Introduction to Industrial Biotechnology

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Biotechnology

- Biotechnology, the term was coined by a Hungarian engineer, Karl Ereky.
- Application of biology in industry is called biotechnology.
- Biotechnology is technology based on biology, especially when used in agriculture, food science, and medicine.
- The UN Convention on Biological Diversity has come up with one of many definitions of biotechnology: "Biotechnology means any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use.“
- The fusion of technology with knowledge creates what the world once assumed as miracles and biotechnology can be considered as a perfect example where the knowledge of biology when blended with technology is making the world a better place by enhancing the quality of life and alleviating the human sufferings.

- Effusing life to life, through life, is what biotechnology is about.
- The idea of modifying products to suit specific applications and engineer them to make more viable, inspired man to reach the pinnacle where Biotechnology stands today.
- Biotechnology has touched almost every aspect of human life and has carved its niche too.
- Biotechnology dealing with medical and health care is termed as **Red biotechnology**.
- It is **Green biotechnology**, when it concerns about agricultural processes and
- **White biotechnology** when comes to industrial processes.

History

- ‘Dolly’, the cloned sheep, human genome project, genetically modified crops, medical science breakthroughs, drew the attraction of the world towards biotechnology and thus it carries a misconception of being a recent advent.

- However, the fact is that it is as old as our civilization.

- If you clearly understood the definition of biotechnology given above, you can figure out that when you convert milk to yogurt or cheese it is nothing but biotechnology, where a living organism (bacteria), makes the product.

- Agriculture, in a way is biotechnology too.
- Selective planting of crops and breeding of animals, has been practiced since Neolithic revolution.
- Sumerians and Babylonians in 6000 BC used yeast to make beer.
- The process of fermentation, a natural process based on biological activity of single celled microorganism was first used by Egyptians to bake breads and make wine.
- The progress of biotechnology in late eighteenth century and dawn of nineteenth century include some crucial discoveries like vaccination, crop rotation to increase yield and land use.
- Discovery of microorganisms, Mendel's work on genetics, Darwin's theory of natural selection, Pasteur's work on communicable diseases dates back to the late nineteenth century.

- Biotechnology made its industrial and agricultural presence at the beginning of twentieth century.
- Production and use of Bio fuel was encouraged during World Wars.
- In 1928, Alexander Fleming discovered penicillin.
- In 1953, structure of DNA was proposed, that stirred the research in molecular biology and genetics.
- With the discovery of restricted enzyme, it became possible to insert foreign genes to bacteria in 1973.
- This paved way for the revolutionary technique ‘Recombinant DNA’.
- This technique enabled production of human insulin from bacteria and is also considered as the birth of modern biotechnology.

Current trends

- Traditional pharmaceutical drugs are small chemicals molecules that treat the symptoms of a disease or illness - one molecule directed at a single target.
- Biopharmaceuticals are large biological molecules known as proteins and these target the underlying mechanisms and pathways of a malady; it is a relatively young industry.
- They can deal with targets in humans that are not accessible with traditional medicines.
- A patient typically is dosed with a small molecule via a tablet while a large molecule is typically injected.
- Small molecules are manufactured by chemistry but large molecules are created by living cells: for example, - bacteria cells, yeast cell, animal cells.

- Modern biotechnology is often associated with the use of genetically altered microorganisms such as E. coli or yeast for the production of substances like insulin or antibiotics.
- It can also refer to transgenic animals or transgenic plants, such as Bt corn. Genetically altered mammalian cells, such as Chinese Hamster Ovary (CHO) cells, are also widely used to manufacture pharmaceuticals.
- Another promising new biotechnology application is the development of plant-made pharmaceuticals.
- Biotechnology is also commonly associated with landmark breakthroughs in new medical therapies to treat diabetes, Hepatitis B, Hepatitis C, Cancers, Arthritis, Haemophilia, Bone Fractures, Multiple Sclerosis, Cardiovascular as well as molecular diagnostic devices than can be used to define the patient population.
- Herceptin, is the first drug approved for use with a matching diagnostic test and is used to treat breast cancer in women whose cancer cells express the protein HER2.

White Biotechnology

- Industrial or White Biotechnology is the application of biotechnology for the processing and production of chemicals, materials and energy.
- White biotechnology uses enzymes and micro-organisms to make products in sectors such as chemistry, food and feed, paper and pulp, textiles and energy.
- White Biotechnology could provide new chances to the chemical industry by allowing easy access to building blocks and materials that were only accessible before via intricate routes or not at all.

- Biotechnology will have a considerable impact by using biomass as an alternative to fossil resources for the production of biochemicals such as biofuels and biopolymers.
- The use of renewable raw materials as alternative feedstock will reduce consumption of the limited fossil resources and lower European dependence on imports.
- Consequently this could contribute to our meeting of the Kyoto protocol targets for reductions in carbon dioxide emissions because of a more favorable CO2 balance.
- At the same time, this technology may also boost the rural economy by providing new markets for agricultural crops and through the development of integrated biorefineries in farming areas.
- It needs to be guaranteed that raw materials can be bought at the cheapest price all over the world.

- White biotechnology processes can help to make industrial manufacturing processes more environmentally friendly.
- They are performed in a contained environment, and have the potential to produce high yields of specific products with low energy use and minimal waste generation.
- The potential of white biotechnology is very promising and it is expected that white biotechnology will be a key technology contributing to the achievement of the dynamic knowledge-based economy in the world.
- World has recognized the importance of white or industrial biotechnology for their industrial base and have already put in place well-funded long-term strategic plans.
- The stakeholders recognize that this Vision will only become a reality with the appropriate enabling political and economical environment stimulating research and innovation, entrepreneurship, product approval and market development.
- Such a supporting environment will help the industries to switch and produce eco-efficient products - when economically feasible – and benefit from the broad potential of white biotechnology to the industry.
- In this type of activity it is of paramount importance to carry out extensive and careful life cycle analysis of the new developments and to compare it with alternative ones, since only a real eco-efficient technology can be implemented in a sustainable fashion.