

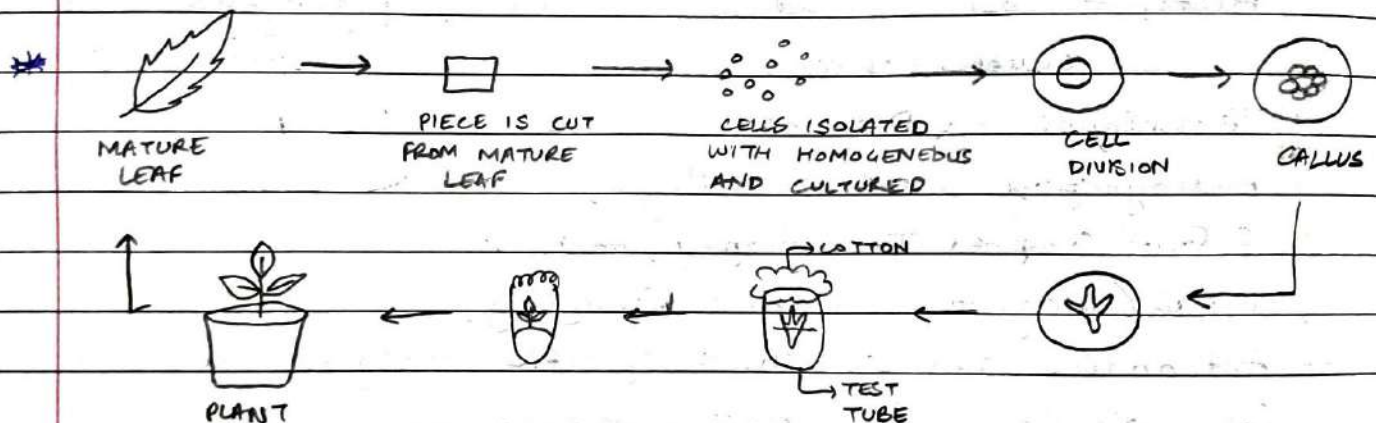
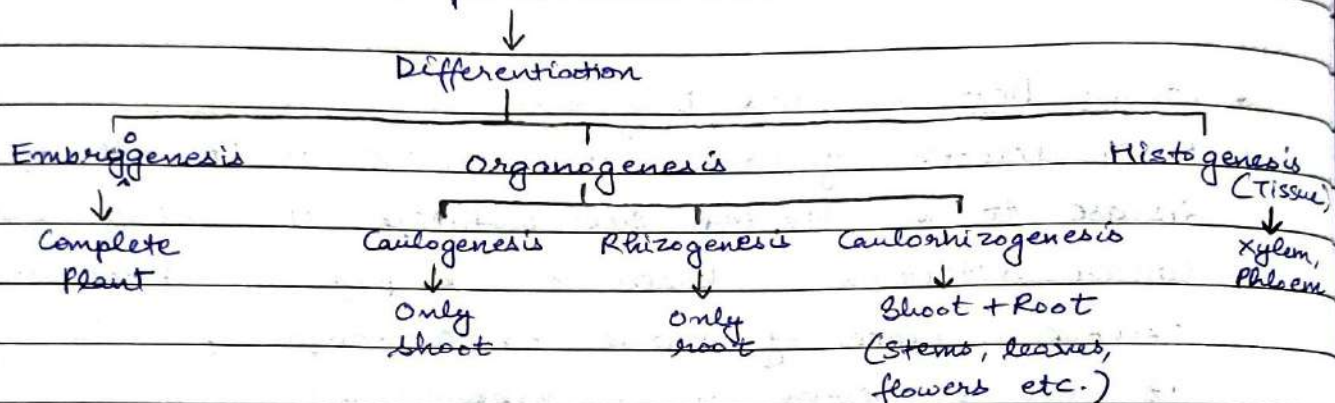
Unit 5 - Biotechnology

> Basics of Biotechnology

* Totipotency - Genetic potential of a plant cell to produce the entire plant

→ Cell with this ability is called totipotent cell.

