People's **D**emocratic **R**epublic of **A**lgeria

Ministry of **H**igher **E**ducation and **S**cientific **R**esearch

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Department of Biology

Scientific English Handout

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FOR THIRD YEAR Biology STUDENTS

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Introduction To Biotechnology

I. Definition of Biotechnology

Biotechnology, as the word suggests, is combination of biology and technology. Biotechnology is the use of technology to use, modify or upgrade the part or whole of biological system for industrial and human welfare.

“Biotechnology is the application of biological organisms, system or process to manufacturing and service industries."

According to the European Federation of Biotechnology, “Biotechnology is the integrated use of biochemistry, microbiology, and engineering sciences in order to achieve technological (industrial) application of the capabilities of micro-organisms, cultured tissue cells.”

Bio-Technology is the use of living things especially cells and bacteria for production of various products for benefiting human beings. It is a combination of various technologies, applied together to living cells, including not only biology, but also subjects like mathematics, physics, chemistry and engineering. Its application ranges from agriculture (Animal Husbandry, Cropping system, Soil science and Soil Conservation, Plant Physiology, Seed Technology etc and Crop Management) to industry (food, pharmaceutical, chemical, byproducts, textiles etc.), medicine, nutrition, environmental conservation, Cell Biology, making it one of the fastest growing fields. Biotechnology is to modify genetic structure in animals and plants to improve them in desired way for getting beneficial products.

