VIJAYABHERI

Malappuram District Panchayath Educational Project

2020-21

Focus-'21

Botany

Study material for higher secondary examination March '21

Prepared by:-

Dhanya
AMHSS, Kottur

Nandhini M.
NHSS, Kolathur

1. REPRODUCTION IN ORGANISM
2. SEXUAL REPRODUCTION IN FLOWERING PLANTS
3. STRATEGIES FOR ENHANCEMENT IN FOOD PRODUCTION
4. BIOTECHNOLOGY-PRINCIPLES AND PROCESSES
5. BIOTECHNOLOGY AND ITS APPLICATIONS
6. ORGANISMS AND POPULATIONS
7. ECOSYSTEM
8. ENVIRONMENTAL ISSUES

Chaper 1 :

REPRODUCTION IN ORGANISMS

Focus points

- Asexual reproduction
- Gametogenesis
- Fertilisation

Reproduction

Based on whether there is participation of one organism or two in the process of reproduction, it can be classified into two types.

(A) Asexual reproduction (B) Sexual reproduction

Asexual reproduction: Uniparental, No gametic fusion

Clone – Morphologically and genetically similar individuals produced through asexual reproduction.

Modes of Asexual reproduction in organisms

1. Cell division - Parent cell divides into two and grows to new organism
2. Binary fission – The cell divides into two halves and each rapidly grows into an adult.
3. Budding – Small **buds** remain attached to the parent cell which finally separated from parent cell and mature into new organism.

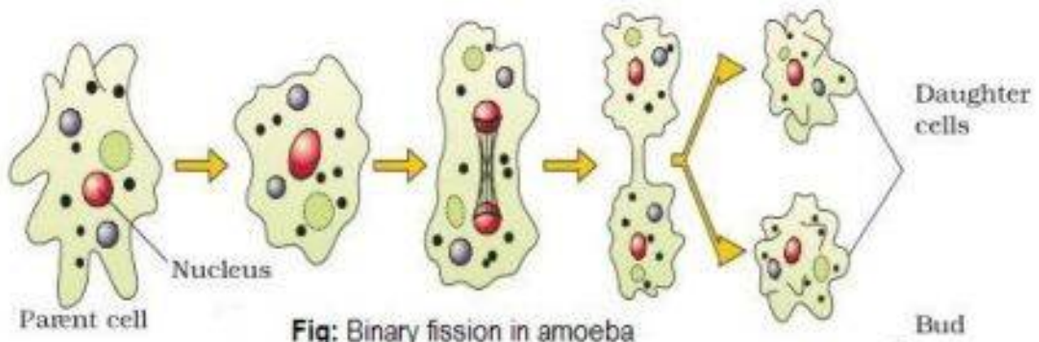


Fig: Binary fission in amoeba

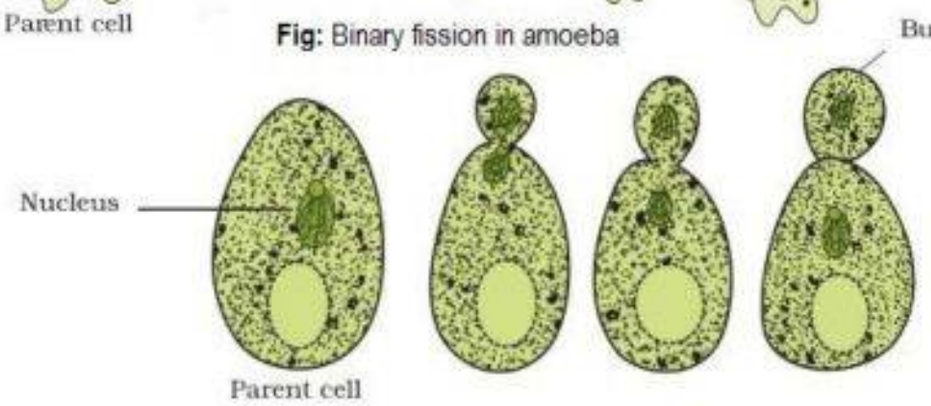
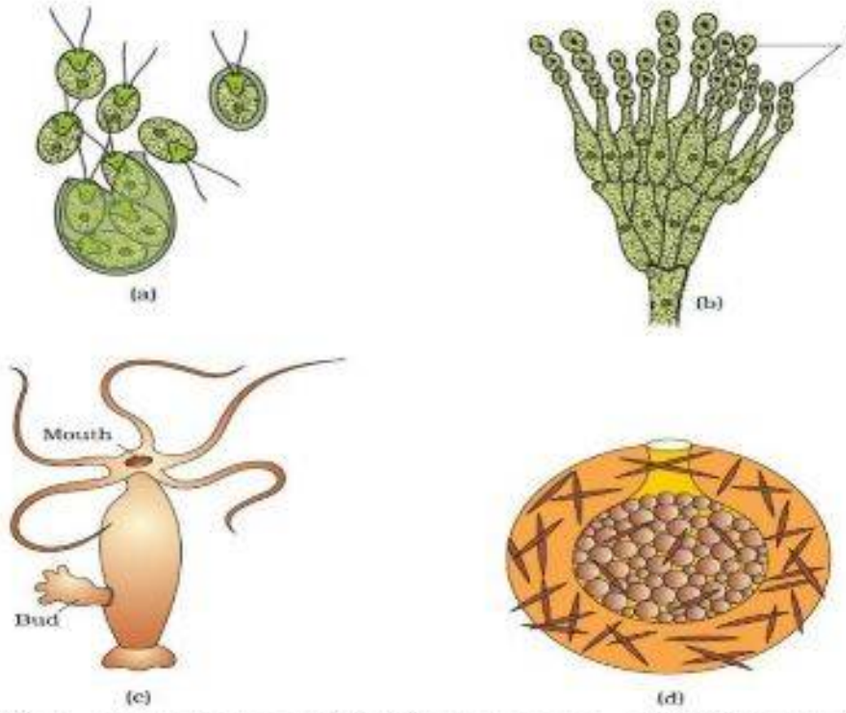


Fig: Budding in yeast

4. Encystation & Sporulation
   Encystation - unfavourable conditions →the amoeba withdraws its pseudopodia → secretes a three layered hard covering or Cyst around itself.
   Sporulation -favourable conditions →the encysted amoeba divides by multiple fission → many minute amoeba or Pseudopodiospores →The cyst wall bursts out → spores are liberated → grow up into many amoebae.
5. Fragmentation – body breaks into fragments , each fragment grows into an adult .
6. Zoospores – Microscopic motile structure
7. Conidia – Nonmotile exogenously formed structures
8. Gemmules – Endogenously formed buds.



