BIOTECHNOLOGY IN EVERYDAY LIFE

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Biotechnology is an essential, challenging and interesting industry to be a part of and helps to lead the way for how we live healthy and prosperous lives. Biotechnology plays a huge role in our day to day life, from the clothes we wear, the food we eat to how we produce them, the medicine we take to treat our bodies, and even the fuel we use for our vehicle. Biotechnology is a field which is growing rapidly, but we must realize that it's just a tip of an iceberg that has been revealed and is yet to be explored further.

What is Biotechnology?

Biotechnology means, genetic manipulation of living things by human beings to make most desirable products by using various techniques. It is the use of biology to develop new products, methods and organisms intended to improve human health and society.

Biotechnology, commonly referred as biotech has been here for very long, since the beginning of civilization and is a multidisciplinary field that involves the integration of natural sciences and engineering sciences in order to attain better application of organisms, cells, parts thereof and molecular analogues for products and services. (**IUPAC Goldbook., 2014.**)

The American Chemical society defines biotechnology as the application of biological organisms, systems or processes by various industries to learn about the science of life and the improvement of the value of materials and organisms such as pharmaceuticals, crops and livestock.(**Biotechnologyportal.acs.org, 2013*).***

The term Biotechnology was coined by Karl ereky in 1919.

Uses of Biotechnology in everyday life

Biotechnology is a swiftly evolving field with significant potential to tackle emerging global challenges and improve the quality of life for people around the globe.

Biotechnology has created a significant impact on many areas of society, from agriculture to medicine. The applications of biotechnology are diverse and have led to the development of essential products like life saving drugs, biofuels, genetically modified crops with increased benefits, developing biodegradable plastics and using microorganisms to clean up contaminated sites.

In today's world it has become integrated with our lives and has proved to make our lives easier and aids to make the best from the least. Biotechnology has become a part of our day to day life in many ways which includes the following,

1. **Biofuel**

Biofuels are alternative sustainable fuels obtained from plants and plant-derived products. Biofuels are mainly used for vehicles. There are two main types of biofuels.

Bioethanol is mainly produced by the sugar fermentation process of cellulose and is used as a wise substitute for petrol. It is mostly derived from maize, tapioca, sugarcane and other starch sources.

On the other hand, biodiesel is mainly produced from oil crops such as palm, rapeseed, jatropha, soybean etc. It is used as a substitute for diesel in diesel vehicles and engines run by diesel. This proves to be more ecofriendly than the former one and is found to emit less unburned carbon.

Biofuel is generally used in vehicles in a blended form with petrol and diesel. This way of using biofuels are useful in reducing the carbon level emission. Thereby, enabling to have a strict control on greenhouse gas emissions. Biotechnology can be used in biofuel production by either developing more efficient enzymes to break down solid biomass or engineering robust microbes that are capable of producing usable biofuel directly. In either way, it proves to improvise our life.

Biotechnologies for first-generation biofuels

First generation biofuels are produced from edible energy crops such as sugar – based crops (i.e, sugarcane, sugar beet and sorghum), starch based crop (i.e, corn, wheat and barley) and oil based crops (i.e, rapeseed, sunflower and canola).

The plant varieties which are being used for first- generation biofuel production have been selected for their agronomic traits relevant for food and/or feed production and not for characteristics that favor their use as feedstocks for biofuel production. Biotechnology helps to speed up the selection of varieties that are more suitable for biofuel production with increased biomass per hectare, increased content of oil (biodiesel crops) or fermentable sugars (ethanol crops), or improved processing characteristics that facilitate their conversion to biofuels. The field of genomics, which is the study of all genetic material of an organism (its genome) plays an important role. Genome sequences of several first- generation feedstocks, such as maize, sorghum and soybean, have already been studied and published. Aside from genomics, certain other biotechnologies such as marker assisted selection and genetic modification also prove to be useful.

