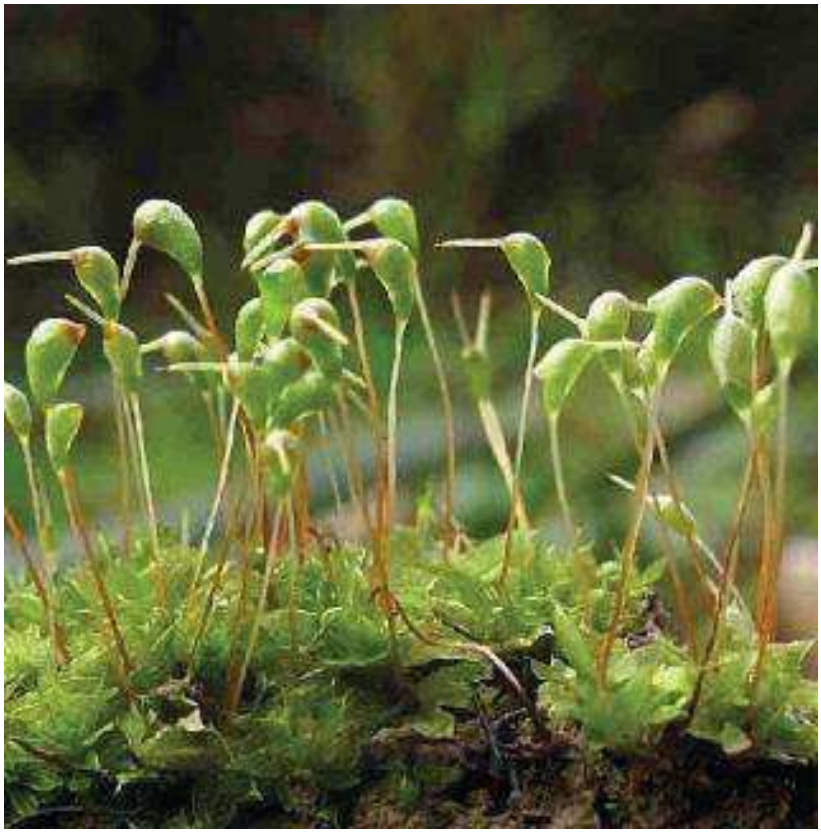
HIGHER SECONDARY EDUCATION

PLUS TWO-BOTANY
FOCUS POINT -RIVISION NOTES



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FOCUS POINT-BOTANY,CONTENT DETAILS

1.REPRODUCTION IN ORGANISMS

1. Asexual reproduction

1.2.1.1 Gametogenesis

1.2.2 Fertilisation

2,SEXUAL REPRODUCTION IN FLOWERING PLANTS

2.2.1. Structure of microsporangium, Structure of pollengrain

2.2.2.Megasporangium-structure, megasporogenesis, Female gametophyte

2.2.3.Pollination Classification based on source of pollen (Autogamy, geitonogamy and xenogamy) and agents of pollination (wind, water and insects - peculiarities with examples) and artificial hybridisation

2.3.Double fertilisation

2.4.2.Embryo- structure

2.4.3. False fruit. True fruit and Parthenocarpic fruit

3.STRATEGIES OF ENHANCEMENT IN FOODS PRODUCTION

9.1. LI.Dairy farm management

9.1 1.3. Bee keeping

9.2. Plant breeding- main steps

9.2.4. Plant breeding for improved food quality

9.3. SCP

9.4. Tissue culture

4.BIOTECHNOLOGY-PRINCIPLES AND PROCESSES

11.2. Tools of recombinant DNA technology

11.2.1 Restriction enzymes, Gel electrophoresis.

11.3. Processes of rDNA technology.

11.3.3. Amplification of gene of interest using PCR

11.3.5 Obtaining the foreign gene product

5.BIOTECHNOLOGY AND ITS APPLICATION

12.1. Biotechnological applications in agriculture-Uses GMOs and Bt cotton

12.2.1. Genetically engineered insulin.

12.2.2. Gene therapy.

6.ORGANISMS AND POPULATION

13.1.3. Adaptations in organisms of deserts, polar regions and high altitudes

13.2.1. Population attributes-Age pyramids and population density

13.2.2. Population growth (Up to population growth equation)

13.2.4. Population interactions - Parasitism, Commensalism and Mutualism

7.ECOSYSTEM

14.2 Productivity

14.3.Decomposition

14.4.Energy flow -Food chain, Food web and Trophic levels

14.5 Ecological pyramids

14.7. Nutrient cycling - Phosphorus cycle

8.ENVIRONMENTAL ISSUES

16.2. Water pollution and its control,BOD. Algal bloom and Eutrophication

16.6. Greenhouse effect and global warming

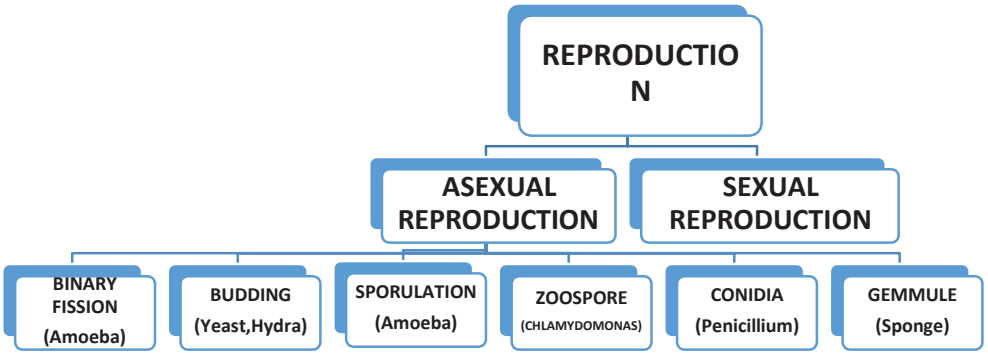
16.7. Ozone depletion in the stratosphere

169. Deforestation

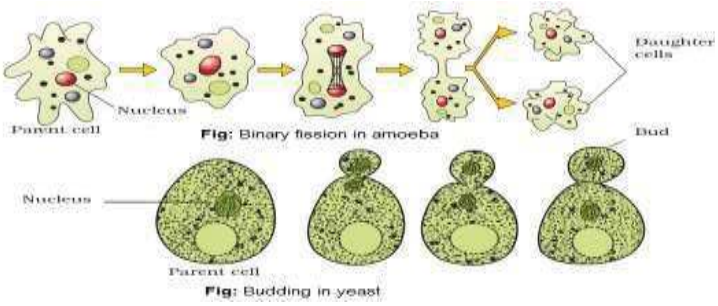
1.REPRODUCTION IN ORGANISMS

Asexual Reproduction

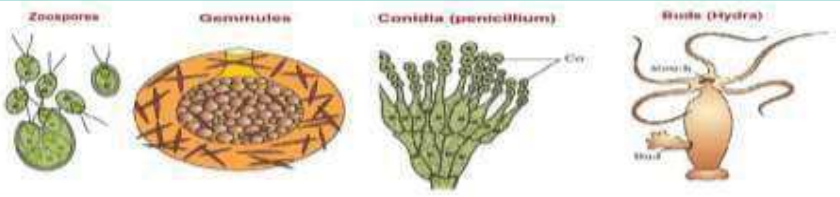
- Usually followed by organisms with relatively simpler organizations.
- Off-springs produced by a single parent.
- With/without involvement of gamete formation.
- Offsprings produced are genetically and morphologically similar to each other and to the parent, i.e. they are clones.



- In Protista and Monera, the parent cells divides into two to give rise to new individuals. Thus, in these organisms **cell division** is the modeof reproduction itself.
- **Binary fission**– in this method of asexual reproduction, a cell divides into two halves and rapidly grows into an adult. Ex- amoeba, paramecium.
- In response to unfavourable living condition, an **Amoeba** withdraws its pseudopodia and secretes a three-layered hard covering or cyst around itself. This phenomenon is termed as **encystation**.
- When favourable conditions return, the encysted Amoeba divides by multiple fission and produces many minute amoeba or p**seudopodiospores**;the cyst wall bursts out, and the spores are liberated in the surrounding medium to grow up into many amoebae. This phenomenon is known as **sporulation**.
- **Budding**– small buds are produced that remain attached initially with parents and get separated on maturation. Ex. Yeast.

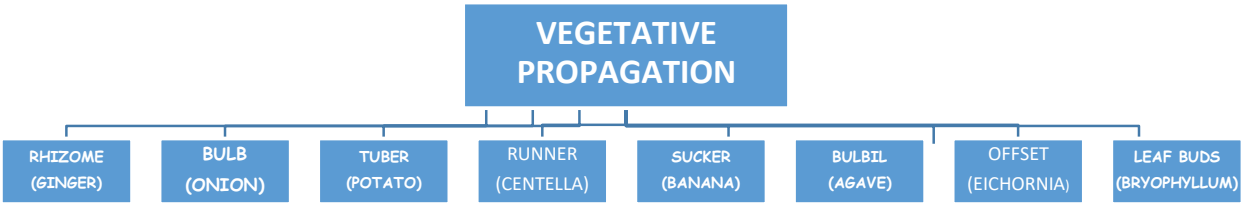


- Fungi and simple plants like algae reproduce through special reproductive structures like zoospores (motile structure),
- In fungi like Penicillium and Aspergillus exogenously formed conidia help in asexual reproduction.
- Other types of asexual reproductive structures include buds (Hydra) and gemmules (Sponges).



