

Biotechnology importance and application

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Biotechnology! Biotechnology! Biotechnology!!! Seems like this word has become a buzz word nowadays. You will hear this word from classroom to cafeterias. It can be commonly found in newspapers, magazine, journals and all sorts of media outlets, which include print media to electronic media. People are organizing huge meetings, conferences and workshops on biotechnology, where participants come from different arenas like science, industry, administration, social work etc. As days pass by, it seems like the way our life is heading, biotechnology will become an essential component of our life. The day is not far from reality, that we cannot fathom our life without biotechnology. If, I have to say in simple words it can be said “ we wake up with biotechnology and we go to bed with biotechnology”.

The word “ biotechnology” has received its importance and significance in last two decades, which is just unprecedented. Probability and possibilities behind this kind of attention towards biotechnology is due to its unlimited potential to serve and benefit humanity. So far biotechnology has touched our life in all aspects like our food, health and animals. We have also noticed the importance and potential of biotechnology towards the improvement of our environment for a better living along with its capability to meet the need of our depleting energy reserves of fossil fuels, through Bio-fuels as all these things are becoming limited for their availability to ever increasing population. In simple terms our life starts with biotechnologically developed tooth-paste, to driving our car based on biotechnologically developed fuels and we retire for the day with bed-side medicine either to keep us healthy or control chronic disease like diabetes to make our life better. Rationally, biotechnology word has been derived from two simple terms of science i. e.,

Biology and Technology. If we try to decipher these words, it simply suggests in lay-man's term that it is the technology which is making our life convenient and comfortable with the employment of biological resources. Question still remains, that is Biotechnology such a new branch of science? A real fact is that biotechnology has been in practice even long before the term "Biotechnology" was itself coined. It is interesting to learn and understand that how and when biotechnology evolved.

Biotechnology: What does it mean?

The term biotechnology was used for the first time by Karl Erkey, a Hungarian Engineer in 1919. Was it the start of biotechnology, answer is no! Later on biotechnology was defined by different scientists. As per one definition biotechnology is "Application of principles of engineering and biological science to create new products from raw materials of biological origin, e. g. vaccines or food." Or in other words it can also be defined as "the use of living organism/s or their product/s to modify or improve human health and human environment". Apart from their beneficial applications, biotechnological principles can be used for destruction too, the best example to explain this is "bioterrorism". Biotechnology from fiction, myth and reality can be simply understood by watching a movie entitled as "Frankstein" where, a human known as Frankstein was created by a physician who became a reason for his destruction itself.

Biotechnology: A Basic Requirement

As we know that the technological application of biological material is considered as biotechnology. If, we want to understand, how does it work? Then it is essential for us to know what is the starting point or material for <https://assignbuster.com/biotechnology-importance-and-application/>

biotechnology or biotechnological applications. In general biotechnology uses either living material or biological products to create new products for use in various pharmaceutical, medical, agricultural, environmental applications with an ultimate goal to benefit humanity e. g., Production of recombinant proteins, resistant crops, vegetables, higher milk producing animals, etc.

Biotechnology and its various stages of development:

There are various stages of development of biotechnology to meet the various needs of humans. Its development was basically based on the observations and applications of these observations to practical scenarios. The complexity of system and evolution has increased with time, which is based on the employment of improved technological advancements along with the better understanding about various life-science principles. If we study systemically the evolutions of biotechnology up to its current stages, it can be divided into 3 different stages or categories 1) Ancient Biotechnology, 2) Classical Biotechnology, and 3) Modern Biotechnology. Some important discoveries related to biotechnology has been shown in Fig 1.

Ancient Biotechnology (Pre-1800)

Most of the developments in ancient period can be grouped as the discoveries or development before the years of 1800. If we study all these development, we can simply conclude that all these inventions are based on the common observation of nature, which could be put to the test for the betterment of human life at that point of time.

