BIOTECHNOLOGY

- The controlled and desired application of simple biological agents living or dead cells or cell components in technically useful operations
- it includes any technique that uses living organism or parts of organisms to make or modify products to improve plants or animals or to develop microorganism for specific uses.
- Louis pasteur –Father of Biochemistry(identified the role of microorganisms in fermentation)
- Karl Ereky a Hungarian agricultural engineer1917
- Old Biotechnology (baking brewing etc)
- New Biotechnology (cell culture cell fusion bioprocessing genetic engineering)

Modern Biotechnology

Watson and crick in 1953

Concepts

- cell- smallest living unit
- basic structural and living unit
- genetic language is universal

Vertical gene transfer

- from parents to offspring
- ie to next generation

Horizontal gene transfer

- Transfer of genes from one organism or species to another in the same generation

Scope of biotechnology

- For commercial development and profits in a wide range of industrial sectors, including health care and medicine agriculture and forestry, fine and bulk chemicals production, food technology, fuel and energy production pollution control and resources recovery

1. Tissue culture technology
2. Pharmaceutical technology
3. r DNA technology
3. Agricultural Biotechnology
4. Food biotechnology
5. Fermatation technology
6. Mining and mineral technology
7. Environmental biotechnology
8. Industrial biotechnology
9. Biomolecular engineering
10. Bioinformatics

Practical applications in Biotechnology

1. Applications in medicine

a) genetically engineered pharmaceuticals

- an alternative strategy is to obtain large amounts of recombinant human proteins and use them as pharmaceuticals
- Bacteria have been widely used to produce human therapeutic proteins

Eg., insulin

b)Vaccines

- polio, measles, TB, Rabis, mumps, rubella, cholera, diptheria pertusis

c)Antibiotics

- pencillin, ampicillin, tetracyclin

d)Bioactive molecules

- insulin, HCG, HGH, Interferon

Health care products

Diagnostic kits

Single cell proteins

e) Animals and microbes as bioreactors

- Bioreactors are the containment vehicles of any biotechnology- based production processes such as brewing, production of organic or amino acids, antibiotics, enzymes or vaccines or for bioremediation
- Transgenic animals can be used as natural bioreactors or living drug factories that can yield valuable transgenic animals such as mice rabbit, sheep, goats,pig,cowsand microbes.

Molecular Ph(f)arming

- Genetic engineering is being employed to develop transgenic animals resistant to certain diseases capable of faster growth rate and more efficient feed conversion and with capacity to produce certain valuable biochemicals and to excrete them in milk urine or blood from which they can be isolated and purified

Biosensors

- A biosensor is a sensitive analytical tool which converts biological signals provided by the analyte into electrical signals.
- The sensitive biological element may be tissues, microorganisms, organelles, cell receptors, enzymes, antibodies, nuclicacid etc
- The biological material is immobilized on the immobilization support.
- the substance to be measured pass through the membrane and interact with the immobilized material and yield the product.
- Product pass through another membrane to the transducer.
- The transducer converts product into a signal which is amplified

Applications

- glucose monitoring
- Industries
- Environmental applications

g. Biotechnology in organ transplantation

- Xenotransplantation -transplantation of living cells, tissues or organs from one species to another such as pigs to humans.
- such cells, tissues or organs are called xenografts
- Rejection of organ as foreign body- problem
- Solution is to alter genetic makeup of donor animal
- no human trial so far

Animal models

Knock out mice

- Transgenic mice carrying a knockout gene (non-functional gene) at the place of a gene of interest is called knockout mice
- Mariocapechi etal 1990
- Such genetic modifications produce different strains of mice that can be used to determine the function of genes of interest.
- effectively used for experimental purpose to find out the causes and treatment of the disease
- Egs. asthmatic mice and Alzheimer's disease

Oncomouse

- the first genetically engineered animal to be patented.
- P. Ledar and T.A Stewart inserted oncogene from chicken virus to fertilized egg of mouse

- these transgenic mice could be used as animal model to test whether a either causes or prevents cancer.

Gene therapy

- is the introduction of the wild type normal gene into somatic or germline cells so that the normal gene product can be synthesized and therefore compensate for defective gene

Somatic cell gene therapy

- involves the removal of somatic cells with the defective gene from patient, culturing those in vitro, introduction of cloned normal healthy genes by microinjection into these cells, and transfer of these cells back to the patient.
- candidate disease for gene therapy-cystic fibrosis, Huntington disease, hemophilia, muscular dystrophy ,Alzheimer disease, phenylketonuria, thalassemia, sickle cell anemia

Germline gene therapy

- involves the replacement of the defective genes with the normal genes in the germ cells or even in zygotes.
- Rectification of all cells of the resulting individual
- Change to germline gene therapy is heritable and passed on to subsequent generations
- effectively forbidden in humans at present
- **anti sense therapy.**

In vitro treatment of genetic diseases by blocking translation of an unwanted protein with an RNA sequence that is complementary to specific mRNA.