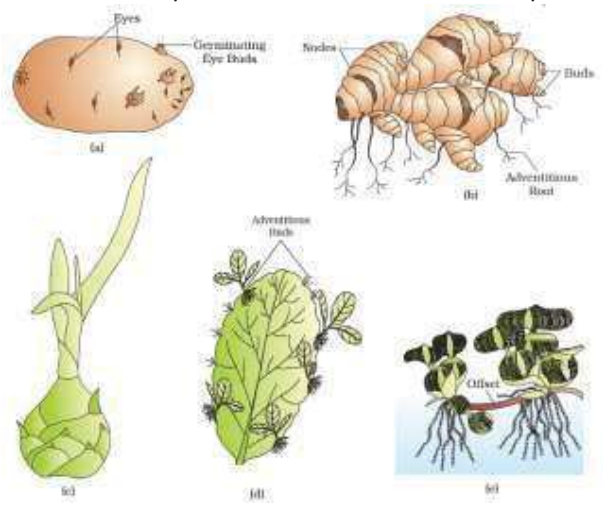
Asexual reproduction in Flowering plants (Vegetative propagation)

- In plants, vegetative reproduction occurs by specialised modified structures called vegetative propagules.
- Most common vegetative propagules include rhizome, bulb,tuber,sucker, offset,bulbil,etc.
- Since the formation of vegetative propagules does not involve two parents, it is also a form of asexual reproduction.



WATER HYACINTH (Terror of Bengal)

- The plant water hyacinth (Eichhornia crassipes) is nicknamed as the "Terror of Bengal" because it grows at an alarming rate and spreads on the surface of the water body.
- It is one of the most invasive weeds
- This can reduce the light availability and drains oxygen from the water.
- Thus, causing the death of fishes and other aquatic organisms.
- Vegetative propagation occurs at a phenomenal rate with the help of Offset.



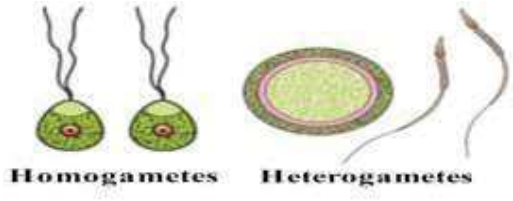
- **a).Stem tuber (Potato),b) Rhizome (Ginger),c) Bulbil (Agave), d) Leaf buds (Bryophyllum),e) Offset (Water hyacinth)**

- Nodes play an important role in many of the vegetative propagules
- When nodes come in contact with damp soil/water they produce roots and new plants.

- Asexual reproduction is the most common method of reproduction in organisms having simpler body like in algae and fungi.

GAMETOGENESIS

- It is the process of formation of male and female gametes.
- Gametes are haploid cells which may be similar or dissimilar in structure.
- In algae, both gametes are similar in structure and are called **homogametes (isogametes)**.
- In higher organism that reproduces sexually, two morphologically distinct gametes are formed and they are called **heterogametes**.
- In such cases male gametes are called **antherozoid or sperm** and female gametes are called **ovum or egg** .



Sexuality in organisms

- Sexual reproduction generally involves fusion of opposite gametes .
- In fungi and plants, homothallic and monoecious terms are used to denote the bisexual condition and heterothallic and dioecious are used for unisexual condition.
- In flowering plants, the unisexual male flower is staminate, i.e., bearing stamens, while the female is pistillate or bearing pistils.
- In some flowering plants both male and female flowers may be present on the same plant(monoecious) or on separate plants (dioecious)
- In animals, species which possess both male and female reproductive organs in same individual are called bisexual or hermaphrodites (earthworm, sponges, tapeworm etc.)
- When male and female sex organs are produced by separate individuals they are called unisexual Eg Cockroach, Human).
- Gametes are always haploid(having half set of chromosome), although organisms may be haploid and diploid.
- Diploid organisms form gametes by meiotic division.
- The organisms belonging to algae, fungi, and bryophytes have haploid plant body and pteridophytes, gymnosperms, angiosperms and most of animals are diploid (having double set of chromosome)
- In diploid organisms, gamete mother cell (meiocyte) undergoes meiosis in which one set of chromosome is present in gametes.
- No of chromosomes present in gametes and meiocytes of some organisms are listed below.

Name of Organism	Meiocyte (2n)	Gamete (n)
Man	46	23
House fly	12	6
Rat	42	21
Dog	78	39
Fruit fly	8	4
Rice	24	12

Onion	16	8
Apple	34	17
Maize	20	10
Potato	48	24
Ophioglossum	1260	630

II. FERTILISATION

- The fusion of male and female gamete is called fertilization or syngamy. It results in the formation of diploid zygote.
- The process of development of new organisms from unfertilized female gamete without fertilisation is called parthenogenesis. For example honey bee, rotifers, and lizards

EXTERNAL FERTILIZATION

- Syngamy occurs outside the body of the organism(usually in the water)
- Large numbers of gametes are released in the surrounding medium.
- Synchronous development and release of gametes are necessary for the success of external fertilization
- Zygotes and embryos formed are not protected from predators.
- Eg.. Bony fishes and Amphibians.

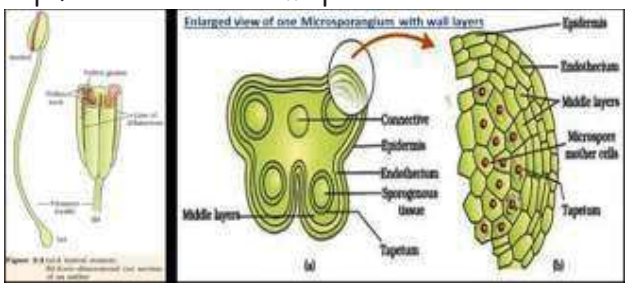
INTERNAL FERTILIZATION

- Syngamy occurs inside the body of the female organism.
- Numbers of ova produced are less, but large numbers of male gametes are carried to the ovum or egg.
- Eg. Bird,Mammals and higher plants.

2,SEXUAL REPRODUCTION IN FLOWERING PLANTS

Stamen, Microsporangium and Pollen Grain :

- ✓ Stamen consists of long and slender stalk called filament and terminal bilobed structure called anther.
- ✓ A typical angiosperm anther is bilobed with each lobe having two theca (chamber).
- ✓ In general the anther is four-sided structure consisting of four microsporangia, two in each lobes.
- ✓ Microsporangia develop further and become pollen sacs which contain pollen grains.



Structure of Microsporangium

- ✓ Microsporangium is generally surrounded by four layered walls- the epidermis, endothecium, middle layer and tapetum.
- ✓ Innermost layer **tapetum** nourishes the developing pollen grains.
- ✓ The cells of the tapetum are multinucleated (due to endomitosis) and have dense cytoplasm.
- ✓ The outer three wall layers perform the function of protection and help in dehiscence of anther to release the pollen.
- ✓ **Sporogenous tissues-** It is compactly arranged homogenous cells which are present at centre of each microsporangium when the anther is young.
- ✓ As the anther develops, the cells of the **sporogenous tissue** undergoes meiosis to form pollen grains.

Pollen grain

- ✓ Pollen grains represent the male gametophytes.
- ✓ Pollen grains have 2 layered wall,outer exine and inner intine.

Exine

- Made up of sporopollenin- most resistant organic matter known.
- It can withstand high temperatures and strong acids and alkali.
- No enzyme can degrade sporopollenin.
- Presence of sporopollenin helps the pollen to be preserved even in fossils.

Intine.

- Thin and continuous layer made up of cellulose and pectin
- A plasma membrane surrounds cytoplasm of pollen grain.

Germ pores

- Apertures or openings on exine where sporopollenin is absent.
- After pollination pollen tube emerges through germ pore.

MATURE POLLEN

- ✓ A mature pollen consist of 2 cells with nucleus (Vegetative cell and Generative cell)

VEGETATIVE CELL

- Larger cell of the pollen grain with abundant food reserves
- Contains large irregular nucleus
- The function of the vegetative cell is to provide the medium for the movement of male gametes inside the pollen tube

GENERATIVE CELL

- Smaller cell of the pollen grain and contain minimum amount of cytoplasm
- It divides mitotically to produce two functional male gametes.

✓ In about 60% of angiosperms, pollen grains are liberated at 2-celled stage.

✓ In about 40% flowering plants, the generative cell divides mitotically to give rise to the two male gametes before pollen grains are shed at 3-celled stage

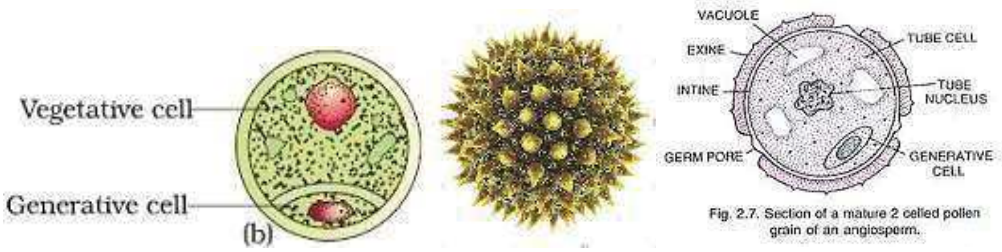


Fig. 2.7. Section of a mature 2 celled pollen grain of an angiosperm.