Asexual reproductive structures. (a) Zoospores of Chlamydomonas (b) Conidia of Penicillium (c) Buds in Hydra (d) Gemmules in Sponge

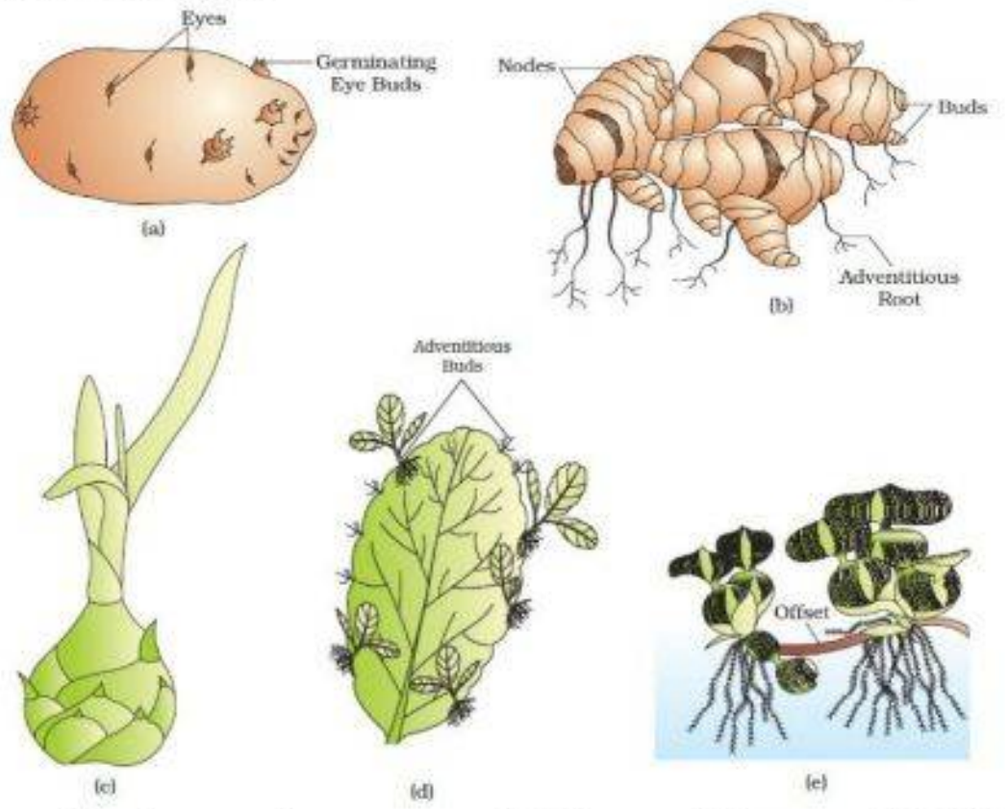
Mode of asexual reproduction	Organism
Cell division	Monera & Protista
Binary fission	Amoeba & Paramecium
Budding	Hydra, Yeast
Fragmentation	Hydra
Encystation &Sporulation	Amoeba
Zoospores	Chlamydomonas
Conidia	Penicillium
Gemmule	Sponge

Vegetative reproduction –

- Regeneration of new plants from vegetative part / **Vegetative propagules.**
- Uniparental.

New plants from Nodes of modified stem

- Buds (eyes) - potato
- Rhizome of banana & ginger



Vegetative propagules in angiosperms. (a) Eyes of Potato (b) Rhizome of Ginger (c) Bulbil of Agave (d) Leaf buds of Bryophyllum (e) Offset of water hyacinth

Vegetative propagule	Example
Tuber	Potato
Rhizome	Ginger
Bulb	Onion
Runner	Grass,Oxalis,Hydrocotyl
Offset	Pistia, Eichhornia
Sucker	Chrysanthemum
Leaf bud	Bryophyllum
Bulbil	Agave

Terror of Bengal – Water hyacinth (Eichhornia), an aquatic weed. Propagate vegetatively at a rapid rate.

- It drains oxygen from water
- death of fishes
- water pollution.

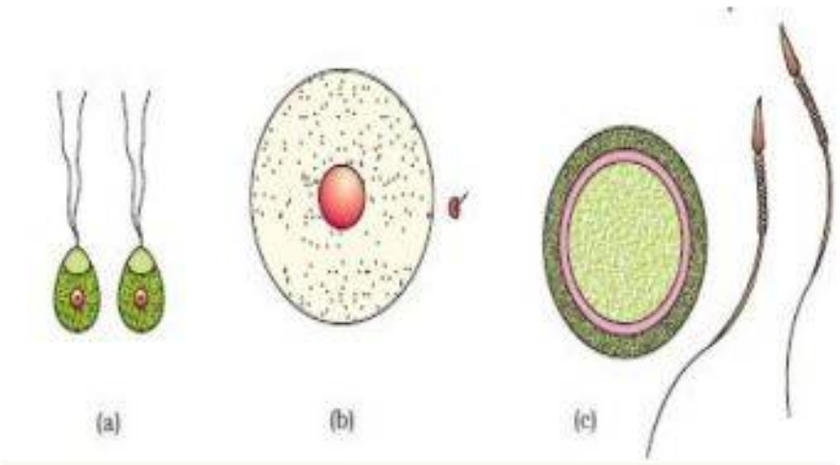
Sexual reproduction

- Fusion of male and female gametes.
- Biparental.

Gametogenesis - Process of formation of two types of gametes. – male &female. Gametes are haploid cells.

Homogametes/Isogametes – Morphologically similar gametes. e .g., Cladophora.

Heterogametes/Anisogamete – Morphologically dissimilar gametes. Male gamete is **antherozoid** or **sperm** , female gamete is **egg** or **ovum** .



Types of gametes. (a) Isogamete of Cladophora (b) Heterogamete of Fucus (c)Heterogamete of humanbeing

Sexuality in Flowering plants

Bisexual – Male and female reproductive structures in same plant or same flower. e.g., Hibiscus, Ixora etc.

Unisexual – Male and female reproductive structures on different plants or different flowers. e .g., Papaya, Datepalm, cucurbita etc. They are of two types.

a) **Staminate** – Unisexual male flower which bear stamens.
b) **Pistillate** – Unisexual female flower which bear pistils.