Food, cloth and shelter are the most important basic needs of a human being whether s/he lived in ancient period or modern period like nowadays. Only thing that has changed is their type and origins. Food has been an inevitable need since the existence of man as well as for the existence of human being. Early man used to eat raw meat, whenever they found a dead animal, However, during harsh weather seasons, there was a paucity of food, so as it is said necessity is the mother of invention, which led to the domestication of food product which in other words can be classified as Agriculture. In ancient time human explored the possibilities to make available food by growing them near their shelter so that the basic need of food could be met. They brought seeds of plants (mostly grains) and sowed them near his shelter, where they understood the importance of water, light and other requirements for optimal growth of food plants. The similar principles and need also led to start domestication of different wild animals which helped them to improve their living condition and now to satisfy their hunger. They need not go for hunting; as animals are available to them at closer proximity as well as they need not to deal with the dangerous condition of hunting, too. Domestication of wild animal was the start of observation, implication and application of animal breeding. Certainly we can say that these were the initial times for the evolution of farming, which led to another need like development of methods for food preservation and storage, where they used cold caves to preserve food for long-term storage as well as evolution for the pots for the storage of food products in the form of leather bags, clay jars, etc.

After domestication of food crops and wild animals, man moved on to other new observations like cheese, curd, etc. Certainly, cheese can be considered as one of the first direct product (or by-product) of biotechnology, because it was prepared by adding rennet (an enzyme found in the stomach of calves) to sour milk which is possible only by exposing milk to microbes (although this understanding was not there at that time). Yeast is one of the oldest microbes which have been exploited by humans for their benefit. Yeast has been widely used for bread making, vinegar production and other fermentation processes which include production of alcoholic beverages like whisky, wine and beer. Vinegar has its significant importance because of its low pH, vinegar is capable of preventing growth of certain microbes, and therefore, vinegar can be used successfully for food preservation. The discoveries and benefits of these observations led people to work on further improvement of the process. Fermentation was such a powerful tool to improve their living conditions, even though they were ignorant about the principle behind it.

One of the oldest examples of crossbreeding for the benefit of humans is Mule. Mule is an offspring of male donkey and a female horse. People started using mule for transportation, carrying loads and for farming when there were no tractors and trucks. Mule is easier to obtain than Hinny (offspring of a male horse and a female donkey). Mule and Hinny both have a chromosome number 63 unlike horse (64) and donkey (62).

Classical Biotechnology

The second phase for the evolution and development of biotechnology can be called as Classical Biotechnology. This phase did exist from 1800 to <https://assignbuster.com/biotechnology-importance-and-application/>

almost mid of 20th century. During this period various observation started pouring in with scientific evidences, they were all very helpful towards solving the puzzle/s of biotechnology. Each and every contribution from different individuals helped to solve the puzzle and pave the path for new discoveries.

The basics for the transfer of genetic information are core to biotechnology. This was for the first time deciphered in plant i. e., *Pisum sativum*, commonly known as a Pea plant. These observations were deciphered by Gregor John Mendel (1822-1884), an Augustinian Monk. Mendel for the time presented laws of inheritance to the Natural Science Society in Brunn, Austria. Mendel proposed that invisible internal units of information account for observable traits, and that these “ factors”-later called as genes are passed from one generation to the next. But the sad part of the story is that Mendel failed to get the due recognition for his discovery for almost 34 year later than his death, when other scientist like Hugo de Vries, Erich Von Tschermak, and Carl Correns validated Mendel’s in 1900. The reason why Mendel’s work remained unnoticed for such a long period of time was, at the same time the Charles Darwin’s Theory of Evolution was so talked about that it shadowed the significance of work done by Mendel.