Megasporangium (Ovule)

✓ Ovule is a small structure attached to placenta.

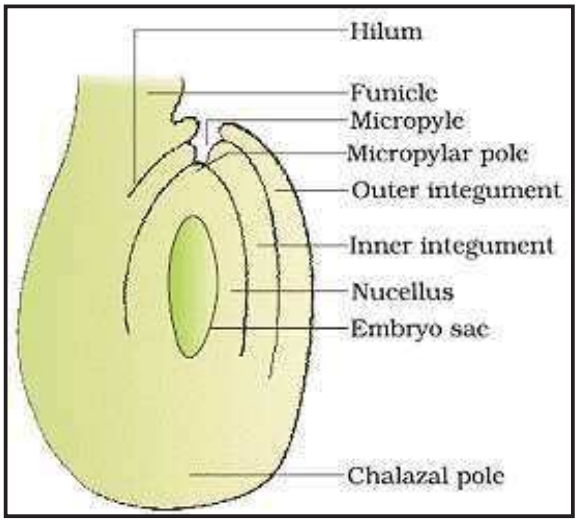
✓ Funicle – stalk by which ovule is attached to placenta

✓ The point of attachment of funicle with the body of ovule is called *hilum*.

✓ The main body of the ovule is covered with one or two envelopes called integuments. These leave an opening at the top of the ovule called micropyle.

✓ The body of the ovule shows two ends: the basal end, often called the chalazal end and the upper end is called micropylar end.

✓ Parenchymatous tissue enclosed inside the integument is called nucellus



Megasporogenesis

✓ The process of formation of megaspore from megaspore mother cell by meiotic division is known as megasporogenesis. This process takes place in ovule

✓ Ovule differentiates a single megaspore mother cell (MMC) in the micropylar region of nucellus.

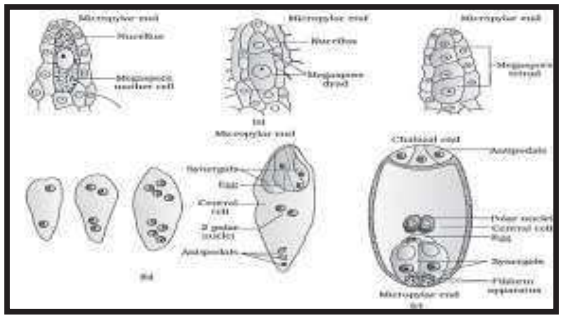
✓ MMC undergoes meiotic division that results into the production of four megaspores.

✓ In most of the flowering plants three megaspores degenerate and remaining single megaspore develops into female gametophyte (embryo sac).

✓ The nucleus of functional megaspore divides mitotically to form two nuclei which move to opposite poles to form 2-nucleate embryo sac.

✓ Two more sequential mitotic division results into 8-nucleate embryo sac.

- ✓ One nucleus from each pole then moves towards the middle of the large central cell and forms a pair of polar nuclei.
- ✓ The three nuclei of the micropylar end form the egg appa•ratus (one central egg and two lateral synergids) and the rest three at the chalazal end are called antipodal cells.
- ✓ At maturity ,embryosac is **8-nucleated and 7 celled.**



POLLINATION

- ✓ Transfer of pollen grains from anther to stigma.

Autogamy–

- Transfer of pollen grains from anther to stigma of same flower.
- It requires synchronous maturation of anther and stigma.
- **Cleistogamous Flower** –
- flower which do not open.
- cleistogamous flowers are autogamous as there is no chance of transfer of foreign pollen to the stigma.
- Cleistogamous flowers ensure the development of seeds even in the absence of pollinators. e.g Viola (common pansy), Oxalis, and Commelina.
- **Chasmogamous** Open flowers with exposed anther and stigma.

Geitonogamy

- Transfer of pollen grains from anther of a flower to stigma of another flower of same plant.
- Geitonogamy is functionally a type of cross-pollination involving a pollinating agent.
- Genetically it is similar to autogamy since the pollen grains coming from the same plant
- **Xenogamy–**
- Transfer of pollen grain from anther to the stigma of a different plant of the same species.

Agents of pollination

- ✓ Pollinating agents includes abiotic (water, wind) and biotic (insects, butterfly, honey bee etc.)
- ✓ Large number of pollen grains are produced by plants using abiotic mode of pollination to compensate the loss of pollen grains during transfer.

Adaptations in flowers for Pollination

WIND POLLINATION

- ✓ Pollen grains light weighted and non- sticky.
- ✓ Have well-exposed stamens (so that the pollens are easily dispersed into *wind* currents)
- ✓ Large and feathery stigma helps to receive pollen grains moving in the air.
- ✓ In wind pollinating plants numerous flowers are packed into an inflorescence.
- ✓ Eg. : Corncob,Rice,Maize,Papaya ,Date palm

WATER POLLINATION

- ✓ Pollen grains protected by mucilaginous covering.
- ✓ Large and ribbon shaped pollen grains in some species.
- ✓ They do not produce nectar/honey
- ✓ Eg : Fresh water plants- *Vallisneria, Hydrilla* Marine Plants - *Zostera*
- ✓ All aquatic plants are not pollinated by water,(Eichornia and water lilly are insect pollinating hydrophytes)

INSECT POLLINATION

- ✓ The flowers pollinated by insects are bright-coloured and produce nectar.
- ✓ The fragrance of the flowers attracts the insects.
- ✓ The pollen grains are sticky, large, and rough so that stick to the body of the insects.
- ✓ The stigmas are also sticky so that the pollens depositing are not dispersed.
- ✓ Eg.Cucumber,Sunflower,Aster

Artificial Hybridization

- ✓ It is one of the innovative methods of the crop improvement program.
- ✓ In artificial hybridization,only desired pollen grains are *are used forpollination and fertilization.*

Emasculation :

- ✓ Removal of anther from a bisexual flower before it releases pollen grain.
- ✓ In the case of unisexual flowers, this step is not necessary.

Bagging :

- ✓ Bagging is the protection of emasculated flower from contamination by undesirable pollen grains
- ✓ Here the flower is covered by a bag, until the flower attains receptivity.
- ✓ In unisexual flowers, bagging is done before the flowers are open.
- ✓ Once the flower attains stigma receptivity, the desired pollens are dusted on the stigma.

Double Fertilisation

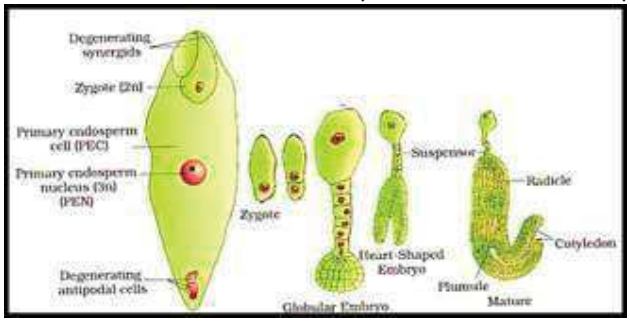
- ✓ After entering into one of the synergids,the pollen tube releases two male gametes in the cytoplasm of the synergid.
- ✓ One male gamete (n) fuses with egg(n) and form a zygote .It is called **Syngamy**.
- ✓ Other male gamete fuses with two polar nuclei to produce a triploid **primary endosperm nucleus (PEN)**.
- ✓ Since two types of fusion takes place in an embryo sac the phenomenon is called **double fertilisation.**
- ✓ The PEN develops into the endosperm and zygote develops into embryo.

Embryo

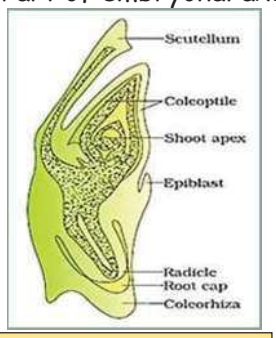
- ✓ Embryo develops at the micropylar end of the embryo sac where the zygote is located.
- ✓ Development of zygote to embryo starts only after endosperm formation has started.
- ✓ This is because endosperm provides nutrition needed for the embryo to develop.

Embryogeny

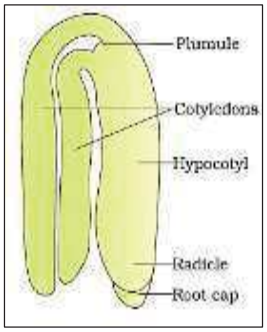
- ✓ Stages of embryo development are same in both monocot & dicot plants
- ✓ The zygote gives rise to the proembryo and subsequently to the globular, heart-shaped and mature embryo.