Fermentation of sugar is pivotal in the production of ethanol from biomass. The most commonly used industrial fermentation micro-organism is the yeast, *Saccharomyces cerevisiae*. It cannot directly ferment starchy material, such as maize starch. The biomass must first be hydrolysed to fermentable sugars using enzymes called amylases. Many of the current commercially available enzymes, including amylases, are produced using genetically modified micro-organisms. Research continues on developing efficient genetic yeast strains that can produce the amylases themselves, so that the hydrolysis and fermentation steps can be combined.

Biotechnologies for second-generation biofuels

Second generation biofuels refer to energy produced from non – food crops including agricultural residues, forest residues and solid wastes.

Lignocellulosic biomass consists mainly of lignin, polysaccharides cellulose (consisting of hexose sugars) and hemicellulose (containing a mix of hexose and pentose sugars). In comparison with the production of ethanol from first-generation biofuels, the use of lignocellulosic biomass in producing biofuel is more complicated because the polysaccharides are more stable and the pentose sugars are not easily fermentable by *Saccharomyces cerevisiae*. In order to convert lignocellulosic biomass into biofuels, the polysaccharides has to be hydrolysed first by using either acid or enzymes. A number of biotechnology-based approaches are being used to find solution for such problems, including the development of strains of

Saccharomyces cerevisiae that can easily ferment pentose sugars, the use of alternative yeast species that can naturally ferment pentose sugars, and the engineering of enzymes that can break down cellulose and hemicellulose into simple sugars.

Apart from agricultural, forestry and other by-products, the chief source of lignocellulosic biomass for second- generation biofuels is most likely to be from “dedicated biomass feedstocks”, such as certain perennial grasses like switch grass, miscanthus, bamboo, sweet sorghum, tall fescue, kochia, wheat grass and forest tree species. Efforts are being made to use genomics, genetic modification and other biotechnologies as tools to produce plants with desirable characteristics for second-generation biofuel production, for example plants that produce less lignin which cannot be broken down to liquid biofuel, that produce enzymes themselves for cellulose and/or lignin degradation, or that produce increased cellulose or overall biomass yields.

Plant Biotechnology and Biofuels

The US Department for Agriculture (USDA) has estimated that one billion dry tons of biomass per year are needed to replace 30% of transportation fuels with biofuels (**USDA and DOE, 2005**). According to an USDA study, this amount of biomass could be produced by 2050, with feasible technological advances while still meeting food, fibre and export demands. The biomass would be mostly derived from crop residues and from the cultivation of perennial energy crops.(**Ragauskas, A.J., et al., 2006).**

The challenge for biotechnology is therefore to substantially increase crop yield, and at the same time develop crops with a suitable set of chemical and physical traits for energy production.

i. **Increasing Plant yield**

Plant growth can be improved by increasing the efficiency of light capture during photosynthesis. The most fruitful approaches have involved introducing genes from photosynthetic bacteria into plants, without affecting the level of activity of plant-specific genes. Another booming biotech application was the manipulation of genes involved in the metabolism of nitrogen which is an essential element in proteins and DNA.

ii. Raising plant protection to abiotic stress

Abiotic stress is the primary cause of crop loss worldwide, reducing average yields by over 50%. Further losses incur due to attack by pests and pathogens. Developing crops with improved resistance to stress, and equipping plants with enhanced resistance to pests and pathogens, are therefore at the center of numerous crop improvement initiatives, both by conventional breeding and by novel biotechnological methods (**Vinocur, B. & Altman, A., 2005).** For example, transgenic rice over-expressing the chloroplastic glutamine synthase gene (GS2) shows increased tolerance to high soil salinity. Such initiatives will have a fundamental impact on plant productivity.

2. Vaccines

Vaccine is a biological product which is administered to individuals to strengthen their immune system against the attack of pathogens which can be bacteria, virus or fungi. Generally vaccines are made of a certain pathogen that has been weakened or antigen components of that particular pathogen, or its killed variant or usually a protein found on the surface of a cell or a viral particle which can be recognized and attacked by the antibody in the immune system.

Vaccines are introduced into the body's immune system to fight pathogens when they attack. It is achieved by introducing the weakened version of the disease causing pathogen into the body and sensitizing the defence system of our body. The weakened pathogens are extracted by using the biotechnological techniques like growing the antigenic proteins in genetically engineered crops.