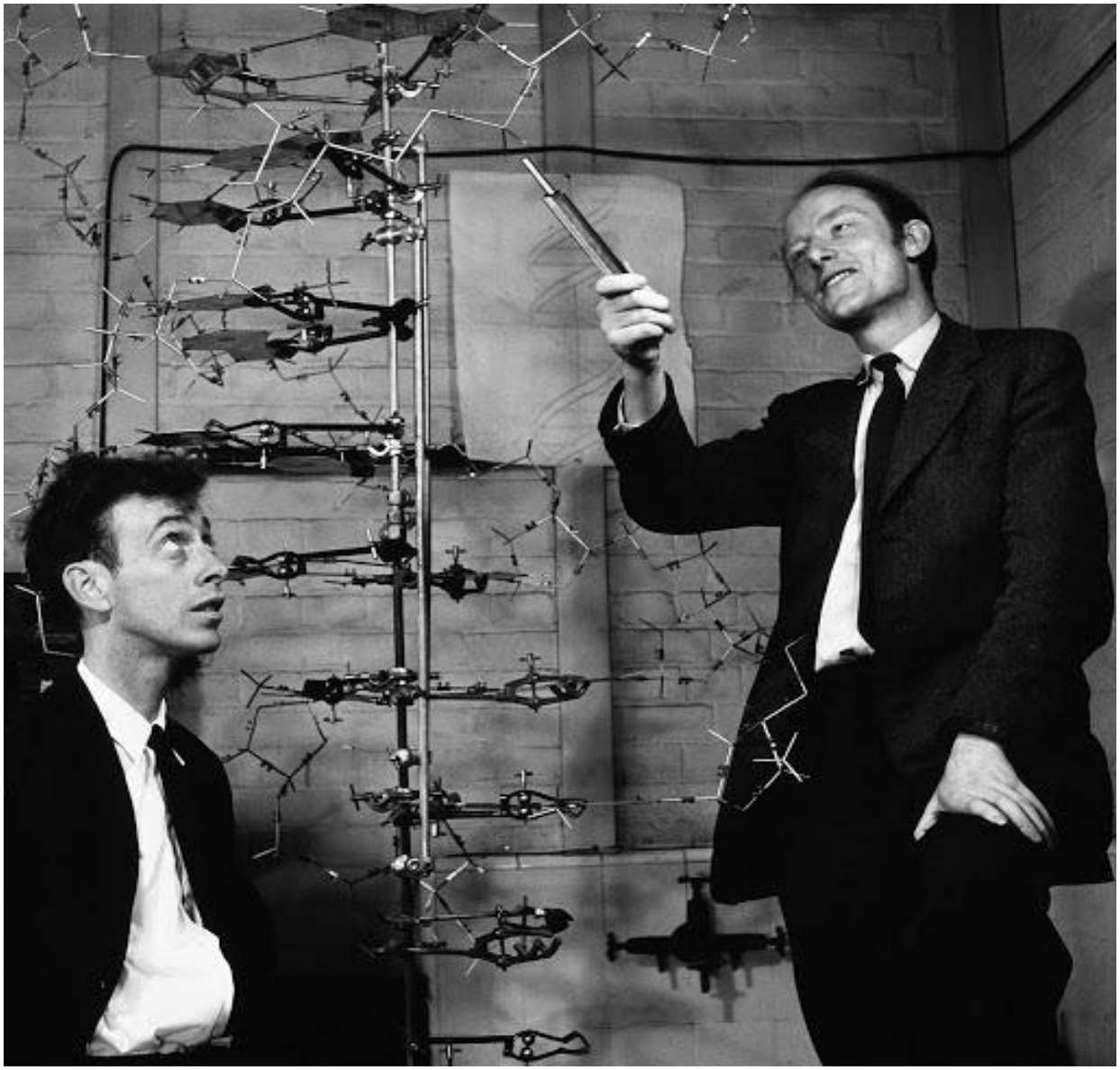
II. History

People were using biotechnology techniques thousands years before but they did not named their working field as biotechnology. The name biotechnology was given by Hungarian engineer Karoly Ereky in 1919 to describe a technology based on converting raw materials into a more useful product.

III. Modern Biotechnology

The Second World War became a major impediment in scientific discoveries. After the end of the second world war some, very crucial discoveries were reported, which paved the path for modern biotechnology and to its current status.

In 1953, JD Watson and FHC Crick for the first time cleared the mysteries around the DNA as a genetic material, by giving a structural model of DNA, popularly known as, 'Double Helix Model of DNA'. This model was able to explain various phenomena related to DNA replication, and its role in inheritance.



Structure of DNA by Watson and Crick (1953)

- Dr. Hargobind Khorana was able to synthesize the DNA in test tube, while Karl Mullis added value to Khorana's discovery by amplifying DNA in a test tube, thousand times more than the original amount of DNA.
- Using this technological advancement, other scientists were able to insert a foreign DNA into another host and were even able to monitor the transfer of a foreign DNA into the next generation.
- **In 1997**, Ian Wilmut an Irish scientist, was successful to clone a sheep and named the cloned sheep as 'Dolly'.
- **In 2003,** the Human Genome Project completes sequencing of the human genome.
- **In 1978,** Boyer was able to isolate a gene for insulin(a hormone to regulate blood sugar levels) from human genome using biotechnology. He then inserted it into bacteria, which allowed the gene to reproduce a larger quantity of insulin for diabetics.

Modern biotechnology provides breakthrough products and technologies to combat rare diseases, reduce our environmental footprint, feed the hungry, use less and cleaner energy, and have safer, cleaner and more efficient industrial manufacturing processes. Currently, there are :

- More than 250 biotechnology health care products and vaccines available to patients, many for previously untreatable diseases.
- More than 13.3 million farmers around the world use agricultural biotechnology to increase yields, prevent damage from pests and reduce farming's impact on the environment.
- More than 50 biorefineries are being built across North America to test and refine technologies to produce biofuels and chemicals from renewable biomass, which can help reduce greenhouse gas emissions.

Biotechnology in Medical

Biotechnology in industry

IV. Fields in Biotechnology

Famous biotechnological fields are:

1. Genetic Engineering:

Genetic engineering, also called genetic modification, is the direct manipulation of an organism's genome using biotechnology. Genes are the chemical blueprints that determine an organism's traits. Moving genes from one organism to another transfers those traits. Through genetic engineering, organisms can be given targeted combinations of new genes, and therefore new combinations of traits that do not occur in nature and, indeed, cannot be developed by natural means. Such an approach is different from classical plant and animal breeding, which operates through selection across many generations for traits of interest.

2. Tissue Culture

Tissue culture, a method of biological research in which fragments of tissue from an animal or plant are transferred to an artificial environment in which they can continue to survive and function. The cultured tissue may consist of a single cell, a population of cells, or a whole or part of an organ. Cells in culture may multiply; change size, form, or function; exhibit specialized activity (muscle cells, for example, may contract); or interact with other cells.

3. Cloning

Cloning describes the processes used to create an exact genetic replica of another cell, tissue or organism. The copied material, which has the same genetic makeup as the original, is referred to as a clone. The most famous clone was a Scottish sheep named Dolly.