- ✓ **Dicotyledonous embryo has the following parts**
- ✓ 1. Embryonal axis - Main axis of the embryo which divides into different regions
- ✓ 2.Cotyledons/embryonic leaves provide nourishment to the developing radicle & plumule
- ✓ 3.Plumule(upper end of the embryonal axis)and radicle(lower end of the embryonal axis)
- ✓ 4. Epicotyle - Part of embryonal axis above the cotyledons which terminates at plumule
- ✓ 5 Hypocotyle - Part of embryonal axis below the cotyledons which terminates at radicle



MONOCOT EMBRYO

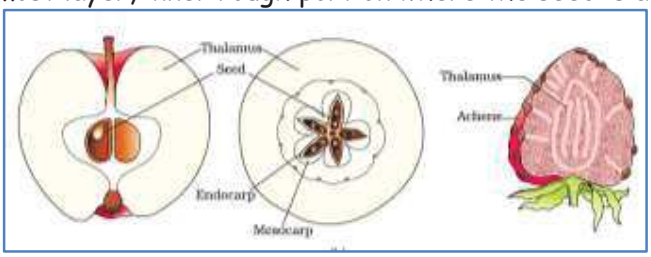


DICOT EMBRYO

- ✓ **Monocotyledonous embryo has the following parts**
- ✓ 1. Embryonal axis - Main axis of the embryo which divides into different regions
- ✓ 2.Single cotyledon called **scutellum** located at one side of the axis.
- ✓ 3.Plumule(upper end of the embryonal axis)and radicle(lower end of the embryonal axis)
- ✓ 4.Coleorrhiza: undifferentiated sheath covering radical & root cap
- ✓ 5.Coleoptile: sheath covering plumule

Fruits

- ✓ Fertilized and mature ovaries are called fruits
- ✓ The wall of ovary develops into wall of fruit called **pericarp.**
- ✓ In some fruits the pericarp is further differentiated into three layers, namely:
- ✓ Epicarp: Outermost layer, forms the peel.
- ✓ Mesocarp: Middle layer, fleshy, edible portion of the fruits
- ✓ Endocarp: Innermost layer, inner rough portion where the seed is accommodated.



- ✓ In true fruits only ovary contributes in fruit formation but in false fruit thalamus also contributes in fruit formation(Eg. Apple,Strawberry,Cashew
- ✓ Fruits formed without pollination and fertilization are called **Parthenocarpic fruits**.Eg.Banana
- ✓ Parthenocarpic fruits are generally seedless in nature.

3.STRATEGIES FOR ENHANCEMENT IN FOOD PRODUCTION

Dairy farm management

- Dairying is the management of animals for its milk and its product for human consumption.
- In dairy farm management, we deal with processes and systems that increase yield and improve quality of milk.
- Selection of good breeds having high yielding potential, combined with resistance to diseases is very important.
- Cattle have to be housed well, should have proper water and be maintained disease free.
- The feeding of cattle should be carried out in a scientific manner (quality and quantity of fodder).
- Strict cleanliness and hygiene are importance while milking, storage and transport of the milk and its products.
- Regular visits by a veterinary doctor would be mandatory for better management of cattle.
- Examples for superior breeds of cattle.
  Cow- Red Sindhi,Sahiwal and Gir
- Buffalo- Murrah, Mehsana and Surti

Bee-keeping

- Bee-keeping or apiculture is the maintenance of hives of honeybees for the production of honey.
- Honey is a food of high nutritive value and also finds use in the indigenous systems of medicine.
- Honeybees also produce beeswax that is used in the preparation of polishes and cosmetics.
- The most common species of honey bee is *Apis indica*.
- The following points are important for successful bee-keeping
  - Knowledge of the nature and habits of bees
  - Selection of suitable location for keeping the beehives
  - Catching and hiving of swarms
  - Management of beehives during different seasons
  - Handling and collection of honey and of beeswax.
- Bees are the pollinators of many of our crop species such as sunflower, Brassica, apple and pear.
- Keeping beehives in crop fields during flowering period increases pollination.
- It improves crop and honey yield.

Plant Breeding

- Plant breeding is a method of altering the genetic pattern of plants to increase their value and utility for human welfare.
- In fact, most of the crops grown in India, such as wheat and rice, have undergone plant breeding during the Green Revolution.
- It is the purposeful manipulation of plant species in order to create desired plant types that are better suited for cultivation, give better yields and are disease resistant.
- Plant breeding is done for the following objectives –
  - ✓ • to increase the crop yield
  - ✓ • to improve the quality of the crop
  - ✓ • to increase tolerance to environmental conditions like salinity. extreme temperatures and drought
  - ✓ • to develop a resistance to pathogens
  - ✓ • to increase tolerance to the insect pest

The main steps in plant breeding are

1. Collection of Variability

- Wild varieties species and relatives of the cultivated species having desired traits should be collected and preserved.
- The entire collection having all the diverse alleles for all genes in a given crop is called **germplasm collection**

2. Evaluation and Selection of Parents

- The germplasm collected is evaluated to identify the plants with desirable characters.
- It is made sure that only the pure lines are selected.
- The selected plants are multiplied and used in the process of hybridization.

3.Cross hybridisation among the selected parents

- The desired characters have to be combined from two different plants (parents).
- E.g. high protein quality of one parent is combined with disease resistance from another Parent
- The Pollen Grain from one desired parent plant(selected as a male parent) is collected and dusted over the stigma of another plant which is considered as the female parent.

4.Selection and testing of superior recombinants

- The selection process is crucial to the success of the breeding objective and requires careful scientific evaluation of the progeny.
- This step yields plants that are superior to both of the parents

5.Testing, releasing and commercialisation of new cultivars

- The newly selected lines are evaluated for their yield and other agronomic traits of quality, disease resistance, yield etc.
- This is done by growing them in the research fields and recording their performance under ideal fertilizer application irrigation and other crop management practices

Bio-fortification

- Breeding crops with higher levels of vitamins and minerals, or higher protein and healthier fats.
- Breeding for improved nutritional qualities have following objectives of improving ·
  - Protein content and quality.
  - Oil content and quality
  - Vitamin content
  - Micronutrient and mineral content
- Atlas 66, having a high protein content, has been used as a donor for improving cultivated wheat.
- **IARI,** New Delhi have released many varieties of vegetables crops rich in vitamnis and minerals like vitamin A enriched corrot, spinacch and pumpkin and vitaminC enriched bitter guard, bathua, mustard ,iron and calcium enriched spinach and bathua; and protein enriched beans – broad, lablab, French and garden peas.

Single Cell Protien (SCP)

- Single cell protein is one of the alternate sources of protein for animal and human nutrition.
- The idea of obtaining vitamins from microorganisms like mushrooms and yeast was developed to solve the problem of hunger and malnutrition.
- Microbes are grown on industrial scale as a source of good protien.
- Spirulina is rich in protein, minerals, fats, carbohydrate and vitamins.

- It is grown on materials like waste water from potato processing plants, straw, molasses, animal manure & sewage.
- This also reduces environmental pollution.
- *Methylophilus methilotrophus* has high rate of biomass production and growth, it can be expected to produce 25 tones of protein by 250 g of microorganism.

TISSUE CULTURE

- It is a method of growing cells, tissue or organ in a nutrient medium under controlled conditions.
- Part which is used for culturing is called explant.
- The capacity to generate whole plants form any plant cell/explant is called totipotency.
- The nutrient medium must provide a carbon source (such as sucrose), inorganic salts, vitamins, amino acids and growth regulators like auxins, cytokinins etc.
- The method of producing thousands of plants in very short time through tissue culture is called **micropropagation.**
- Each of these plants will be genetically identical to the original plant from which they were grown, i.e., they are somaclones.
- Tissue culture is also used for recovering healthy plants from diseased plants.
- The meristem (it will be free of virus) from infected plant is removed and grown it in vitro to obtain virus-free plants.
- Somatic hybridization: Protoplasts from two different varieties of plants (with desirable characters) are fused to get hybrid protoplasts.
- It can be grown to form a new plant called somatic hybrids. This process is called somatic hybridization.
- Protoplasts can be isolated after digesting the cell walls of single cells of plants.
- A protoplast of tomato has been fused with that of potato, to form new hybrid plants **(pomato)** with the characteristics of tomato and potato.
- But it has no useful characteristics for its commercial utilization.

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4.BIOTECHNOLOGY PRINCIPLES AND PROCESSES

TOOLS OF RECOMBINANT DNA TECHNOLOGY:

1.Restriction enzymes
2.Plymerase Enzyme
3.Ligase Enzyme
4.Cloning vector
5.Competent host (For transformation With Recombinant DNA)

Restriction Enzymes (Molecular Scissors):

- Restriction enzymes are the enzymes produced by certain bacteria and they have the property of cleaving DNA molecule at specific base sequences.
- A bacterium produces a restriction enzyme to defend against bacterial viruses called bacteriophages, or phages.
- The restriction enzyme prevents replication of the phage DNA by cutting it into many pieces.
- The restriction enzymes cut DNA at specific base pair sequence, and these specific base sequence is known as the **recognition sequence.**

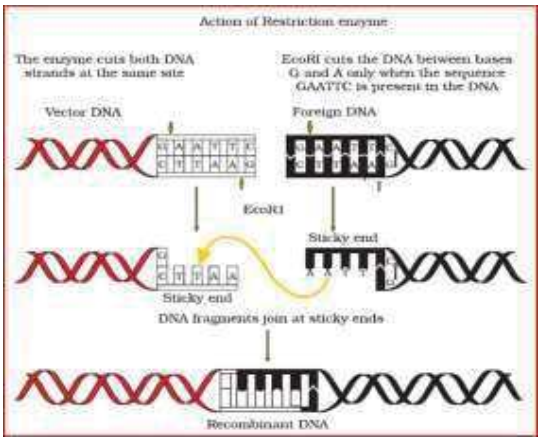
The first discovered restriction endonuclease - Hind II