The development of vaccines are closely related to biotechnology. The techniques of modern biotechnology such as genetic engineering and cell culture aids in an effective, quick and economical development of vaccines. Recombinant DNA technology enables antigen of a certain pathogen to be produced in a host cell which is relatively non pathogenic (e.g. *E. coli* or yeast), so that a direct harvest from the original pathogen is not required.

Commercial vaccine production also implements an aspect of biotechnology called bioprocess which includes upstream processes and downstream processes .

For protein-based vaccines, the coding gene of the protein can be inserted into the plasmid and transformed into the host cell (e.g. *E.coli* or mammalian cells) which can then express that gene into protein. The protein produced is then harvested, purified and formulated into vaccine. The production of protein based vaccines are relatively more complex as it requires extra effort and applications, but it can produce a relatively higher titre of antigens and increased efficacy in comparison to the other.

The traditional vaccines are either killed microorganism or attenuated ones which generates immune response in body after their inoculation. Biotechnology has revolutionized the field of biomedicines with its remarkable improvements and innovations. Recombinant Hepatitis B surface antigen (HBsAg) was the first recombinant vaccine cloned and expressed in *Saccharomyces cerevisiae* and currently is being used as vaccine against HBV around the globe. Deoxyribonucleic acid (DNA) vaccines are basically genetically engineered DNA that when injected produce antigen and induce strong immune response. Messenger RNA (mRNA) vaccine, reverse vaccinology and reverse genetics platforms are utilized in various development of vaccines and has shown promising results. Biotechnology has transformed the field of immunization and its utmost demand of time to put efforts in research to find cure for already existing and other upsurging diseases for the betterment of mankind.

i.After emergence of Recombinant DNA Technology is a sub-field of Biotechnology remarkable positive impacts were observed on human health. From production of safe proteins, antibodies and gene therapy RDT revolutionized different aspects of biological studies [**Khan S et al., 2016**].

Recombinant Sub-Unit Vaccine

After the discovery of gene cloning new doors were open in the field of therapeutics. It is a useful technique by cloning antigenic protein (fragment) or its sub-type and clone it animal or other expression system to transcribe it. The purified expressed protein is administered in body to induce immune system [**Burnette W N. 1991]**

Recombinant Hepatitis B surface antigen (HBsAg) was the first recombinant vaccine developed by Maurrice Hellmen and his team using cloning techniques. HBsAg was purified from serum of infected HBV carrier serum and then clone and expressed *Saccharomyces cerevisiae* (Baker,s Yeast). The HBsAg sub-type adw was expressed and purified from yeast culture. The vaccinated animals (monkeys, chimpanzee and mice) were protected from disease after HBV adw and ady subtype challenge **[Mc Aleer etal., 1984**].

DNA Vaccines

Deoxyribonucleic acid (DNA) vaccines are basically genetically engineered DNA that when injected produce antigen and induce strong immune response. The gene responsible for immunogenic response is identified, cloned and then expressed in host by directly injecting it. DNA vaccines have higher immune response inducing potential as compared to conventional live attenuated or killed vaccine [**Alarcon J B etal., 1999**).

In 1990 DNA vaccines were coined for the first time when plasmid DNA was injected in muscle or skin and induce immune response against viral along with non-viral antigens. DNA vaccines were thought to hold very promising future [**Tang D c etal., 1992**] .

mRNA vaccines

mRNA vaccines work by introducing a piece of mRNA that corresponds to a viral protein. Individuals who gets vaccinated with an mRNA vaccine are not exposed to the virus, nor can they become infected with the virus by the vaccine. The mRNA introduced aids in the production of viral protein. As part of the normal immune response, the immune system recognizes the proteins as foreign antigen and generates specialized proteins called antibodies. Antibodies protect the body against infection by promptly recognizing individual viruses or other pathogens, attaching to them, and marking the pathogens for destruction. The antibodies once produced against a particular pathogen will be present in the body for lifetime which helps in encountering the second attack of the infection more effectively and protects the body from morbidities. These antibodies are called as memory cells. These memory cells are responsible for the swift reaction against the infection and the destruction of the pathogen.