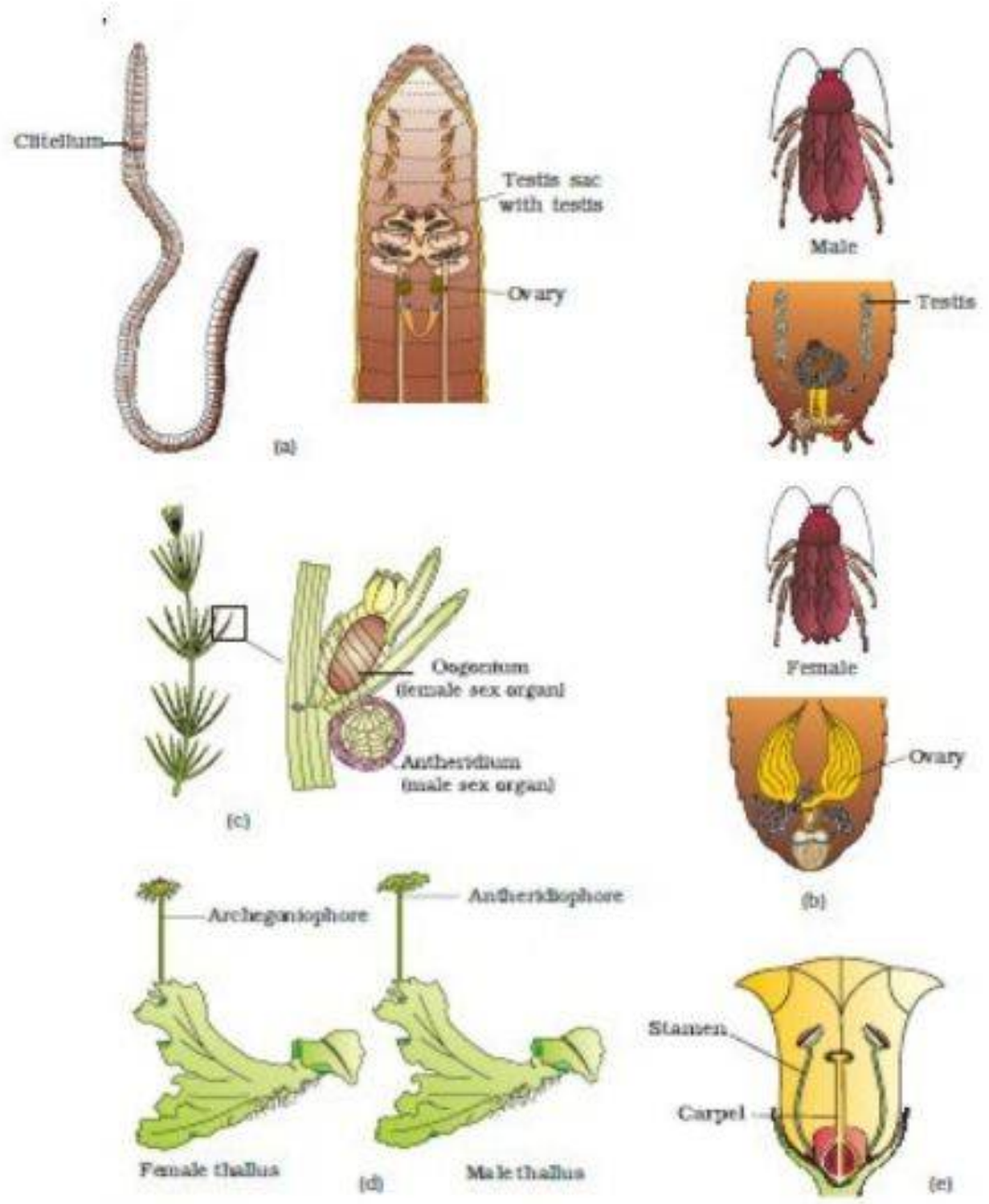
Unisexual plants are again grouped into two. They are

a) **Monoecious -** male and female flowers on the same plant. e.g., Coconut, Cucurbita etc.
   Homothallic - male & female sex organ on the same thallus. e .g. Chara.
b) **Dioecious** – male and female flowers on different plants. e.g., Papaya, Date palm. **Heterothallic -** male & female reproductive structure on different thalli. e.g., Marchantia.

Sexuality in animals –

Bisexual animals/ Hermaphrodites – Animals which possess both male and female reproductive organs. e .g., Earthworm, Sponge, Tapeworm, and Leech.

Unisexual animals – Individuals are either male or female. e .g., Human beings, Cockroaches, Cat etc.



Diversity of sexuality in organisms. (a) Bisexual animal (Earthworm) (b) Unisexual animal (cockroach) (c) Monoecious plant (chara) (d) Dioecious plant (Marchantia) (e) Bisexual flower (Sweet potato.

Cell division during gamete formation – Gametes in all heterogametic species are of two types. They are **male** & **female** . Gametes are haploid.

Haploid parent produces gametes by **mitosis** . e .g., Monera, Fungi, Algae and bryophytes.

Diploid parent produces gametes by **meiosis** . e.g., Pteridophytes, Gymnosperms, Angiosperms and most of the animals including Man.

Name of organism	Chromosome number	
	In meiocyte	In gamete
Human being	46	23
Housefly	12	6
Rat	42	21
Dog	78	39

Cat	38	19
Fruitfly	8	4
Ophioglossum	1260	630
Apple	34	17
Rice	24	12
Maize	20	10
Potato	48	24
Butterfly	380	190
Onion	16	8

Meiocytes - Specialised cells/**gamete mother cells** in diploid organisms , which undergo meiosis to form haploid gametes.

Fertilisation/ Syngamy

Male gamete (n) + Female gamete (n) → Zygote (2n)

Parthenogenesis - The female gamete develops into new organisms without fertilization. e .g., **Rotifers, Honeybees, Some lizards and birds (turkey)**

External fertilization – Syngamy occurs outside the body of organisms in the external medium (water). e .g. majority of **algae, fishes and amphibians**.

Advantages of external fertilization

a) Release of male and female gametes at the same time.
b) Release large number of gametes into the surrounding medium.
c) Large number of offsprings are produced. e.g., bony fishes and frog

Disadvantage of external fertilization

Offsprings are vulnerable to predators.