Nomenclature of Restriction Enzymes

- The naming of restriction enzymes are based on their origin and type of action
  For e.g. Eco RI
- E - The first letter of the enzyme name comes from the first letter of the genus of the prokaryotic cell from which enzyme were isolated (here 'E' stands for Escherichia)
- Co - The second two letters come from the species name.('co' stands for coli)
- R- Third letter indicates first letter of name of strain('R' stands for RY 13 strain of bacteria from which the enzyme obtained)
- I (roman numeral one)- Indicates the order of discovery of enzyme
- Restriction enzymes belong to a larger class of enzymes called Nucleases.
- These are of two kinds; Exonucleases and Endonucleases.
- Exonucleases remove nucleotides from the ends of the DNA whereas, endonucleases make cuts at specific position within the DNA.
- Each restriction endonuclease recognizes a specific palindromic nucleotide sequences in the DNA.
- Palindromes are groups of letters that form the same words when read both forward and backward.eg. "MALAYALAM".
- The palindrome in DNA is a sequence of base pairs that reads same on the two strands when orientation of reading is kept the same.
- The recognition site of Eco,RI is given below ; it is a palindromic sequence

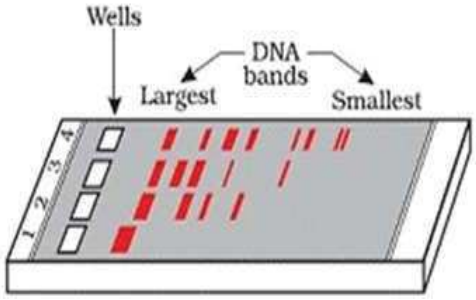
G A A T T C
C T T A A G

- Restriction enzymes cut the strand of DNA a little away from the center of the palindrome sites, but between the same two bases on the opposite strands.
- This leaves single stranded portions at the ends called Sticky ends.
- The stickiness of the strands facilitates the action of the enzyme DNA ligase.
- For e.g. EcoRI cut the DNA between G and A only when the sequence GATTC present in the DNA. It is the recognition site of EcoRI
- Restriction endonucleases are used in genetic engineering to form recombinant molecules of DNA which are composed of DNA from different sources or genome.



Separation and Isolation of DNA fragments (DNA of interest):

- The cutting of DNA by restriction endonucleases results in the fragments of DNA.
- These fragments can be separated by a technique known as Gel Electrophoresis.
- Negatively charged DNA fragments can be separated by forcing them to move towards the anode under an electric field through a medium.
- Nowadays most commonly used matrix/medium is Agarose Gel,which is a natural polymer extracted from sea-weeds.
- The DNA fragments are separated according to their size through sieving effect provided by the agarose .
- The particles with a smaller size have been reported to move faster and farther away from the well.
- As a result the molecules are separated by size.
- Electrophoresis enables you to distinguish DNA fragments of different lengths.
- The separated DNA fragments can be visualized only after staining the DNA with **Ethidium bromide** followed by exposure to UV radiation.
- Now DNA fragments appear bright orange coloured bands.
- The separated bands of DNA are cut out from the agarose gel and extracted from the gel piece. This step is known as **Elution**



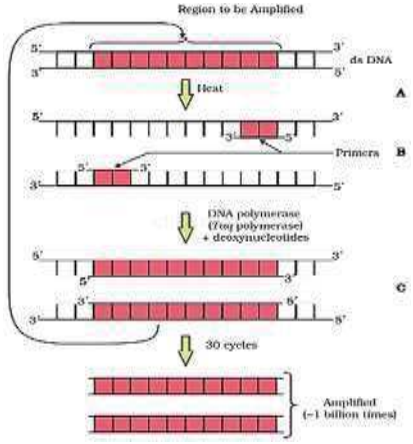
PROCESSES OF REOMBINANT DNA TECHNOLOGY:

- Recombinant DNA technology involves several steps in specific sequence such as

1)Isolation of the Genetic material
2)Cutting of DNA at specific locations
3)Amplification of Gene of interest using PCR
4)Insertion of Recombinant DNA Into the Host cell /organism 5)Obtaining Foreign gene product
6)Down stream Processing

3. Amplification of Gene of interest using PCR

- PCR stands for polymerase chain reaction. In this reaction, multiple copies of the gene of interest can be synthesized in vitro under three steps



1. Denaturation

- In this process the double stranded DNA is converted into the single stranded DNA.
- It is normally achieved by heating.

2. Annealing.

- The two sets of primers bind to their complementary sequences on single stranded DNA.
- Here primers are single-strand sequences of DNA around 20 to 30 bases in length.
- They serve as the starting point for the synthesis of DNA.

3. Extension

- The enzyme DNA polymerase extends the primers using the nucleotides provided in the reaction and the genomic DNA as template.
- If the process of replication of DNA is repeated many times segment of DNA can be amplified to approximately billion times.
- Such repeated amplification is achieved by the use of thermostable DNA polymerase (Taq polymerase enzyme obtained from bacteria called *Thermus aquaticus*)

Obtaining the Foreign Gene Product:

- The recombinant cells can be multiplied in large scale using a continuous culture system.
- Once the foreign DNA is inserted in to a host, it is multiplied and ultimately desirable protein is produced.
- For the production of the desired protein, the gene encodes for it needs to be expressed.

Bioreactors :

- Large scale production of desired proteins can be achieved by using bioreactors.
- In a bioreactor about 100 to1000 liters of cultures are processed.
- A bioreactor is a large culture vessel in which raw materials are biologically converted into specific products.
- The culture is done by using microbial , plant or human cells.
- In a bioreactor availability of optimum temperature , pH, substrate, salts, vitamins and oxygen are provided for culture.

Stirred-tank reactor:

- It is usually cylindrical or with a curved base to facilitate the mixing of the reactor contents.
- The stirrer facilitates even mixing and oxygen availability throughout the bioreactor.
- Alternatively air can be bubbled through the reactor.
- The bioreactor has an agitator system, an oxygen delivery system and a foam control system, a temperature control system, pH control system and sampling ports

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5 BIOTECHNOLOGY AND ITS APPLICATIONS

Biotechnological Applications in Agriculture

- The three options that can be thought for increasing food production are, a) Agro-chemical based agriculture b) Organic agriculture and c) Genetically engineered crop-based agriculture.
- Green revolution successfully increased the food production many folds by using better management practices and use of agrochemicals, fertilizers and pesticides.
- But yet it was not enough to meet the food needs the growing human population.
- Scientists have decided that use of genetically modified crops is a possible solution.
- Plants, bacteria, fungi and animals whose genes have been altered by manipulation are called **Genetically Modified Organisms (GMO).**
- Genetic modifications has many advantages.
  - Made crops more tolerant to abiotic stresses
  - Reduced reliance on chemical pesticides
  - Helped to reduce post harvest losses
  - Increased efficiency of mineral usage by plants
  - Enhanced nutritional value of food, eg., Vitamin 'A' enriched rice(Golden rice).

Application of Biotechnology in production of pest-resistant plants

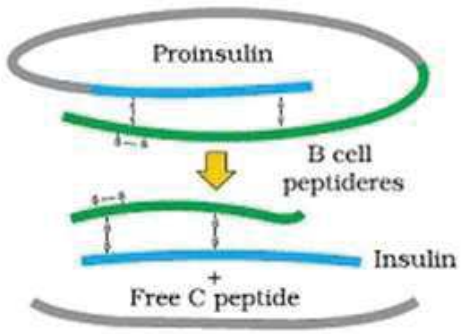
- Pest resistant plants decrease the amount of pesticides used.
- Bt toxin is produced by a bacterium called *Bacillus thuringiensis*.
- Bt toxin gene has been cloned from the bacteria and been expressed in plants to provide resistance to insects,This reduces the use of insecticides.
- Examples are Bt cotton, Bt corn, rice, tomato, potato and soya bean etc

Bt cotton

- Bacterium *Bacillus thuringiensis* produce proteins that kill certain insects like lepidopterans, coleopterans (beetles) and dipterans (flies, mosquitoes).
- *Bacillus thuringiensis* produce crystals that contain a toxic insecticidal protein.
- This toxic protein present in bacterium as inactive protoxins but as soon as insect ingest the inactive form, it is converted into an active form of toxin due to the alkaline pH of the gut which solubilise the crystals.
- The activated toxin binds to the surface of mid-gut epithelial cells and create pores that cause cell swelling and lysis and eventually cause death of the insect.
- The gene from *B. thuringiensis* has been incorporated into several crop plants like cotton, maize, rice etc.
- The toxin is coded by a gene named cry. The protein coded by the genes cry I Ac and cry II Ab control the cotton bollworms, cry I Ab controls corn borers.

GENETICALLY ENGINEERED INSULIN

- Diabetes is caused due to the decreased production of insulin.
- Adult diabetes can be controlled by taking insulin at regular intervals.
- Nowadays insulin can be prepared using techniques of biotechnology.
- Insulin was earlier extracted from pancreas of slaughtered cattle and pigs but insulin from these sources develops allergy or other types of reactions to the foreign protein.
- Insulin consists of two short polypeptide chains- chain A and chain B, that are linked together by disulphide bridges.
- In humans, insulin is synthesised as a prohormone, which contains an extra stretch called C-peptide(along with A peptide and B peptide),which is absent in mature insulin.
- The main challenge for production of insulin using rDNA technique was getting insulin assembled into a mature form



- In 1983 an American company called Eli Lilly first synthesised the genetically engineered insulin.
- They prepared two DNA sequences corresponding to A and B polypeptides of insulin.
- These DNA molecules for A and B polypeptides are introduced separately into *E. coli* bacteria through plasmid vectors.
- The bacteria then cultured and their progenies are made.