→ Totipotent Cell

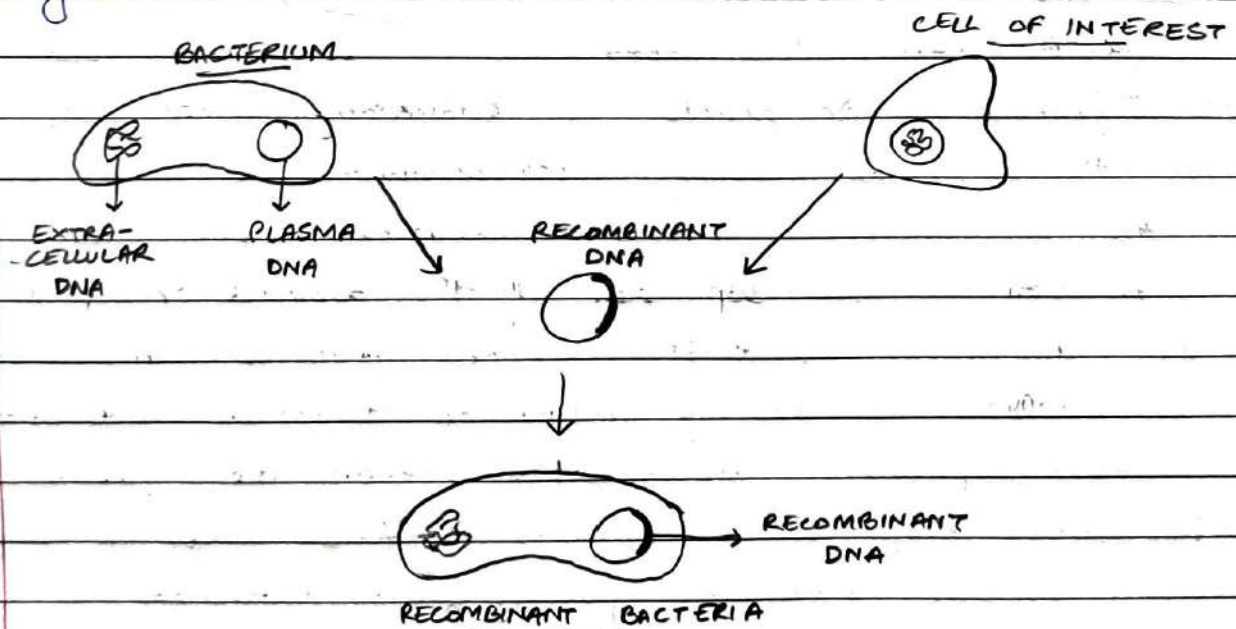


Application of Totipotency [Diagram above included]

- Totipotent cells with a bit of callus tissue can be stored in liquid nitrogen for a long period. For germplasm preservation of endangered species, totipotency can be utilized successfully.
- Plant breeders, horticulturists and commercial plant growers utilize totipotency in developing new plants.

* Gene Manipulation / Cell Manipulation

- It is also called genetic engineering
- It is the direct manipulation of an organism's genes using biotechnology.
- A set of technologies ^{is} used to change the genetic make up of cells including the transfer of genes within and across species' boundaries to produce improved or ^{new} [↑] novel organisms
- New DNA is obtained by either isolating or copying the genetic material of interest using recombinant DNA methods or by artificially synthesizing DNA.
- A construct is usually created and used to insert this DNA into the host organism.
- An organism that is generated through genetic engineering is considered to be genetically modified organism.



* Classification of Biotechnologies

1) Medical Biotechnology

eg. vaccines i.e. chemicals that stimulate the body's immune system to better fight pathogens.

2) Agriculture Biotechnology
eg. pest-resistant crops ; plant & animal breeding

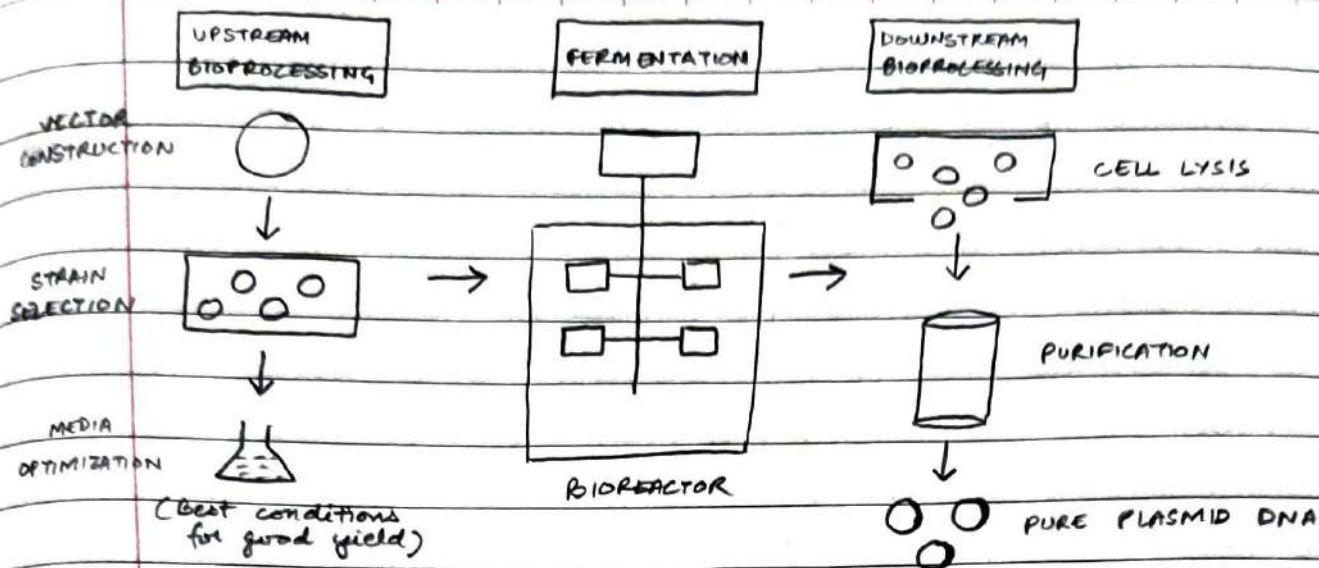
3) Industrial Biotechnology
eg. biocatalyst - desired enzymes can be manufactured by fermentation in commercial quantities using biotechnology microorganisms.