Internal fertilization – Syngamy occurs inside the body of organism.

e.g., many terrestrial organisms belonging to **Fungi, raptiles, mammals, bryophytes, pteridophytes, gymnosperms and angiosperms.**

- Egg is formed inside the body of female parent, where they fuse with male gamete.
- Male gametes are motile, number of male gametes produced is very large.

- The number of eggs produced is very small.
- In seeded plants (gymnosperms &angiosperms) the non –motile male gametes are carried to female gamete by pollen tube.

Previous questions and answers

1 MARK QUESTIONS

1. Name the process of formation of new organism directly from an unfertilized egg
2. The asexual reproductive structure of Sponges are……..
3. Bulbil is the vegetative propagule of which plant ?
4. Chromosome number in meiocyte of Ophioglossum is …… (n=630)
5. Name the asexual reproductive structure of penicillium

2 MARK QUESTIONS

6. Which of the following are monoecious and dioecious?
Earthworm
Chara
Marchantia
Cockroach
7. All papaya and date palm plants bear flowers but fruits are seen only in some. Why?
8. Leaves not only produce food but also produce young ones. Justify with one example
9. Write technical terms for the following
a) Morphologically different types of gametes
b) Process of formation of male and female gametes

3 MARK QUESTIONS

10. What are the differences between external fertilization & internal fertilization? Mention the disadvantages of external fertilisation.
11. Describe the post fertilization changes in a flower.

Answers

1.Parthenogenesis
2.Gemmules
3.Agave
4.1260
5. Conidia

6. Earthworm-Monoecious

Chara -Monoecious

Marchantia –Dioecious

Cockroach –Dioecious

7. They are dioecious plants or Male and female flowers on different plant. Fruits are seen only in pistillate flowers.

8.In some plants the leaves are the means of vegetative propagation in addition to photosynthesis. In such plants, plantlets are formed on the leaves. Eg; Bryophyllum

9. a) Heterogametes

b) Gametogenesis

10. **External fertilization –**

- Syngamy occurs outside the body of organism
- Release large number of gametes into water
- Release male and female gametes at the same time to external medium
- large number of offsprings are produced.

Internal fertilization –

- •Syngamy occurs inside the body of organisms
- •Male gametes are motile & produced in large numbers .
- •Egg is formed inside the body of organism
- •Number of egg produced is less and are nonmotile
- •Male gametes are carried to female gametes by different agents

Disadvantage of External fertilization

- •Offsprings are vulnerable to predators
- •There is no protection to young ones
- •Require synchronous release of male& female gametes (Gametes must be released at the same time)

11.i) Zygote develops into embryo

ii) Ovule develops into fruit

iii) Ovary develops into fruit

iv) Sepals,petals and stamens fall off.

CHAPTER 2:

SEXUAL REPRODUCTION IN FLOWERING PLANTS

Focus points

- Structure of microsporangium,structure of pollen grain
- Megasporangium-structure,Megasporogenesis,Female gametophyte
- Pollination-classification basedon source of pollen(Autogamy,Geitonogamy,Xenogamy)and agents of pollination(wind,water and insects- Peculiarities withexamples)and artificial hybridization
- Double fertilization
- Embryo structure
- False fruit,True fruit and Parthanocarpic fruit

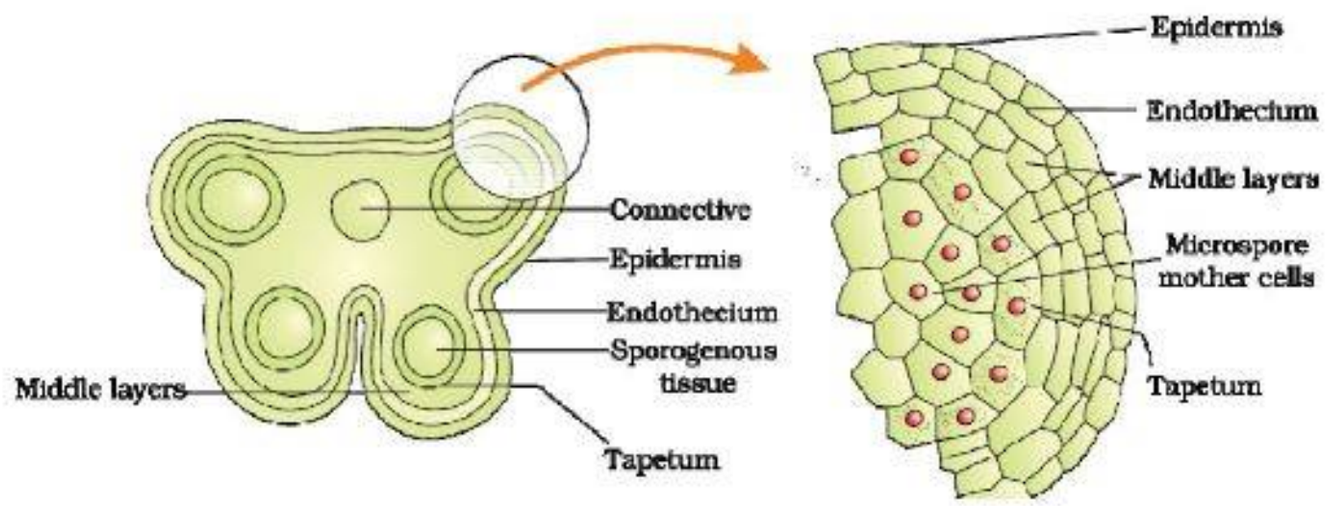
STRUCTURE OF MICROSPORANGIUM

Microsporangium is surrounded by four wall layers. In T.S, microsporangium appears circular in outline

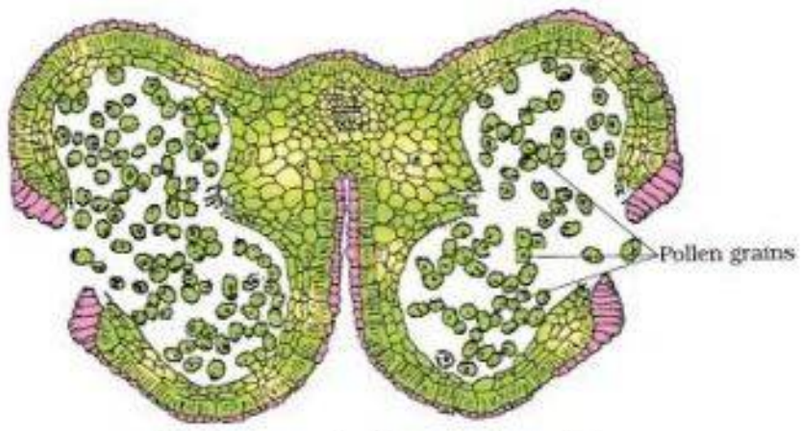
- **Epidermis –** Protection &dehiscence of anther to release pollen
- **Endothecium -** Protection &dehiscence of anther to release pollen
- **Middle layers** - Protection &dehiscence of anther to release pollen
- **Tapetum** – Innermost wall layer. Multinucleated. Dense cytoplasm present. Nutritive tissue which give food to developing pollen grains.

A typical **young anther** has **four microsporangia.** When anther mature, the wall between two microsporangia in each lobe disorganizes and forms two pollen sacs with numerous pollen grains. Anther wall breaks and pollengrains are liberated.

Sporogenous tissue – Located at the centre of each microsporangium. Group of tissues which contain microspore mother cells. Surrounded by tapetum



Structure of young anther Microsporangium- Enlarged view



Mature dehisced anther

Microsporogenesis

The process of formation of haploid **microspores** from diploid **microspore mother cell / pollen mother cell (PMC)** through **meiosis**

Microspore tetrad – Microspores arranged in a group of four cells. Each cell of the sporogenous tissue gives rise to microspore tetrad.

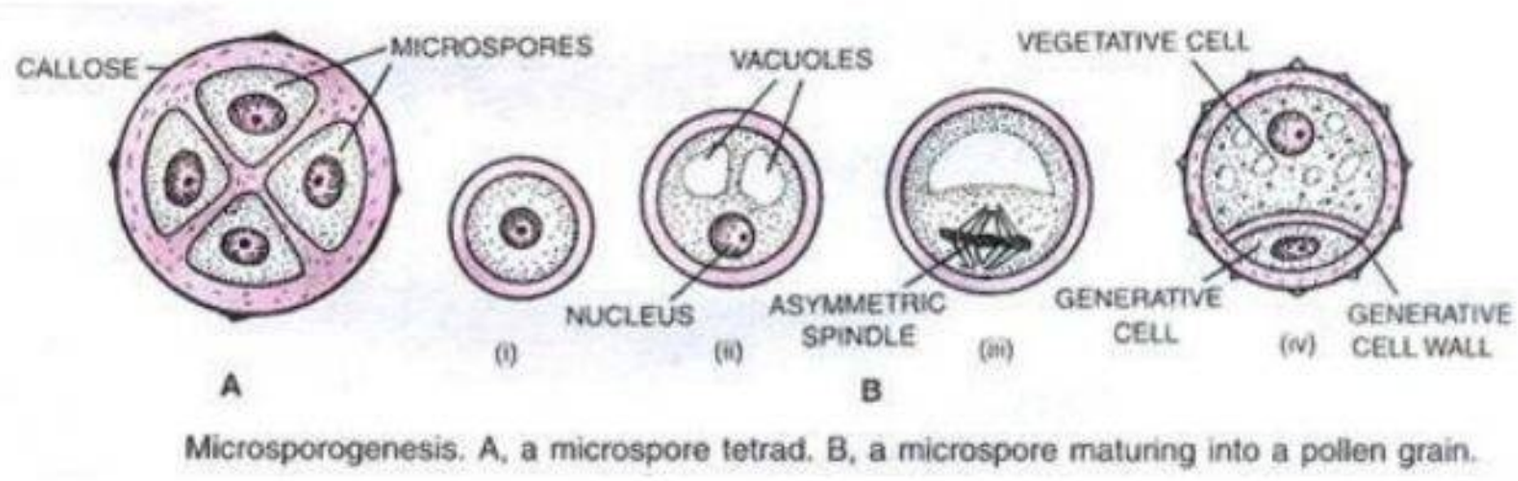
As the anther mature and dehydrate haploid microspores separate from each other and develop into pollen grain. Each microsporangium encloses thousands of pollen grain. Pollen grains are released with the dehiscence.

STRUCTURE OF POLLEN GRAINS

Pollen grains represent **male gametophyte.**

- **Spherical in shape** about 20-25 micrometers in diameter.
- Two wall layers. **Exine** & **Intine**
- **Exine –** Hard outer layer , made up of **sporopollenin.**
- **Sporopollenin** – Highly resistant organic material. It can resist high temperature, strong acids &alkali. Cannot be degraded by enzymes. Due to the presence of sporopollenin, pollen grains **preserved as fossils.**
- **Germ pores –** Thin walled area in exine where sporopollenin is absent.Pollen tube comes out through germ pore during germination.
- **Intine** – Inner thin layer of pollen grain , made up of **cellulose & pectin**
- Pollen grain has central haploid nucleus and dense cytoplasm. Later vacoules develop , pushing the nucleus towards the periphery. Cytoplasm is surrounded by plasma membrane.
- Haploid nucleus divides to form two **celled male gametophyte.**
- **Vegetative cell** – Bigger cell. Contain reserve food materials. Large irregularly **shaped nucleus.**

- **Generative cell** – Small cell. Float in the cytoplasm of vegetative cell. Spindle shaped with dense cytoplasm and nucleus.
- Generative cell divides mitotically into two non motile male gametes (**three celled stage** with one vegetative cell and two male gametes.**)**
- Over 60% of angiosperms pollengrains shed at 2 celled stage. In others, at 3 celled stage.

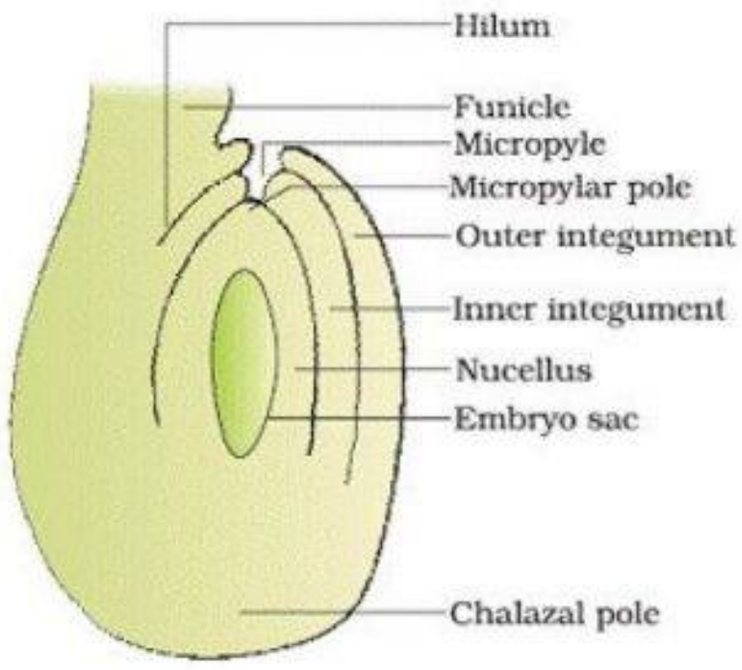


Microsporogenesis. A, a microspore tetrad. B, a microspore maturing into a pollen grain.