GENE THERAPY

- It is a collection of methods that allows correction of a gene defect that has been diagnosed in a child or embryo.
- The correction of defective gene involves delivery of a normal gene into the individual or embryo to take over the function of and compensate for non-functional gene.
- The first clinical gene therapy was done in 1990 to a 4 year old girl with **adenosine deaminase (ADA) deficiency**.
- This disorder is caused due to the deletion of the gene for adenosine deaminase that is essential for immune system to function.

Conventional treatment

- 1) In some children the disease is cured by bone marrow transplantation.
- 2) It can be also treated by injecting the functional enzyme (ADA) to the patient.

- The problem of above treatments is that they are not completely curative.

Gene therapy for ADA Deficiency

- As a first step towards gene therapy, lymphocytes from the blood of the patient are grown in a culture outside the body.
- A functional ADA, cDNA is then introduced into these lymphocytes.
- These lymphocytes are then returned into the patient.
- As these cells(lymphocytes) are not immortal the patient requires periodic infusion of such genetically modified lymphocytes
- However, if the gene isolate from bone marrow cells producing ADA is introduced into cells at early embryonic stages, it could be a permanent cure.

13.1.3 ADAPTATIONS

- Adaptation is morphological, physiological and behavioral attribute of an organism that enables them to survive and reproduce in their habitat.

Adaptation of animals in desert

- In the absence of an external source of water, the kangaroo rat in North American deserts is capable of meeting all its water requirements through its internal fat oxidation
- It also has the ability to concentrate its urine so that minimal volume of water is used to remove excretory products.

Adaptation of plants in desert

- Thick cuticle and sunken stomata on the leaf surface of many desert plants prevents loss of water.
- CAM plants open their stomata during night to reduce the loss of water during photosynthesis.
- In some plants like Opuntia , leaves are modifies into spines to reduce transpiration and photosynthesis takes place in flat green stem called as **phylloclade.**

Adaptation of animals in cold climate

- Mammals from colder climates have shorter ears and limbs to minimize heat loss. This is called Allen's Rule.
- In polar seas aquatic mammals like seals have a thick layer of fat called blubber, below their skin that acts as an insulator and reduces loss of body heat.

Adaptation in high altitude

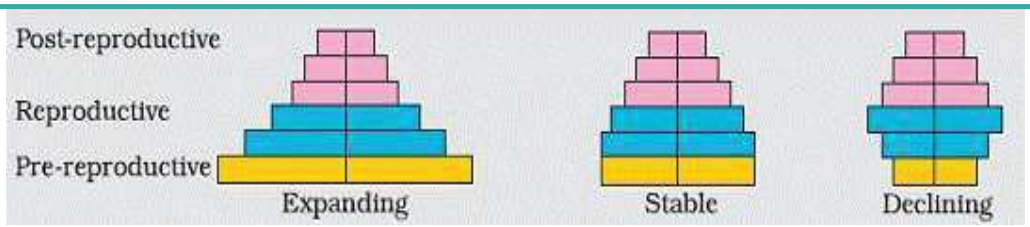
- When a person moves to high altitude place, develops altitude sickness because in the low atmospheric pressure of high altitudes, the body does not get enough oxygen.
- Symptoms include nausea, fatigue and heart palpitations.
- The body compensates low oxygen availability by increasing red blood cell production, decreasing the binding capacity of hemoglobin and by increasing breathing rate.
- The person gradually get acclimatized and stop experiencing altitude sickness. This is a type of physiological adaptation.

Behavioural adaptation

- Desert lizards deal with the high temperatures of their habitat, by managing to keep their body temperature fairly constant by behavioural adaptation.
- Desert lizards bask in the sun and absorb heat when their body temperature drops below the comfort zone and move into shade when the ambient temperature starts increasing.
- Some species are capable of burrowing into the soil to hide and escape from the above-ground heat

13.2.1 POPULATION ATTRIBUTES- AGE DISTRIBUTION

- Age distribution is also an important attribute of population.
- A population comprises different age groups such as pre-reproductive, reproductive and post-reproductive age groups.
- This age distribution is graphically represented by an age pyramid.
- The age pyramid indicates whether a population is growing, stable or declining.



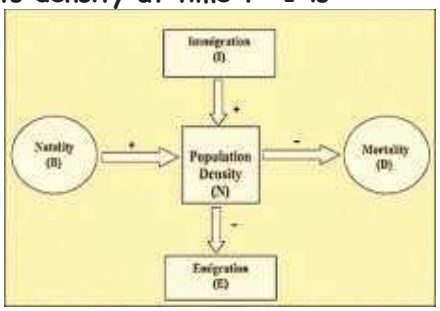
- It shows the size of the population. It is determined by counting the no.of individuals,or by biomass.
- The population size is more technically called as population density.
- Population density can be measured by
- Counting the number,by measuring percent cover or biomass, or Pug marks and faecal pellets for some animals.

13.2.2 POPULATION GROWTH

- The size of population is not static. It keeps changing with time, depending upon food availability, predation pressure and reduce weather.
- The density of a population in a given habitat during a given period, fluctuates due to changes in four basic processes which are
  - **1.Natality (B)** : Number of births during given period in the population that are added to the initial density
  - **2.Mortality (D)**:Number of deaths in the population during a given period.
  - **3.Immigration (I)** :It is the number of individuals of the same species that have come into the habitat from elsewhere during the time period under consideration
  - **Emigration (E)** : Emigration is the number of individuals of the population who left the habitat and gone elsewhere during the time period under consideration
- **If N is the population density at time t, then its density at time t +1 is**

$$N_{t+1} = N_t + [(B + I) - (D + E)]$$

Where
N = Population Density
B = the number of births
I = the number of immigrants
D = the number of deaths
E = the number of Emigrants.



Growth model

- Growth of population takes place according to availability of food, habit condition and presence of other biotic and abiotic factors.
- There are two main types of growth models

Exponential Growth

- Any species grow exponentially under unlimited resources conditions and can reach enormous population densities in a short time.
- Population grows exponentially and after attaining the peak value ,the population shows sudden decrease.
- For example many insect populations show rapid increase during rainy season followed by their disappearance at the end of season .
- This type of growth is not so realistic.

- If in a population of size N, the birth rates as represented as 'b' and death rate as 'd'. Then increase and decrease in N during unit period time 't' will be

  dN / dt = (b – d) × N
  Let (b – d) = r, then
  dN / dt = rN

  Then, the ' r ' in this equation is called 'intrinsic rate of natural increase'.
- In nature, a given habitat has enough resources to support a maximum possible number, beyond which no further growth is possible. This is called **carrying capacity (K)** of a habitat.
- Due to competition between individuals for limited resources, the fittest individual will survive and reproduce.
- A population growing in a habitat with limited resources show initially a lag phase, followed by phases of acceleration and stationary phase, when the population density reaches the carrying capacity.
- The logistic growth shows sigmoid curve and this is also called Verhulst-Pearl logistic growth

Where N = Population density at time t
r = Intrinsic rate of natural increase
K = Carrying capacity

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$$

13.1.3 POPULATION INTERACTIONS

PARASITISM

- Parasitism is generally defined as a relationship between the two living species in which one organism is benefitted at the expense of the other.
- The organism that is benefitted is called the parasite, while the one that is harmed is called the host.
- Some parasites are host-specific (one parasite has a single host) in such a way that both host and parasite tend to co-evolve.
- Some of the parasitic adaptations are-
  - Loss of unnecessary sense organs
  - Presence of adhesive organs or suckers to cling on to the host.
  - Loss of digestive system.
  - High reproductive capacity.
- The life cycles of parasites are often complex, involving one or two intermediate hosts or vectors to facilitate parasitism on its primary host.
- The human liver fluke depends on two intermediate hosts, a snail and a fish to complete its life cycle.

Effects of parasites on the host

- Majority of the parasites harm the host.
- They may reduce the survival, growth and reproduction of the host and reduce its population density.
- They make the host more vulnerable to the predators, by making it physically weak.

Types of parasite

ECTOPARASITE:

- Feeds on the external surface of the host. Eg.Lice on human ,Ticks on dog, Cuscuta ,a parasitic plant grow on hedge plants.

ENDOPARASITE:

- Parasites that live inside the host body at different sites. Eg. Tape worm, liver fluke.

BROOD PARASITISM:

- Special type of parasitism found in birds.
- The parasitic birds lay its eggs in the nest of its host and let the host incubate them.
- The egg of the host is very similar with the egg of the parasite. Eg.Cuckoo lays eggs in the nest of the crow.

COMMENSALISM:

- This is the interaction in which one species benefits and the other is neither benefited nor harmed. Some examples are
- Orchids growing as an epiphyte on a mango branch. Barnacles on back of whales.
- Clown fish living among tentacles of sea anemone. Cattle Egret and grazing cattle.

MUTUALISM

- Mutualism is the interaction between two living organisms where both the organisms are equally benefitted and no one is harmed.
- Lichens represent an intimate mutualistic relationship between a fungus and photosynthetic algae.
- Mycorrhizae are associations between fungi and the roots of higher plants
- Plants provide nectar and pollen for pollinating agents and the pollinating agents in turn pollinate the flowers of plants.
- Animals disperse the seeds of plants and plants provide juicy fruits for seed dispersers.
- Mutualism exists between fig tree and a pollinator species,wasp.
- A fig species can be pollinated only by its partner wasp species.
- The wasp pollinates the fig flower while in search for egg lying site,in return fig offers the wasp the developing seeds for developing larvae.