Almost the same time Robert Brown had discovered the nucleus of cells, while in 1868 Fredrich Miescher, a Swiss biologist reported nuclein, a compound that consist of nucleic acid that he extracted from pus cells i. e., White Blood Cells. These two discoveries became the basis of modern molecular biology for the discovery of DNA as genetic material and role of DNA in transfer of genetic information. In 1881, Robert Koch, a German

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physician described the bacterial colonies growing on potato slices (First ever solid medium). Walter Hesse, one of the co-workers in Koch's laboratory discovered agar when he asked her wife what kept the jelly solid even in high temperature of summer. Since then nutrient agar became the most acceptable and useful medium to obtain pure microbial culture as well as for their identification. In 1888, Heinrich Wilhelm Gottfried Von Waldeyer-Hartz, a German scientist coined the term Chromosome, which is considered as an organized structure of DNA and protein present in cells or a single piece of coiled DNA containing many genes, regulatory elements and other nucleotide sequences. Other discoveries during this period were vaccination against small pox and rabies developed by Edward Jenner a British Physician and Louis Pasteur a French Biologist.

By this time the development and growth of biological sciences seemed to be reaching to the exponential phase. Principle of genetics in inheritance were redefined by T H Morgan who has shown inheritance and role of chromosome in inheritance using Fruit flies i. e., *Drosophila Melanogaster*. This landmark work of T H Morgan was named as “ The theory of the Gene” in 1926. Before the publication of Morgan's work, in 1909 the term “ Gene” had already been coined by Wilhelm Johannsen (1857-1927), who described “ gene” as carrier of heredity. Johannsen coined terms genotype and phenotype. ‘ Genotype’ was meant to describe the genetic constitution of an organism, while ‘ Phenotype’ was meant to describe actual organism. By this time genetics started gaining its importance, which led to start of Eugenic Movement in USA in 1924. As a result this in 1924 U. S. Immigration Act was

used to restrict the influx of poorly educated immigrants from Southern and Eastern Europe on the grounds of their suspected genetic inferiority.

Almost the same time in Britain, Alexander Fleming a physician discovered antibiotics, when he observed that one microorganism can be used to kill other microorganism, a true representation “ divide and rule” policy of humans. Fleming noted that all bacteria (staphylococci) died when a mold was growing in petri-dish. Later he found out “ penicillin” the antibacterial toxin from the mold *Penicillium notatum* could be used against many infectious diseases. Fleming wrote, “ When I woke up just after dawn on September 28, 1928, I certainly didn’t plan to revolutionise all medicine by discovering the world’s first antibiotic, or bacteria killer”. As a matter of fact vaccine and antibiotics turned out to be the best savior of humanity. Can we attribute to these two discoveries for ever increasing population as well ever ageing population of the world?

Modern Biotechnology

The Second World War became a major impediment in scientific discoveries. After the end of Second World War some very crucial discoveries were reported which paved the path for the modern biotechnology and its current status. In 1953, JD Watson and FHC Crick for the first time cleared the mysteries around 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 phenomenon related to DNA replication and its role in inheritance. Later, Jacob and Monad has given the concept of Operon in 1961, while Kohler and Milestein in 1975 came up with the concept of cytoplasmic hybridization and produced first ever monoclonal antibodies.

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By this time it seemed like world's scientific community had almost all the basic tools available to them for their applications along with majority of basic concepts have been elucidated, which has fast forwarded the path for important scientific discoveries. 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 thousands time 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 foreign DNA in to next generation. The advent of HIV/AIDS as a deadly disease has helped to improve tremendously various tools employed by life-scientist for discoveries and applications in various aspects of day-to-day life. In the mean time Ian Wilmut an Irish scientist was successful to clone an adult animal using sheep as model and he named the cloned sheep as " Dolly". Craig Venter in 2000 was able to sequence Human Genome; the first publically available genome is from JD Watson and Craig Venter, itself. These discoveries have unlimited implications and applications. In 2010, Craig Venter was successful to demonstrate that synthetic genome can replicate autonomously, should that be considered as a new possibility for creating a life in test-tube, which can be planned and designed by a human using pen, pencil, computer and bioinformatics as a tool.

Biotechnology has brought humanity to this levels of comfort, the next question is where it will it take us? Biotechnology has both beneficial and destructive potential. It is WE who have to decide that how to use this technology, so it should be there to help humanity rather than destroying it.

Legend to Figure

Some of the important biotechnology discoveries have been plotted in this graph, with a possibility for its unlimited growth in future.