3. Bioremediation

Bioremediation is a branch of biotechnology that engages the living organisms, like microbes and bacteria, in the removal and processing of contaminants, pollutants, and other toxins from soil, water, and other environments.

Bioremediation is based and focuses on stimulating the growth of certain microbes that utilize contaminants like oil, solvents, and pesticides as sources of its food and energy. These microbes convert the contaminants into harmless by-products thus creating a safer environment.

It requires a combination of the important factors like right temperature, nutrients, and foods. The absence or relative deficiency of these elements may prolong the cleanup of contaminants thus making it less effective.

The time involved in the process of bioremediation is variable and may vary anywhere from several months to years for the completion of the task. The factors which has influence over the process includes the size of the contaminated area, temperature, the concentration of contaminants, soil density, and whether bioremediation will occur in-situ or ex-situ.

The three types of bioremediation are:

i.Biostimulation

The process is initiated by stimulating the bacteria which explains the name itself. The contaminated soil is prepared for the process by first mixing it with special nutrient substances including other vital components either in the form of liquid or gas which stimulates the growth of microbes thus resulting in efficient and quick removal of contaminants by the microbes . Microbes are stimulated to begin the remediation process via chemicals or nutrients that can activate them.

ii) Bioaugmentation

In certain circumstances microorganisms are required to extract the contaminants. For example – municipal wastewater. In these special cases, the process of bioaugmentation is employed. This has a major drawback of limitation of the growth of microorganism in the process of removing the particular contaminant. It is mainly used in cleaning up soil contamination. This process works by adding bacteria to the surface of the affected area, where they are then allowed to grow.

iii) Intrinsic Bioremediation

Intrinsic bioremediation is most effective in the soil and water because of these two biomes which always have a high probability of being contaminated with pollutants and toxins. The process of intrinsic bioremediation is more commonly used in underground places like underground petroleum tanks. In such place, it is difficult to detect a leakage whereas contaminants and toxins can find their way to enter through these leakages and contaminate the petrol.

The microorganisms remove the toxins and cleanup the tanks converting toxic materials into inert ones using the native microbiome .

4. **Environmental engineering**

Environmental engineering is an application of blending science and engineering principles to improve the environment to provide healthy water , air and land for human habitation and for other organisms and to remediate polluted sites**.**

Environmental engineers employ the principles of engineering, soil science, biotechnology and chemistry to find solutions to environmental problems. They help to improve recycling, waste disposal, public health, water and air pollution control in an effective way.

Bioremediation presents a potentially low cost and environmentally agreeable alternative to current physico-chemical remediation strategies. However, heavy metals such as mercury cannot be converted into non-toxic forms by naturally occurring bacteria. Annual global emissions estimates for mercury released into the environment are in the thousands of tons per year. Mercury (Hg) is one of the most toxic heavy metals. Pollution by this element is a serious environmental problem, even at low concentrations, which affects all systems: soil, water and air [**Attwaters, 2023, Ballabio C etal., 2021, Munthe J etal., 2019**] while the remediation cost is in the thousands of dollars per pound. Mercury is released into the environment as a result of human activities and natural events. Finding new bioremediation technologies is an urgent need.

Environmental engineering and biotechnology are two important fields that can work together to solve some of the most tormenting environmental challenges. One of these challenges is waste water treatment, which involves removing pollutants and contaminants from water sources. Bioremediators are biological agents used for bioremediation to clean up contaminated sites. Bacteria, algae, archaea and fungi are typical prime bioremediators.

Biological treatment of wastewater is cost effective and sustainable. The genetically engineered biological organisms enhance the pollutant removal rate from wastewater and helps in maintaining the water quality of the discharge.

A genetically engineered bacteria, *Pseudomonas putida* is used for cleaning up of oil spills by digesting the hydrocarbons of crude oil.