Sexual deceit

- Mediterranean orchid Ophrys employs 'sexual deceit'.
- Petal of the flower resembles the female bee.
- The male bee attracted to what it perceives as a female, 'pseudocopulates' with the flower but does not get any benefits.

14.2 PRODUCTIVITY

- In ecology, productivity refers to the rate of formation of biomass in the ecosystem.
- It can also be referred to as the energy accumulated in the plants by photosynthesis.
- There are two types of productivity, namely:
  1.Primary Productivity
  2.Secondary Productivity
- Primary productivity is defined as the amount of biomass or organic matter produced per unit area over a period time by plants during photosynthesis.
- Primary productivity is expressed in terms of weight or energy
- Primary productivity can be divided into
  a) Gross primary productivity (GPP)
  b)Net primary productivity (NPP).
- Gross primary productivity of an ecosystem is the rate of production of organic matter during photosynthesis.
- The solar energy trapped by the photosynthetic organism is called **gross primary productivity**
- Gross primary productivity minus respiration losses (R), is the net primary productivity (NPP). **GPP – R = NPP**
- It is the net energy stored in the plants. This energy serves as food for the animals that feed on plants.
- Secondary productivity is defined as the rate of formation of new organic matter by consumers.

14.3 DECOPOSITION

- Decomposition is the process by which the complex organic substances breakdown into simpler substances by the action of microorganisms.
- Dead plant remains such as leaves, bark, flowers and dead remains of animals, including fecal matter is called **detritus**.
- Detritus is the raw material for decomposition.
- **Detritivores** are the organisms that break down detritus into smaller particles. Example- millipedes, dung flies, woodlice, burying beetles.
- The important steps in the process of decomposition are
- Fragmentation, leaching, catabolism, humification and mineralisation

Fragmentation

- It is the initial stage of decomposition.
- Fragmentation means the breakdown of detritus into smaller pieces by the detritivores

Leaching

- The fragmented particles may contain a lot of water-soluble nutrients which are inorganic in nature.
- The process by which water soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts is called as leaching.

Catabolism

- The process by which bacterial and fungal enzymes degrade detritus into simpler inorganic substances called as catabolism.
- **Humification** is the accumulation of a dark coloured amorphous substance called humus.
- The humus is further degraded by some microbes and release of inorganic nutrients occur by the process known as mineralisation.

Factors affecting the rate of decomposition

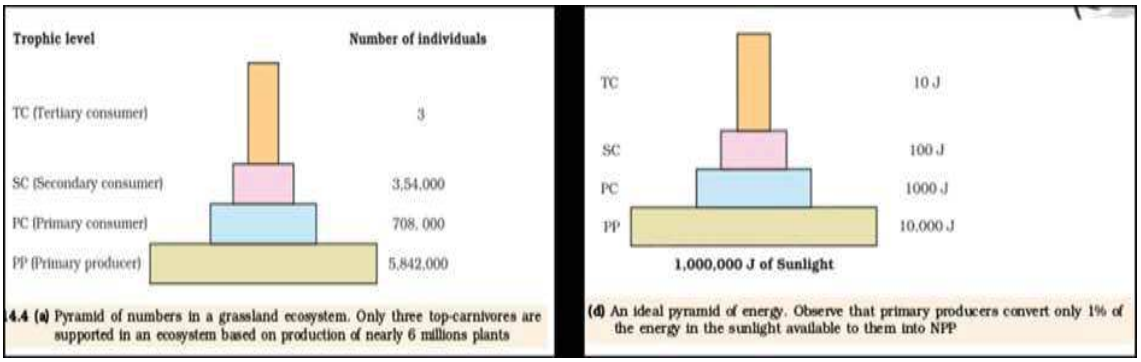
- **1. Chemical composition** - decomposition rate will be slow when detritus is rich in lignin and chitin
- Rate of decomposition increases when detritus is rich in nitrogen and water soluble substances like sugars.
- **2. Climatic conditions** – warm and moist environment favour decomposition and low temperature and anaerobiosis inhibit decomposition.

14.4 ENERGY FLOW

- All living organisms are directly or indirectly dependent on producers, for their food.
- There is a unidirectional flow of energy from the sun to producers and then to consumers.
- Photo synthetically active radiation (PAR) is responsible for the synthesis of food by plants.
- Animals obtain their food from plants, so they are called consumers.
- Animals feed on green plants are called primary consumers or herbivores.
- The animals eat herbivores are called secondary consumers or primary carnivores. Example- goat.
- The animals which feed on primary carnivores are called tertiary consumers or secondary carnivores. Example- man.
- Based on the source of their nutrition or food, organisms occupy a specific place in the food chain that is known as their trophic level.
- Producers belong to the first trophic level, herbivores (primary consumer) to the second and carnivores (secondary consumer) to the third trophic level.
- Food chain is the flow of energy from one trophic level to another trophic level by eating and being eaten.
- Food chain is two types-
  - **Grazing food chain (GFC)**
  - **Detritus food chain (DFC)**
- Food chain which starts from producers and ends on carnivores through herbivores is called grazing food chain. **Grass --> goat --> man**
- Food chain which starts from dead organic matter and passes through organisms feeding on detrivores is called detritus food chain.
- Detrivores are decomposers which meet their energy and nutrient requirements by degrading dead organic matter or detritus, these are also known as saprotrophs.
- The interconnected matrix of food chain is called **food web**.
- For example- specific herbivore of one food chain may serve as food of carnivores in another food chain.
- Each trophic level has a certain mass of living material at a particular time called as the **standing crop**.
- The standing crop is measured as the mass of living organisms (biomass) or the number in a unit area.

14.5 ECOLOGICAL PYRAMIDS

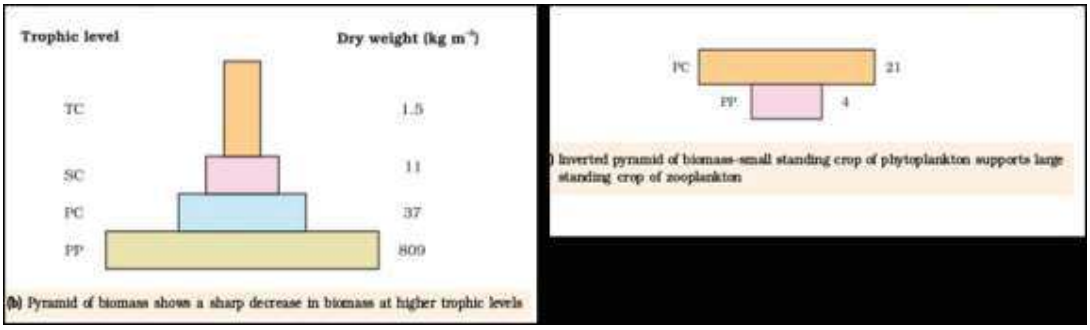
- An ecological pyramid is a graphical representation of the relationship between the different living organisms at different trophic levels.
- The base of a pyramid is broad and it narrows down at the apex.
- The base of each pyramid represents the producers or the first trophic level while the apex represents tertiary or top level consumer.



4.4 (a) Pyramid of numbers in a grassland ecosystem. Only three top-carnivores are supported in an ecosystem based on production of nearly 6 millions plants

(d) An ideal pyramid of energy. Observe that primary producers convert only 1% of the energy in the sunlight available to them into NPP

- The three ecological pyramids that are usually studied are
- **a) Pyramids of number-** employs the number of individuals per unit area at various trophic levels with producer at base and various consumers at successively higher levels.
- It is generally upright.
- A pyramid of number in case of a big tree is generally inverted because number of insects feeding on that tree generally exceeds in number.



(b) Pyramid of biomass shows a sharp decrease in biomass at higher trophic levels

) Inverted pyramid of biomass–small standing crop of phytoplankton supports large standing crop of zooplankton

- **b) Pyramids of biomass**- represent the biomass in various trophic levels.
- A pyramid of biomass is upright except in aquatic food chain involving short lived plankton.
- A pyramid of biomass in sea is generally inverted because biomass of fishes generally exceeds that of phytoplankton
- **c) Pyramids of energy**- that gives graphic representation of amount of energy trapped by different trophic levels per unit area.
- Pyramid of energy is always upright, can never be inverted, because energy flows from producer level to the consumer level.

Limitations of ecological pyramids

- It does not taken into account the same species belonging to two or more trophic levels.
- It assumes a simple food chain, something that almost never exists in nature
- It does not accommodate a food web.
- Saprophytes are not given any place in ecological pyramids.

14.7 NUTRIENT CYCLING

- The movement of nutrient elements through the various components of an ecosystem is called nutrient cycling.
- It is also called as biogeochemical cycles.
- The amount of nutrients present in the soil at any given time, is called as the **standing state**
- The reservoir for gaseous type of nutrient exists in the atmosphere and for the sedimentary cycle the reservoir is located in Earth's crust.

Phosphorus Cycle

- Phosphorus is a major constituent of biological membranes, nucleic acids and cellular energy transfer systems.
- Many animals also need large quantities of this element to make shells, bones and teeth.
- The natural reservoir of phosphorus is rock, which contains phosphorus in the form of phosphates.
- When rocks are weathered, minute amounts of these phosphates dissolve in soil solution and are absorbed by the roots of the plants.
- Herbivores and other animals obtain phosphorous from plants.
- The waste products and the dead organisms are decomposed by phosphate-solubilizing bacteria releasing phosphorus.

