PCR), a process that allows the amplification of specific DNA sequences.

**Richard Lower** was concerned principally with two areas of investigation: transfusionand cardiopulmonary function.

**Rachel Carson** is author of Silent Spring, and credited with advancing the globalenvironmental movement.

**Major Historical Developments:**

**Antiquity:**

Humans domesticate crops and livestock.

**4000–2000 B.C.**

* Biotechnology is first used to leaven bread and ferment beer with yeast (Egypt).
* Production of cheese and fermentation of wine begin.

**1590–1608**

* The compound microscope is invented in the Netherlands.

**1663**

* English physicist Robert Hooke discovers existence of the cell.

**1675**

* Dutch scientist Antonie van Leeuwenhoek discovers bacteria.

**1830–1833**

* 1830 — Proteins are discovered.
* 1833 — First enzyme is discovered and isolated.

**1911**

* American pathologist Peyton Rous discovers the first cancer causing virus.

**1914**

* Bacteria are used to treat sewage for the first time in Manchester, England.

**1944**

Canadian-born American bacteriologist Oswald Avery and colleagues discover that DNA carries genetic information.

**1946**

* Scientists discover that genetic material from different viruses can be combined to form a new type of virus, an example of genetic recombination.

**1953**

* The scientific journal *Nature* publishes James Watson and Francis Crick’s manuscript describing the double helical structure of DNA, which marks the beginning of the modern era of genetics.

**The 1950s**

* Interferons are discovered.
* The first synthetic antibiotic is created.

**1963**

●●New wheat varieties developed by American agricultural scientist Norman Borlaug increase yields by 70 percent.

**1966**

* The genetic code is cracked, demonstrating that a sequence of three nucleotide bases (a codon) determines each of 20 amino acids. (Two more amino acids have since been discovered.)

**1972**

* American biochemist Paul Berg publishes the results of his work creating the first DNA molecules that combine genes from different organisms.

**1976**

1. The tools of recombinant DNA (rDNA) are first applied to a human inherited disorder.

**1978**

1. Recombinant human insulin is first produced.

**1980**

1. The U.S. Supreme Court, in the landmark case *Diamond v. Chakrabarty*, approves the principle of patenting organisms, which allows the Exxon oil company to patent an oil-eating microorganism.
2. The U.S. patent for gene cloning is awarded to American biochemists Stanley Cohen and Herbert Boyer.

**1982**

1. The first biotech drug is approved by FDA: human insulin produced in genetically modified bacteria.

**1984**

1. The DNA fingerprinting technique (using PCR) is developed.

**1986**

1. The first recombinant vaccine for humans is approved, a vaccine for hepatitis B.
2. Interferon becomes the first anticancer drug produced through biotech.

**1987**

1. The first field test for a biotech crop — virus-resistant tomatoes — is approved.
2. Frostban, a genetically altered bacterium that inhibits frost formation on crop plants, is field-tested on strawberry and potato plants in California, the first authorized outdoor tests of a recombinant bacterium.

**1990**

1. Chy- Max™, an artificially produced form of the chymosin enzyme for cheese-making, is introduced. It is the first product of recombinant DNA technology in the U.S. food supply.
2. The Human Genome Project — an international effort to map all the genes in the human body — is launched.
3. The first experimental gene therapy treatment is performed successfully on a 4-year-old girl suffering from an immune disorder.
4. The first transgenic dairy cow — used to produce human milk proteins for infant formula — is created.
5. The first insect-protected biotech corn is produced: Bt corn.
6. The first food product of biotechnology is approved in U.K.: modified yeast.

**1994**

●●FDA approves the first whole food produced through biotechnology: FLAVRSAVR™ tomato.

●●The first breast-cancer gene is discovered.

**1997**

●●Dolly the sheep is unveiled in Scotland as the first animal cloned from an adult cell.

**1998**

●●Human embryonic stem cell lines are established.

●●The FDA approves the breast cancer drug Herceptin® (trastuzumab) for patients whose cancer overexpresses the HER2 receptor. It is widely considered the first pharmacogenomic (or personalized) medicine.

●●An early rough draft of the human genome map is produced, showing the locations of thousands of genes.

**2000**

●●A rough draft of the human genome sequence is announced.