MEGASPOROGENESIS

The process of **formation** of haploid **megaspores from** diploid **megaspore mother cell (MMC)** through **meiosis.**

STRUCTURE OF MEGASPORANGIUM / OVULE



Funicle – Stalk of the ovule

Hilum – Junction between ovule and funicle.

Nucellus – Multicellular mass of tissue with resrerve food materials (Give food to Embryo sac). **Integuments** – Protective covering. (Outer and inner integuments)

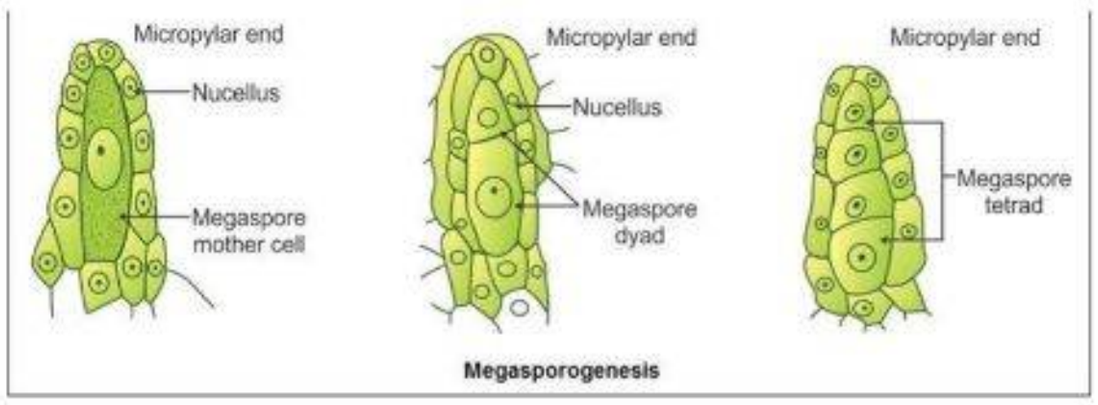
Micropyle – Small opening through which pollen tube enters into the ovule.

Chalaza – Opposite side of micropyle where integuments originate

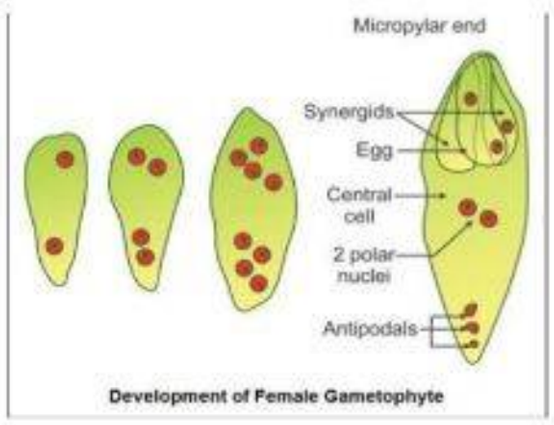
Emryosac / female gametophyte – Central oval shaped structure

FORMATION OF EMBRYOSAC / FEMALE GAMETOPHYTE

- **Single megaspore mother cell** is differentiated **at micropylar end of nucellus** with dense cytoplasm and prominent nucleus.
- Diploid **megaspore mother cell** undergo **meiosis** to form **four haploid megaspores** (they are arranged in a linear tetrad).
- **One of the megaspore is functional** (first cell of female gametophyte), other three degenerate
- **Haploid nucleus** of functional megaspore undergo **three repeated mitotic division** to form **8 nucleate stage** .
- Three nucleus located at micropylar end, three nucleus at chalazal end , other two move towards centre of the embryosac. 6 of the 8 nuclei are surrounded by cell wall.
- 3 haploid cells at micropylar region (2 **synergids** and 1 **egg cell**) are called **egg apparatus**.
- 3 haploid cells at chalazal end are **antipodals.**
- **Filiform apparatus –** Finger like projections at micropylar tip. It **guide pollen tube into the synergids**.
- **Secondary nucleus / Polar nucleus / Central cell –** Central diploid cell.
  Monosporic development of Embryo sac – Embryosac developed from single haploid megaspore.



Megasporogenesis



Development of Female Gametophyte

POLLINATION

Transfer of pollen grains from anther to stigma.

Based on the source of pollen, pollination can be divided into three.

1) **Autogamy/ Self pollination –** Transfer of pollen grains from anther to stigma **of same flower.** A normal flower with exposed anther and stigma, complete autogamy is rare. Autogamy in such flowers requires (a) **synchrony in pollen release & stigma receptivity** (b) **anther and stigma should lie close to each other.**

Chasmogamous flowers – Flowers with exposed anther and stigma

Cleistogamous flowers –

- Closed flowers .
- Anther and stigma lie close to each other.
- Autogamous.
- No chance of cross pollination.
- Assured seed set in the absence of pollinators.
- No chance for variation.
- Causes inbreeding depression

2) **Geitonogamy** – Transfer of pollen grains from anther to stigma of **another flower of the same plant. Genetically** similar to **autogamy** (pollen grains come from the same plant) but **functionally** similar to **cross pollination**
3) **Xenogamy / Cross pollination** – Transfer of pollen grains from **anther of a flower to stigma of the flower of another plant of same species.**

- Ensure genetic recombination and variation
- Reduce inbreeding depression
- Pollen grains are transferred by external agencies.

AGENTS OF POLLINATION

ABIOTIC AGENTS

1) **Wind pollination / Anemophily** – Pollination by the agency of wind.

Characteristic features of anemophilous flowers.

- light , non sticky and dry pollen grains.
- Well exposed stamens.
- Feathery stigma.
- Colourless.
- nectorless.
- Odourless (Do not have smell)
- Pollen grains are produced in large quantities.
- Single ovule in each ovary.
- Numerous small flowers are packed into an inflorescence.
- Unisexual flowers.
- e.g., **Coconut, rice, wheat, grasses, maize, date palm** etc.

2) **Water pollination / Hydrophily** – Pollination by the agency of water. It is quite rare in angiosperms and is limited to about 30 genera, mostly monocots. e . g., **Vallisneria** (submerged aquatic dioecious plant) , **hydrilla**, sea grasses like **zostera** etc.

Characteristics of hydrophilous flowers.

- Colourless
- Nectorless
- Odourless
- Unisexual flowers
- Pollen grains are protected by mucilagenous covering.
- Sticky and unwettable stigma
- **Female flowers** occur above the surface of water by their **long coiled stalk** as in vallisneria.
- Female flowers remain submerged below the surface of water as in sea grass (zostera)
- Male flowers are released on to the surface of water and carried by water currents to the surface of stigma as in vallisneria.
- **Long, ribbon like pollen grains** which are released inside the water and carried by water as in zostera.

BIOTIC AGENTS

Insect pollination / Entomophily - Flowers are pollinated by insects. e .g., **Rose, Sunflower, Jasmine, Orchids etc.**

In some species, floral rewards come in providing safe places to lay eggs for insects (e.g, **Amorphophallus**, which is the tallest flower about 6 feet in height and **Yucca.**

Pollen robbers/ Nector robbers – Insects consume pollen grains / nector without bringing about pollination.

Characteristics of entomophilous flowers

- Large, colourful flowers
- Produce nector.
- Produce fragrance. It may be **pleasant** (Jasmine, Rose etc,) or **foul** (Rafflessia, Aristolochia)
- Sticky and spiny pollen grains.
- Sticky stigma.
- Small flowers clustered into inflorescence in Sun flower, Dahlia etc.

ARTIFICIAL HYBRIDISATION

Process of crossing of two genetically different organisms artificially.

Steps

- **Selection of parents**
- **Emasculation** – Removal of anther from the flower buds of a bisexual flower before maturity to prevent self pollination.
- **Bagging** – Emasculated flowers are covered with a bag to prevent cross pollination.
- **Artificial pollination** – pollen grains from male parent are dusted on stigma of female parent, when stigma attain receptivity.
- **Rebagging** to prevent cross pollination
- **Tagging and labeling**

Seed set

DOUBLE FERTILISATION

Syngamy and Triple fusion take place in the embryo sac.

Syngamy

Male gamete (n) + female gamete/egg cell (n) →Zygote (2n)

Triple fusion

Male gamete (n) + Secondary nucleus / polar nucleus (2n) → PEN (3N) → Endosperm (3n)

PEN – Primary endosperm nucleus.

POST FERTILISATION CHANGES

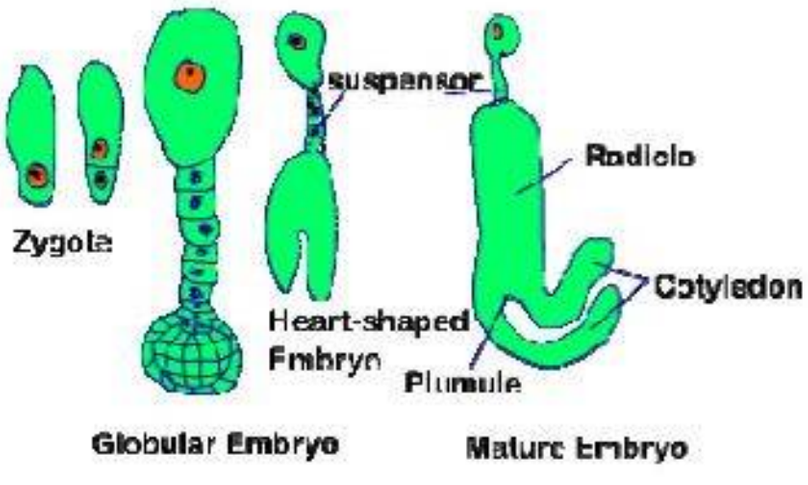
EMBRYOGENESIS

Formation of embryo from zygote. Embryo develops at the micropylar end. Zygote divides only after the formation of endosperm. **Endosperm** provide **nutrition** to developing **embryo.**

Zygote →Proembryo →Globular embryo → Heart shaped embryo →Mature embryo

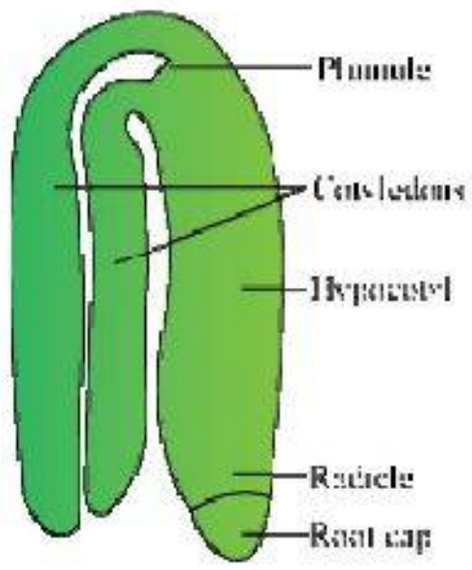
Steps

- Zygote divide transversely to form two celled **Proembryo** with basal cell towards micropylar end and terminal cell towards chalazal end.
- **Terminal cell** divides to form multicellular **Globular , Heart shaped** and **Mature embryo**.
- **Basal cell** divides to form a filamentous **suspensor** which pushes the developing embryo into the endosperm and absorb nutrients.



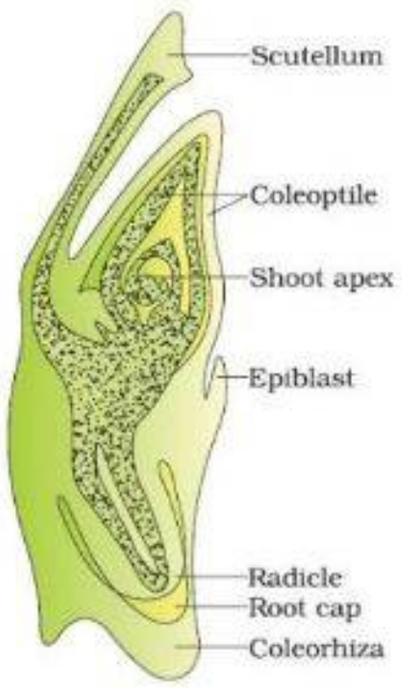
DICOT EMBRYO

- Dicot embryo consists of an **embryonal axis** and **two cotyledons**.
- **Epicotyl** – embryonal axis above the level of cotyledons which terminates with **plumule** (stem tip).
- **Hypocotyl** – cylindrical portion below the level of cotyledon that terminates with the **radicle** (root tip)
- Root tip is covered with a **root cap.**



MONOCOT EMBRYO

- Monocot embryo consists of **embryonal axis** and **one cotyledon**.
- **Scutellum** – Single cotyledon of monocot embryo, situated towards the lateral side of the embryonal axis.
- **Epicotyl** – Portion of embryonal axis above the level of cotyledon terminates with **plumule.**
- **Hypocotyl** – Portion below the level of cotyledon terminates with **radicle.**
- **Coleoptyl** – Covering of plumule
- **Coleorrhiza** – Covering of radicle.



(b)

FRUITS

- **Ovary develops into fruit.**
- **Pericarp** – Fruit wall
- **True fruit** – Fruit developed from the ovary . e.g., mango
- **False fruit** – Fruit develop from the part of the flower other than ovary. e .g., **Apple** , **Strawberry** , **Cashew** . Here **Thalamus** is the **edible** part.

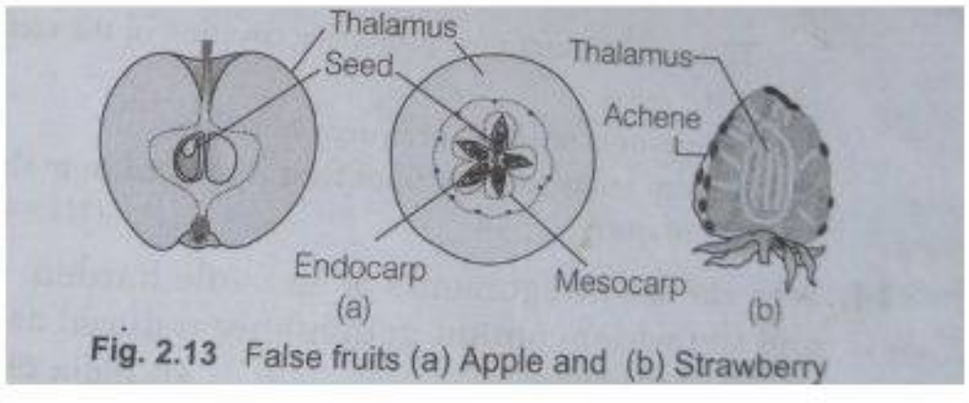


Fig. 2.13 False fruits (a) Apple and (b) Strawberry

Parthenocarpic fruits -

- **Fruit formed without fertilization.**
- Seedless fruits.
- Parthenocarpy can be induced by hormones like **Auxin** and **Gibberellin.**
- e .g., **Banana , Seedless grapes** etc.

Previous questions and answers

1 MARK QUESTIONS

1. Find out which of the sentence is false
   a) Ovary develops into fruits
   b) Zygote develops into embryo
   c) Ovule develops into fruits
   d) Endosperm develops from PEN

2. Perisperm is the remnants of .....

3. Select a plant from the following in which pollination takes place by means of water
   Lotus, Vallisnaria, Coconut, Water lily

4. Find the odd one out
   Epidermis, Endodermis, Middle layer, Tapetum

5. Observe the relationship between the given pair and fill up the blanks.
   a) Male gamctophyte: ---------- b) Female gametophyte: Embryosac

6. A unisexual flower having no androecium is called
   (a) Dithecous (b) Dioecious (c) Monoecious (d) Pistillate
7. A typical angiosperm embryo sac at maturity is
   a. 7 nucleated 8 celled b. 8 nucleated 8 celled c. 7 nucleated 7 celled d. 8 nucleated 7 celled

2 MARK QUESTIONS

8. What are Chasmogamous flowers? Can cross pollination occur in Cleistogamous flowers? Give reasons for your answer

9. Arrange the following terms in the correct developmental sequence.

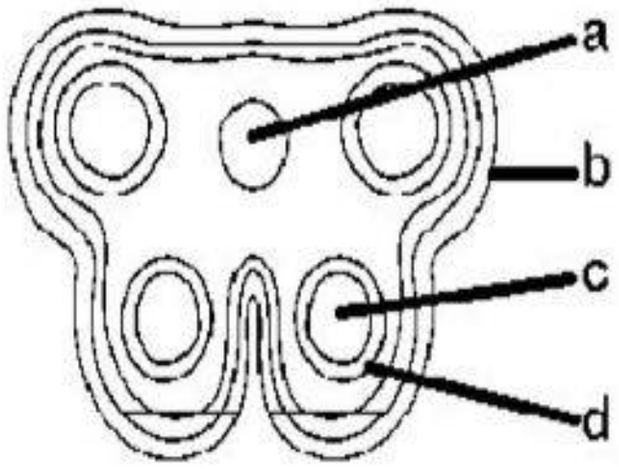
Pollengrain, Sporogenous tissue, Microspore tetrad, Pollen mother cell, male gamets.

10. Apple is called a false fruit. Why?

a) Which part of the flower forms the fruit?

11. All the tissues of stamen will decay, but the pollen do not comment on

12. The diagram given below shows the transverse section of a young anther.



i. Identify the parts a, b, c and d..

ii.

13. The synergids have special cellular thickenings. Name the thickening and write its function.

14. Peculiarity of certain parts of ovule are given below. Name the parts.

a. Protective envelops of the ovule.

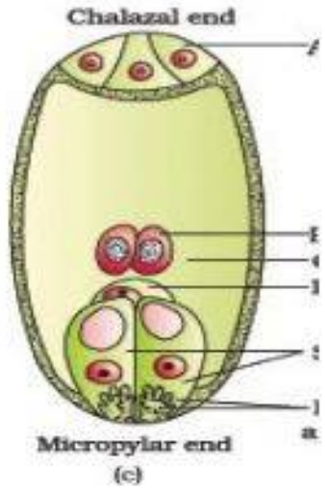
b. Stalk of the ovule

c. The layer of cells within the integuments

d. Junction between ovule and funicle

3 MARK QUESTIONS

15. Copy the figure given below and mark the following.

a) Antipodal 

) Egg d) