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WHAT IS THE SCIENCE OF BIOTECHNOLOGY?

The word biotechnology is a cross between the Greek words 'bios' (everything to do with life) and 'technikos' (involving human knowledge and skills). The OECD (the Organisation of Economic Co-operation and Development) defines biotechnology as "the application of scientific and engineering principles to the processing of materials by biological agents". More simply, it is using living organisms to make useful products. Production may be carried out by using intact organisms, such as yeasts and bacteria, or by using natural substances (e.g. enzymes) from organisms. Biotechnology makes use of biological systems and processes to manufacture useful products and provide services

Healthcare or red biotechnology refers to a medicinal or diagnostic product or a vaccine that consists of, or has been produced in, living organisms and may be manufactured via recombinant technology (recombinant DNA is a form of DNA that does not exist naturally. It is created by combining DNA sequences that would not normally occur together).

The second major field of red biotechnology is gene therapy, which deals with the diagnosis and treatment of genetic diseases and some other diseases such as cancer. This therapy encompasses the manipulation of genes and the correction of defective genes. During this process genes are inserted, deleted or modified. One of the most common forms of gene therapy is the incorporation of functional genes into an unspecified genomic location in order to replace a mutated and dysfunctional gene. Pharmacogenomics and genetic testing both use techniques of red biotechnology that are individual-specific. In pharmacogenomics the genetic information of the individual is derived, and drugs are developed that can be inserted into that particular individual, whereas in genetic testing different tests are conducted among family members to determine genetic diseases, sex and carrier screening. It can also be used in paternity disputes. Monoclonal antibodies, DNA and RNA probes are used for the diagnosis of various diseases and valuable drugs such as insulin and interferon have been synthesized by bacteria for the treatment of human diseases. DNA fingerprinting is utilized for the identification of parents and criminals. The development of recombinant vaccines for diseases such as human hepatitis B using genetically engineered microbes is one of the list of notable achievements.

Agricultural or green biotechnology encompasses a range of modern plant breeding techniques. For centuries, farmers have tried to improve their crops by means of crossing, relying on the random rearrangement of existing genes between two closely related parent plants. Modern agricultural biotechnology improves crops in more targeted ways. The best known technique is genetic modification, but the

term agricultural biotechnology (or green biotechnology) also covers such techniques as Marker Assisted Breeding, which increases the effectiveness of conventional breeding. Whatever the particular technology used, the crops may be destined for use for food, biomaterials or energy production.

Industrial or white biotechnology uses enzymes and micro-organisms to make biobased products in sectors such as chemicals, food and feed, detergents, paper and pulp, textiles and bioenergy (such as biofuels or biogas). In doing so, it uses renewable raw materials and is one of the most promising, innovative approaches towards lowering greenhouse gas emissions.

Blue biotechnology is based on the exploitation of sea resources to create products and industrial applications. This branch of biotechnology is the most used for the industries of refining and combustion principally on the production of bio-oils with photosynthetic micro-algae.

Yellow biotechnology refers to the use of biotechnology in food production (food industry), for example in making wine (winemaking), cheese (cheesemaking), and beer (brewing) by fermentation. It has also been used to refer to biotechnology applied to insects. This includes biotechnology-based approaches for the control of harmful insects, the characterisation and utilisation of active ingredients or genes of insects for research, or application in agriculture and medicine and various other approaches.

Gray biotechnology is dedicated to environmental applications, and focused on the maintenance of biodiversity and the remotion of pollutants.

Brown biotechnology is related to the management of arid lands and deserts. One application is the creation of enhanced seeds that resist extreme environmental conditions of arid regions, which is related to the innovation, creation of agriculture techniques and management of resources.

Violet biotechnology is related to law, ethical and philosophical issues around biotechnology.

Dark biotechnology is the color associated with bioterrorism or biological weapons and biowarfare which uses microorganisms, and toxins to cause diseases and death in humans, livestock and crops. At its simplest, biotechnology is technology based on biology - biotechnology harnesses cellular and biomolecular processes to develop technologies and products that help improve our lives and the health of our planet. We have used the biological processes of microorganisms for more than 6,000 years to make useful food products. Modern biotechnology provides breakthrough products and technologies to combat debilitating and rare diseases, reduce our environmental footprint, feed the hungry, use less and cleaner energy, and have safer, cleaner and more efficient industrial manufacturing processes

Biotech is helping to heal the world by harnessing nature's own toolbox and using our own genetic makeup to heal and guide lines of research by:

- Reducing rates of infectious disease;
- Saving millions of children's lives;
- Changing the odds of serious, life-threatening conditions affecting millions around the world;

- Tailoring treatments to individuals to minimize health risks and side effects;
- Creating more precise tools for disease detection; and
- Combating serious illnesses and everyday threats confronting the developing world.

Biotech uses biological processes such as fermentation and harnesses biocatalysts such as enzymes, yeast, and other microbes to become microscopic manufacturing plants. Biotech is helping to fuel the world by:

- Streamlining the steps in chemical manufacturing processes by 80% or more;
- Lowering the temperature for cleaning clothes and potentially saving $4.1 billion annually;
- Improving manufacturing process efficiency to save 50% or more on operating costs;
- Reducing use of and reliance on petrochemicals;
- Using biofuels to cut greenhouse gas emissions by 52% or more;
- Decreasing water usage and waste generation; and
- Tapping into the full potential of traditional biomass waste products.

Biotechnology has numerous applications, particularly in medicine and agriculture. Examples include the use of biotechnology in merging biological information with computer technology (bioinformatics), exploring the use of microscopic equipment that can enter the human body (nanotechnology), and possibly applying techniques of stem cell research and cloning to replace dead or defective cells and tissues (regenerative medicine). Companies and academic laboratories integrate these disparate technologies in an effort to analyze downward into molecules and also to synthesize upward from molecular biology toward chemical pathways, tissues, and organs.

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