- useful in blocking the effect of many abnormal genes including oncogenes
- application in large scale production processes such as brewing industry, food processing ,pharmaceuticals, chemical industry, mining industry and waste treatment

Mining industry-

- **Bioleaching or microbial leaching** is the process by which microorganisms are used to dissolved elements or their compounds from more complex substances forming aqueous solutions from which the element may be recovered by further processing.
- ores of copper, gold, iron, manganese and uranium.

Industrial fermenters

- A variety of organisms are employed in the manufacture of products that can be used in medicine and as foods

Enzyme manufacturing

- microorganisms are used to manufacture different enzymes that are required in metabolic processes
- Immobilized enzymes-lactose free milk can be using immobilized enzyme lactase

Biosensors

- used to detect certain analytes are employed in industry.
- Applications in food industry for monitoring food quality and safety
- Used in fermentation industry for fermentation process conditions

3. **Environment management and pollution control**

- Aims at the application of biotechnology towards the protection of environment and sustainable development
- biosensors in environmental monitoring to detect toxic chemical at ultra trace levels in industrial products, chemical substances or environmental samples
- use of biosensors in industrial pollution include waste management, decontamination and detoxification of spillage, effluent treatment for a variety of industries tanning industry **Bioremediation**

- is the cleaning up of toxic contaminants in the environment using the activity of natural microbial populations in the contaminants or other wastes
- Treatment of substances like oil, and hazadous radioactive waste
- In situ bioremediation, composting landfarming are different types of bioremediation.
- Petroleum eating bacteria-pseudomonas –Anand Chakrabarthy.
- Bioremediation uses natural as well as recombinant microorganisms to breakdown toxic and hazardous substances already present in the environment.
- vast potential to treat soil and ground water contaminated with a variety of hazardous chemicals, including refractory organics ,oils, polyaromatic hydrocarbons, pesticides etc.

Biological control

- potential development of biocides with amplified persistence in mosquito habitats

Biofilteration

- is a biotechnological technique applied to detoxify polluted air and water
- Microorganisms consume the gaseous organic pollutants or the dissolved organic pollutants

Applications in forensics and judiciary

Forensic tool

- forensic DNA analysis play a role in investigation and resolution of thousands of crime

DNA fingerprinting

- DNA fingerprints can be prepared from miniscule of blood samples, semen, hair or any cell of body
- paternity testing and maternity testing, identify victims of disasters

DNA barcoding

Potential hazards of biotechnology

Release of new virulent organisms into environment

- The GE method of artificial gene transfer works by penetrating or weakening the immune system and using virulent genes as delivery vehicles

Gene transfer to wild or weedy relatives

- Genes introduced to transgenic crops may not always confine themselves to the target plants .
- Cross pollination may occur to wild or weed relatives making them super weeds

Reduction of biodiversity

- Genetic engineering followed by cloning to crate many identical animals or plants is sometimes viewed as threat to biodiversity
- it may endanger species and reduce biological diversity

Biological weapons (biowarfare and bioterrorism)

- they are complex systems that disseminate disease causing organisms such as bacteria, viruses and fungi with the intent to kill or incapacitate humans, animals or plants
- chemical weapons are poison gases while biological weapons are live organisms specially engineered to transmit infectious diseases

Gene Doping

- In sports gene doping refers to the use of anabolic steroids particularly those that are forbidden by the organizations (WADA) that regulate competitions
- Gene doping- technique of augmenting gene activity to improve performance by products similar to proteins synthesized by body
- These proteins are not discriminated from naturally occurring proteins

not easily detected by anti doping tests

Elimination of Farming

- The patenting of genetically engineered food and widespread biotech food production will eliminate farming

Seed technology

- multinational seed companies have come out with genetically engineered seeds that possess desirable qualities as well as several genetically alerted genes

Terminator technology-monsanto

- Is the expression of toxic trans gene the terminator gene at a critical stage of embryonic development killing the embryo
- It is feared that terminator gene could spread from the transgenic crop to wild plants

Traitor technology-Astra Zeneca

- restricts farmers options for fertilizers
- Genetic switch that genetically programs the crop to accept fertilizers and pesticides only of a particular company