4) Environmental Biotechnology
eg. bioremediation - applications of biotechnological ^{methods} which help ^{develop} ~~design~~ enzymes and design bioreactors which not only retreat some industrial & food waste components but also allow their efficient removal via sewage system, without using solid waste disposal mechanism.

* Bioprocessing Technologies

- Bioprocessing employs various techniques including fermentation, purification and downstream bioprocessing to produce desired products. [eg antibiotics]
- Fermentation is the process of converting sugars into alcohol or organic acids using microorganisms such as bacteria, yeast & fungi.
- Purification involves separation of the desired product from the mixture of products produced during fermentation. It involves the use of techniques such as filtration, chromatography & centrifugation.
- Downstream bioprocessing involves the final steps in bioprocessing which include formulation, packaging & distribution of final biological product.

[P.T.O.] →



* Upstream Bioprocessing

→ Upstream bioprocessing is critical to the success of bioprocessing as it sets the foundation for the quality & quantity of the final product.

→ It refers to the initial stages of production process in which biological materials are prepared and optimized for downstream bioprocessing.

→ Process development begins with

- 1) Selection of appropriate microorganisms or cell line, followed by media development which involves selecting the optimal nutrient composition and environmental conditions to promote growth and productivity.
- 2) Inoculation i.e. the selected microorganisms or cells are introduced into the media and allowed to grow and multiply.
- 3) Fermentation or cell culture i.e. cells are cultivated under controlled conditions including temperature, pH and oxygen levels.

After fermentation, the cells are harvested and processed to extract the desired product, which is then purified in downstream bioprocessing.

* Downstream Bioprocessing

- It includes purification and separation of the desired product from the complex mixture of ^{the biological} material obtained from upstream bioprocessing.
- The objective of downstream ^{bio} processing is to isolate, purify and concentrate the target product to a level that is suitable for use in pharmaceuticals, vaccines and other pharmaceutical applications.
- The steps involved are:
 - 1) Harvesting and filtration, followed by primary capture, buffer exchange and concentration.
 - 2) Purification i.e. target product is isolated and purified from the mixture of impurities and raw materials.
Techniques include chromatography (ion exchange chromatography, size exclusion, affinity chromatography, hydrophobic interaction chromatography)
After purification, the product is concentrated to remove any remaining impurities and to increase the concentration of target production.
Techniques - ultrafiltration, evaporation, precipitation.
 - 3) Formulation i.e. purified and concentrated product is formulated into final product format such as liquid or lyophilized powder.
- The product is then subjected to validation and quality control tests to ensure that it meets the required standard.

* Imaging Techniques

1) X-Rays

- Imaging method: Ionizing radiations
- X-Rays are quick, painless tests that produce images of structure inside the body, especially bones.
- This method is used to diagnose bone fractures, arthritis,

osteoporosis infection, swallowed items, digestive tract problems.

2) CT Scan (Computed Tomography)

- Imaging method: Ionizing radiations
- CT Scan uses a series of X-Rays to create cross-section of the inside of the body, including bones, blood vessels and soft tissues.
- The patient will lie on the table that slides into the scanner which looks like a large doughnut
- The X-Ray tube rotates around the patient, to take images used to diagnose injuries from trauma, bone fractures, tumors and cancer, muscular disease, heart disease, infections and used to guide biopsy.

3) MRI (Magnetic Resonance Imaging)

- Imaging method: Magnetic waves
- MRI uses magnetic fields and radiowaves to create detailed images of organs and tissues in the body.
- The patient lies on the table that slides into the MRI machine which is deeper and narrower than the CT scanner
- The MRI magnet creates loud tapping or thumping sounds.
- Used to diagnose multiple sclerosis, stroke, spinal chord disorders, tumors, blood vessels tissue, joints and tendons injuries.

4) Ultrasound

- Imaging method: Sound waves.
- Ultrasound uses high frequency sound waves to produce images of the organs and structures within the body.
- A technician applies gel to the skin, then presses a

small probe against it, moving it to capture images of the inside of the body of the patient

- ↳ Used to diagnose gall bladder disease, joint inflammations, blood flow problems, monitoring pregnancy and to guide biopsy,

c) PET (Positron Emission Technique)

- ↳ Imaging method : Radio traces.
- ↳ This scan uses radioactive drugs called tracers and a scanning machine to show how tissues and organs are functioning.
- ↳ The patient is allowed to swallow or have a radioactive injection. The patient then enters into a PET Scanner which looks like the CT Scanner and leads the radiation given off by the radio-tracer.
- ↳ Used to diagnose cancer, heart disease, epilepsy, coronary artery disease