Phosphorus cycle:

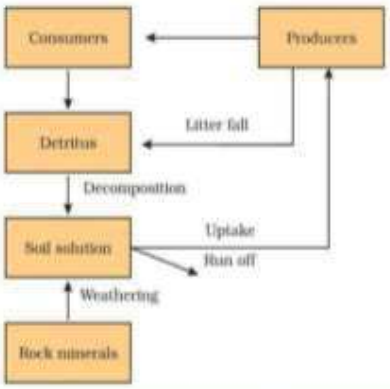


Figure 14.7 A simplified model of phosphorus cycling in a terrestrial ecosystem

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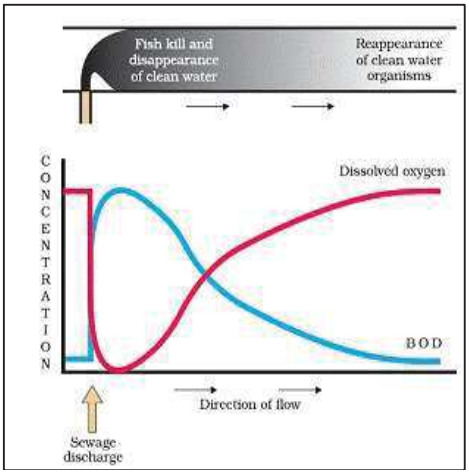
8.ENVIRONMENTAL ISSUES

16.2 WATER POLLUTION AND ITS CONTROL

- Any undesirable change in the physical, chemical or biological characteristics of water is called water pollution.
- Government of India has passed the Water (Prevention and Control of Pollution) Act, 1974 to protect the water resources.
- When water gets polluted, it adversely affects all lifeforms that directly or indirectly depend on this source
- Sewage is a domestic waste contains biodegradable organic matter, nitrates, phosphates, and other nutrients, and toxic metal ions.
- The amount of organic matter in sewage water is estimated by measuring **Biochemical Oxygen Demand (BOD).**
- The amount of oxygen needed by biological organisms (such as bacteria) in a given water sample for the breakdown of organic matter by oxidation process is called the Biochemical Oxygen Demand.



Harmful effects of water pollution

- Micro-organisms involved in biodegradation of organic matter in the receiving water body consume a lot of oxygen.
- It results in a sharp decline in dissolved oxygen (DO) downstream from the point of sewage discharge which causes mortality of fish and other aquatic organisms.
- Sewage from our homes as well from hospitals contains many undesirable pathogenic microorganisms which can cause diseases like dysentery, typhoid, jaundice and cholera.

1.ALGAL BLOOM

- Presence of large amount of inorganic nutrients in water causes excessive growth of planktonic or free floating algae called algal bloom.
- Due to the presence algal bloom colour of water bodies get changed.
- This may cause deterioration of the water quality and fish mortality.

2.BIOMAGNIFICATION OR BIOLOGICAL MAGNIFICATION

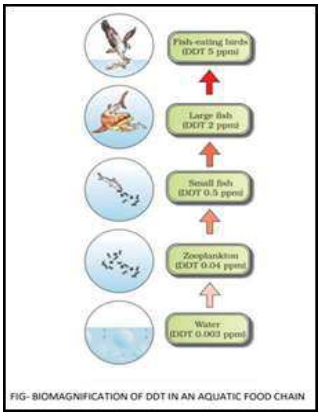


FIG- BIOMAGNIFICATION OF DDT IN AN AQUATIC FOOD CHAIN

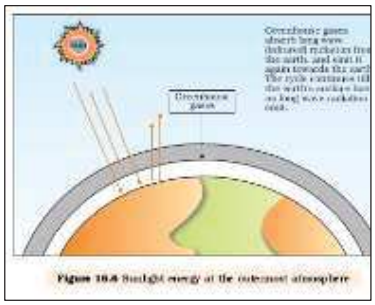
- Toxic wastes present in industrial wastes and water from farmhouse containing pesticides and weedicides, this may enter the food chain of aquatic organisms.
- The increase in concentration of toxicant at each successive trophic levels is called biological magnification.
- The most common toxicant that get accumulated at successive trophic levels includes DDT and Mercury.
- High concentrations of DDT disturb calcium metabolism in birds, which causes thinning of egg shell and their premature breaking eventually causing decline in bird population.

3.EUTROPHICATION

- It is the natural aging of a lake by biological enrichment of its water.
- Due to addition of nutrients such as nitrogen and phosphorus that encourage the growth of aquatic organism.
- The accumulation of organic remains in course of time leads to shallowing of lake.
- Over the centuries the silt and organic debris piles up at the bottom of lake and encourage the growth of marshy plants in the shallow and begin to fill in the original lake basin.
- Eventually large masses of floating plants grows and finally converting into land.
- The pollutants from man's activities such as effluents from the industries and homes radically accelerate the aging of lake.
- This phenomenon is called Cultural or **Accelerated Eutrophication**

16.6 GREEN HOUSE EFFECT AND GLOBAL WARMING

- The greenhouse effect is a naturally occurring phenomenon that is responsible for heating of Earth's surface and atmosphere.
- Carbon dioxide and methane are commonly known as greenhouse gases.
- Clouds and gases reflect about $\frac{1}{4}$ th of the incoming solar radiation and absorb some of it.
- Almost half of incoming solar radiation falls on Earth's surface heating it, while a small proportion is reflected back.
- The surface of earth re- emits heat in the form of infrared radiation.
- During this process, the heat is absorbed by the greenhouse gases in the earth's atmosphere.
- This is makes the surface of the earth warm.
- Greenhouse effect is important to increase the temperature which is essential for the organisms to live.



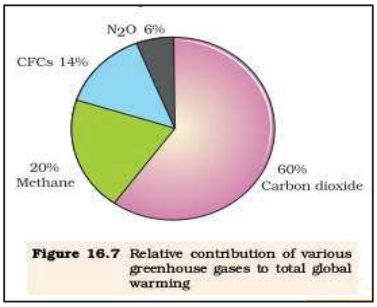


Figure 16.7 Relative contribution of various greenhouse gases to total global warming

Global Warming

- It is the phenomenon of a gradual increase in the average temperature of the Earth's atmosphere.
- The main cause for this environmental issue is the increased volumes of greenhouse gases such as carbon dioxide and methane.

Effects of global warming:

- Deleterious changes in the environment and resulting in odd climatic changes (e.g. El-Nino effect).
- Increased melting of polar ice caps as well as of other places like the Himalayan snow caps.
- Rise in sea level that can submerge many coastal areas.

CONTROL OF GLOBAL WARMING:

1. Reduce use of fossil fuel.
2. Improving efficiency of energy usage.
3. Reducing deforestation.
4. Promoting aforestation programme.
5. Slowing down growth of human population

16.7 OZONE DEPLETION

- Ozone found in the upper part of the atmosphere (stratosphere).
- It acts as a shield absorbing ultraviolet radiation from the sun.
- The thickness of the ozone-layer in a column of air from the ground to the top of the atmosphere is measured in terms of Dobson units (DU).
- Ozone (O3) gas is continuously formed by the action of UV rays on molecular oxygen, and also degraded into molecular oxygen in the stratosphere.
- There should be proper balance of formation and degradation of ozone.
- The balance has been disrupted due to enhancement of ozone degradation by chlorofluorocarbons (CFCs).
- **Steps leading to ozone depletion :**
  - UV-rays split CFCs and release atomic chlorine (Cl)
  - UV-rays also split ozone into oxygen.
  - Chlorine atoms trap oxygen atoms and ozone is not formed again from oxygen. This leads to depletion of ozone in the stratosphere
- Ozone layer depletion is the thinning of the ozone layer present in the upper atmosphere.
- Ozone depletion resulted in formation of a large area of thinned ozone layer, commonly called as the ozone hole.
- Ozone layer absorbs the harmful UV-rays. It causes aging of skin, damage to skin cells and various types of skin cancers.
- In human eye, cornea absorbs UV-B radiation, and a high dose of UV-B causes inflammation of cornea, called snow-blindness cataract, etc. Such exposure may permanently damage the cornea.

16.9 DEFORESTATION

- It is the conversion of forested areas to non-forested ones due to human activities like slash and burn agriculture also called Jhum cultivation.
- In Jhum cultivation farmers cut down trees and burn the plant remains.
- Ash is used as a fertiliser and the land is then used for farming or cattle grazing ;use of fertilizers and cutting of trees for industries and residential use.
- Main consequence of deforestation includes-
  - Enhanced carbon dioxide concentration
  - Loss of biodiversity
  - Disturbed hydrologic cycles
  - Soil erosion
  - Desertification etc.
- **Reforestation:** Process of restoring a forest that was removed at some point of time in the past.
- The Government of India has recently started the **Amrita Devi Bishnoi Wildlife Protection Award.**

- This award is given to individuals or communities from rural areas that have shown extraordinary courage and dedication in protecting wildlife.
- **Chipko Movement** – In 1974, local women of Garhwal Himalayas showed tremendous courage in protecting trees from the axe of contractors by hugging them.
- People all over the world have appreciated the Chipko movement.
- Realising the importance of participation by local communities, the Government of India in 1980s has introduced the concept of **Joint Forest Management (JFM)** so as to work closely with the local communities for protecting and managing forests.

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