Genetically engineered microbes are produced by introducing a stronger protein of desired function into bacteria through biotechnology or genetic engineering to enhance the desired trait. Biodegradation of oil spills, halobenzoates, naphthalenes, toluenes, trichloroethylene, octanes, xylenes etc. has been accomplished using genetically modified microbes such as bacteria, fungus and algae. Bioengineered microorganisms are more powerful than naturally occurring ones and can degrade contaminants faster because they can quickly adapt to new pollutants they encounter or co – metabolize. Genetic engineering is a worthy process that will benefit the environment and ultimately the health of human.

Genetic engineering can be used to integrate genes into bacteria to enhance mercury resistance and accumulation.

5. **Pest Resistant crops**

The never-ending process of multiplication of living organisms sets off an increasing demand food production with a limited source and area. Biotechnology has enabled us in producing effective crops which has high yield with desirable quality. Controlling pest has been a great challenge to all the agriculturists and farmers.

Biotechnology has offered various techniques for the creation of crops that naturally display anti-pest characteristics. *Bacillus thuringiensis* is a gram-positive, spore-forming bacteria which is mainly found in the soil. It produces proteins that are toxic to insects. Organic farmers use this bacterium in a solution and spray it on the plants to protect them from pests.

The practice of using *Bacillus thuringiensis* began in the year 1996 with small quantities of genes from the bacterium. This facilitated the production of cry proteins in plant cells that helped to kill pests. Pests like European and southwestern corn borer, tobacco and cotton budworm, pink bollworm and Colorado potato beetle largely destroyed the crop yields. *Bacillus thuringiensis* proves to be protective against such pests. *Bacillus thuringiensis* genes being transferred to crops makes them naturally resistant to the pests thus limiting the need of dusting and spraying the plants with pesticides. Bt Crops are transgenic crops that produce the same toxin as the bacterium *Bacillus thuringiensis* in the plant cell, thereby, protecting the crops from pests. The bacterium produces specific proteins known as “cry proteins" which is proved to be toxic to insects. A few of the Bt crops include cotton, brinjal, corn, etc.

When an insect feeds on the transgenic plants, the toxic cry protein present in the plants crystallizes the digestive system of insects, eventually leading to its death. However, it has no harmful effects in human beings.

Some Examples of Bt crops

GMO field crops include Bt-potatoes, Bt-corn, Bt-sweet corn, Roundup Ready soybeans, Roundup Ready Corn, and Liberty Link corn.

Bt Cotton

The Bt cotton variety is genetically transformed with the Bt gene to protect the plants from bollworm, a major pest of cotton. The worms present on the leaves of Bt cotton becomes lethargic and sleepy and thus, cause less damage to the plants.

Bt Brinjal

Bt brinjal is also produced by genetic transformation of a crystal protein gene cry 1 Ac from the bacterium *Bacillus thuringiensis*. Bt brinjal was developed to provide resistance against lepidopteron insects. The proteins produced by Bt genes bind to the receptors present on the insect's membrane, resulting in the formation of pores on the membranes. This disrupts the digestive process and leading to the death of the insect.

6. **Biotechnology in Alcoholic beverages**

One among the most basic uses of biotechnology is in the area of alcohol production. Every day, people across the world are consuming alcohol in varied amount. Beer, for example, is made from water, barley, brewer's yeast, and certain flavouring.

Initially the starch contained in the barley is converted to sugar by enzymes and is then fermented. Then, the brewer's yeast metabolises the sugars to produce alcohol and carbon dioxide. The enzymes and microbes are standard tools used in industrial biotechnology.

Alcoholic fermentation is the anaerobic transformation of the monosaccharides , fructose and glucose into ethanol and carbon dioxide. The process is conducted by yeasts and a few bacteria (for eg, *Zymomonas mobilis*).

The process of alcoholic fermentation regenerates the NAD+ taken up at the time of glycolysis, and provides yeast with an energy gain of 2 ATP molecules through the metabolized hexose.

In grape juice fermentation, *Saccharomyces cerevisiae* (Species of yeast), primarily directs the pyruvate for the production of ethanol to regenerate NAD + consumed by the process of glycolysis. This process is referred to as alcoholic fermentation.