There are three different types of cloning:

- Gene cloning, which creates copies of genes or segments of DNA
- Reproductive cloning, which creates copies of whole animals
- Therapeutic cloning, which creates embryonic stem cells. Researchers hope to use these cells to grow healthy tissue to replace injured or diseased tissues in the human body.

V. Impact of Biotechnology

Biotech is helping to heal the world by harnessing nature's own toolbox and using our own genetic makeup. Biotech improves crop insect resistance, enhances crop herbicide tolerance and facilitates the use of more environmentally sustainable farming practices. Biotechnology is:

- Reducing rates of infectious disease;
- Tailoring treatments to individuals to minimize health risks and side effects;
- Using biofuels to cut greenhouse gas emissions
- Decreasing water usage and waste generation
- Using biotech crops that need fewer applications of pesticides
- Developing crops with enhanced nutrition profiles that solve vitamin and nutrient deficiencies;
- Producing foods free of allergens and toxins
- Improving food and crop oil content to help improve cardiovascular health.

So, we can say that Biotechnologists have a broad scope. They can:-

- Help in increasing productivity and in improving energy production and conservation by conducting research and development work.
- Work with chemical processes, genetic engineering, textile development cosmetic development etc...
- Exploit and control the potential of micro-organisms and living systems for the benefit of mankind as by using micro-organisms in the production of drinks, bread, cheese and yogurt.
- Find new ways to design and use antibiotics and pesticides
- Use genetic modification and genome mapping to improve crop production or crop resistance to pests and diseases.
- Combating environmental pollution by developing the use of biosensors for early detection of pollutants. .
- Carry out their work in the laboratories, as it is a scientific research oriented field.
- Help medical professionals in improving in the methods of diagnosis, medicines and vaccinations for diseases.

VI. Drawbacks of Biotechnology

- **Ethics**

Debates over the ethics of biotechnology have been ongoing for decades. The question mostly lies in the morality of various practices employed in research and development. Ethics-related concerns include cloning, xenotransplantation, stem cell research, fetal tissue use, and genetic modification of organisms.

- **Uncertainty**

The biggest concern over biotechnology is the uncertainty in its long term effects. The immediate advantages are clear in many circumstances, but they may directly or indirectly impact the future in unforeseen ways.

- **Cost**

Balancing benefits of biotechnology with cost, especially in the field of medicine, can be one tricky aspect. In terms of investment, the value of biotech products is often miscalculated with failure to include the factors of risk and product development periods, which can ultimately lower the return on profit. Thus far, biotech products are often more expensive and less practical than alternatives.

- Too much altering of crops is destroying tha soul of natural farming
- Genetically modified species can damage the natural ecosystem.

In short, Today's biotechnology is continuing to help improve the way we live, and it helps us do so more responsibly.

The result of biotechnology is a diverse and nearly endless set of practical biotechnology products helping us live longer and healthier lives, have a more abundant and sustainable food supply.

Biotechnology has brought humanity to this level of comfort; the next question is, where will it take us? Biotechnology has both beneficial and destructive potentials. It is, WE who should decide how to use this technology to help humanity rather than to destroy it.

Biotechnology & plants

Yeast responsible for bread & curd formation

Product of biotechnology, The DOLLY sheep

The evolution of biotechnology
over the last century

Year 2020
Biotechnology innovations lead the **fight against the SARS-CoV-2 pandemic.**

Year 2013
The **first bionic eye** is produced in the US giving hope to blind people worldwide.

Year 2010
A group of researchers from the J.Craig Ventere Institute creates the **first synthetic cell.**

Year 1998
A **draft of the human genome map** is created that locates more than 30,000 genes.

Year 1997
Scientists introduce the world to Dolly the sheep, the **first clone of a mammal.**

Year 1983
The **first genetically modified (transgenic) plant** is presented.

Year 1969
An **enzyme is synthesized in vitro** for the first time in history.

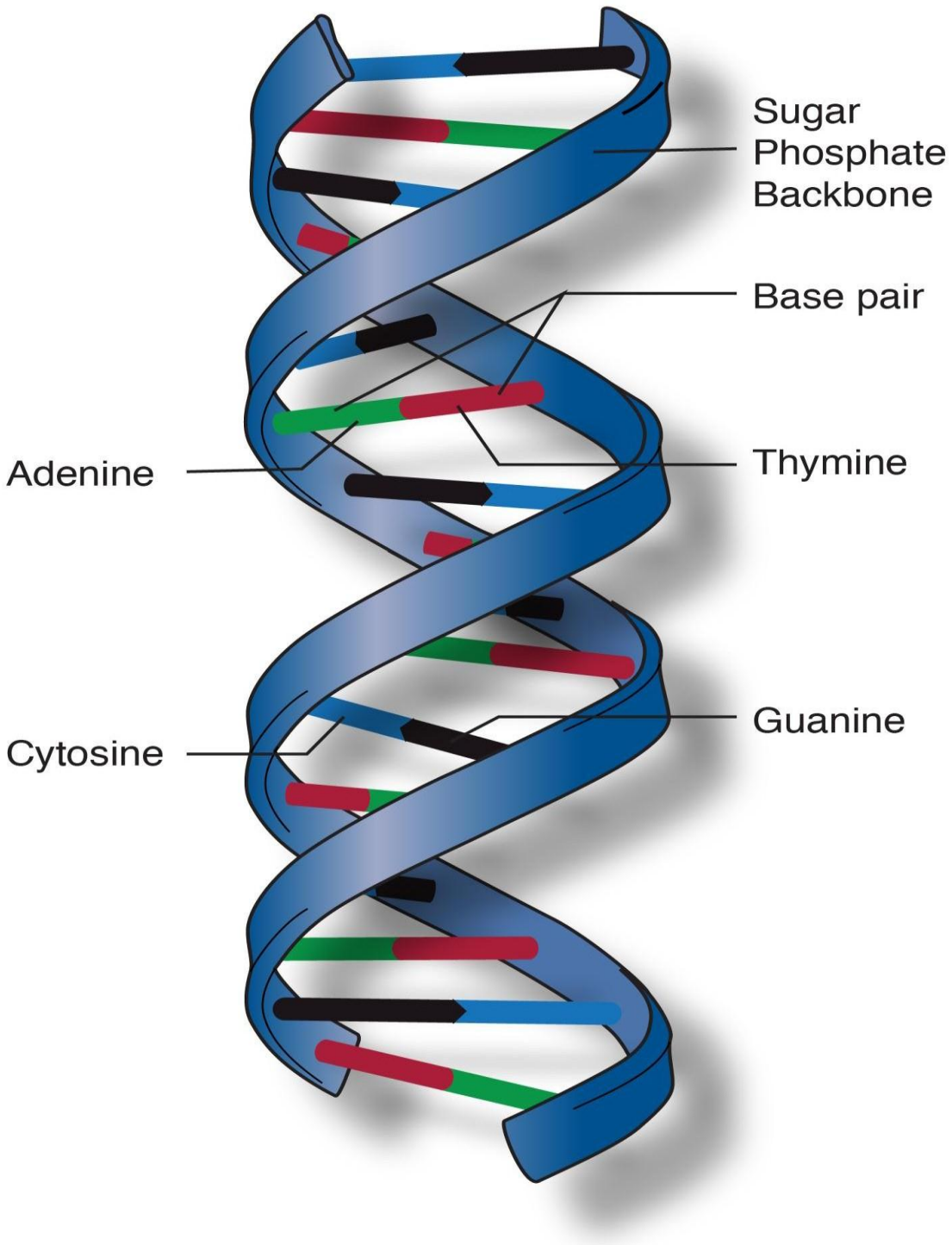
Year 1953
Biologists James Watson and Francis Crick describe the **double helix of DNA.**

Year 1943
Canadian scientist Oswald Theordore Avery discovers that **DNA is the carrier of genes.**

Year 1928
Scottish bacteriologist Alexander Fleming discovers the **antibiotic use of penicillin.**

Year 1919
Hungarian agronomist Karl Ereky coins the **term biotechnology.**

Double helix is the description of the structure of a DNA molecule. A DNA molecule consists of two strands that wind around each other like a twisted ladder. Each strand has a backbone made of alternating groups of sugar (deoxyribose) and phosphate groups. Attached to each sugar is one of four bases: adenine (A), cytosine (C), guanine (G), or thymine (T). The two strands are held together by bonds between the bases, adenine forming a base pair with thymine, and cytosine forming a base pair with guanine.



The Human Genome Project (HGP) was the international, collaborative research program whose goal was the complete mapping and understanding of all the genes of human beings. All our genes together are known as our "genome."