7. Biotechnology in Textile industries

Biotechnology, the use of living organisms or their products to perform specific functions or make products, has the potential to revolutionize the textile industry by enabling the creation of new materials and processes with unique properties and benefits. Here are a few examples of the role of biotechnology in the production of textiles.

Biotechnology is used in textile industries in the following possible ways,

i. The bacterium *Acetobacter xylinum* are used to produce cellulose fibers and chitin, which can be spun into a variety of fabrics. This leads to the production of natural fibres which can replace the synthetic ones.
ii. Biotechnology is also used to improve the dyeing of textiles. Bacteria can be used to produce natural dyes, such as indigo, which can be used to color textiles. Enzymes can be used to improve the colorfastness and vibrancy of dyes, enabling us to avoid the use of harsh chemicals.
iii. Inspite of being useful in dying the textiles, microorganisms can also be used to remove dyes from textiles through the process of biodegradation. The bacterium *Pseudomonas putida* can be used to biodegrade azo dyes, which are commonly used in the textile industry.
iv. Enzymes can be used to soften and improve the drape of natural fibers, such as cotton and wool, making them more suitable and comfortable to wear.
v. Textile desizing refers to the process of reducing the size, or removing the starch, from woven fabrics during the production of textiles. Biotechnology is being used in this process by utilizing enzymes to break down the starch molecules into simpler sugars. This is referred to as enzymatic desizing and is considered to be a more eco friendly alternative to the existing chemical desizing methods. Enzymes employed in enzymatic desizing can be produced through fermentation using microorganisms, making the process a form of biotechnology. Enzymes are chosen for their ability to selectively break down starch molecules without damaging the fabric.

vi. Biotechnology is also used in the scouring process of textiles, which involves the removal of impurities, such as oils, dirt, and waxes, from the fabric. Enzymes are used in this process to break down and remove certain types of impurities. For instance, proteases can be used to break down protein-based impurities, such as blood and sweat stains, while lipases are employed to break down fat or oil-based impurities. Microbial scouring agents are found to be more environmental friendly than traditional chemical scouring agents, as they are biodegradable and produce fewer wastewater by-products.

vii. Biotechnology can be used to create water-repellent textiles by the use of special coatings or treatments. Enzymes can be used to create hydrophobic surfaces on textiles, or bacteria can be used to produce self-assembling peptides that form a water-repellent layer on the surface of fabrics making them water proof in a natural way.

viii. Biodegradable finishes for textiles can help to reduce the environmental impact of textile production and disposal. Bacteria can be used to produce biodegradable polymers, such as polylactic acid (PLA), which can be used to create a variety of finishes.

ix. In addition to creating new materials, biotechnology can also be used to improve the sustainability of the textile industry. Bacteria can be used to break down and recycle textile waste, or to produce biodegradable alternatives to synthetic fibers.

The use of biotechnology in textiles may also raise ethical considerations, such as the potential impact on the environment and biodiversity, the use of genetically modified organisms, and the potential for misuse or abuse. It is important for the textile industry to consider and address these ethical issues in a responsible manner.

The use of biotechnology has a lot of potential benefits in textiles, there are also few challenges and limitations in its use. The production of biotechnology-based materials requires specialized equipment and expertise, and the materials can be comparatively expensive than the traditional fibers. The scalability and reliability of biotechnology-based processes may be one of the concerns too .

The use of biotechnology in textiles is still in its early path, and is likely that the technology will continue to evolve and develop in the coming years. Some potential future application of biotechnology in textiles include the development of new types of sustainable and functional materials, the integration of sensors and electronics into textiles, and the use of biotechnology to improve the efficiency and sustainability of the textile manufacturing process in a ecofriendly manner.

As a whole, the use of biotechnology in the production of textiles has the potential to create new materials and processes with better properties and sustainability. It is also important to carefully consider the potential risks and impacts of biotechnology, and to ensure the responsible and ethical use of this technology.

8. Biotechnology in Forensic science

Forensic biotechnology is the scientific study and investigation of genomic information for the identification of specific sign of act. Biotechnology is used by forensic scientists to collect trace evidence such as blood, bones, skin, hair, semen samples, etc., which is found at crime spots. An important aspect of modern forensics is the use of genetic fingerprinting or DNA profiling.

The data gathered from forensic biotechnology are utilized by the legal system to make necessary interpretations about the nature of crime and criminals. Because of its potential to identify unique genetic markers, the discipline has also been applied for the determination of parenthood or other familial characteristics. Earlier this field relied on a few basic techniques of genetics like DNA fingerprinting. However, the recent developments in the field of genomics, transcriptomics and proteomics have made the forensic sciences increasingly sensitive and reliable. The availability of the minutest amount of sample (like blood, hair, or other body tissues) can help in bringing out the information in a timely manner that would otherwise have taken months or years to obtain.

9. Invitro fertilization/ Test Tube baby

In recent times we have observed several couples who are unable to bear children because of minor bodily problems. This is the place where in vitro fertilization (IVF) plays a vital role in bringing fruitfulness in life to such couples.

In vitro fertilization (IVF) is the process by which, a woman's egg and a man's sperm is fused in a laboratory condition. In vitro means outside the body. Fertilization means the fusion of sperm and the egg.

The fertilized egg is then cultured for 2–6 days and allowed to be divided 2-4 times inside a test tube (thereby getting the name test tube baby also). These fertilized eggs are then planted to the mother's uterus where they can be developed normally.

A test-tube baby is the product of a successful human reproduction that results from methods beyond sexual intercourse between a man and a woman and instead utilizes medical intervention that manipulates both the egg and sperm cells for successful fertilization. The term used to refer to the babies born from the earliest method of artificial insemination and has now been expanded to refer to children born through the use of in vitro fertilization, the practice of fertilizing an egg outside of a woman's body. The use of the term in both media and scientific publications in the twentieth century has been accompanied by discussion as well as controversy regarding the ethics of reproduction technologies such as artificial insemination and in vitro fertilization. The evolution of these terms over time shows our ability to manipulate the human embryo, as seen by the general public and the scientific community.

10. Gene editing

Genome editing also called gene editing is a group of techniques that give scientists the ability to change an organism's DNA. These techniques allow the genetic material to be added, removed, or altered at particular locations in the genome.

Gene editing is of great interest in the prevention and treatment of human diseases. Currently, genome editing is used in cells of animal models in research labs to understand diseases. Scientists are still working to determine whether this approach is safe and effective for use in people. It is being explored in research and clinical trials for a wide variety of diseases, including single-gene disorders such as cystic fibrosis, hemophilia, and sickle cell anaemia disease. It also opens the gateway in the treatment and prevention of more complex diseases such as, cancer, mental illness, heart disease, HIV infection, etc.

Most of the changes introduced with genome editing are limited to somatic cells, which are cells other than germline cells (egg and sperm cells). These changes are isolated to only certain tissues and are not passed from one generation to the next. However, changes made to genes in egg or sperm cells or to the genes of an embryo could be passed to future generations. Germline cell and embryo genome editing bring up a number of ethical challenges, including whether it would be permissible to use this technology to enhance normal human traits (such as height or intelligence). Based on concerns about ethics and safety, germline cell and embryo genome editing are currently illegal in the United States and many other countries.

Some Recent research in biotechnology

i. Researchers develop 3D bioprinting technology for eliminating cancer cells. A three-dimensional (3D) bioprinting technology capable of eliminating cancer cells using the function of immune cells has been developed for the first time in the world.

ii. New method for assessing the structural changes in cardiac arrhythmia- A multidisciplinary study led by scientists at the Centro Nacional de Investigaciones Cardiovasculares (CNIC) presents a new method for assessing the structural and electrophysiological changes, called atrial remodeling, produced in the heart of patients with atrial fibrillation, one of the most frequent forms of cardiac arrhythmia.

iii. Current plant biotechnology has developed as a new age of science and technology where production of secondary metabolites, valuable plant genetics improvements, germplasm conservation, and production of large numbers of disease-free and new varieties.

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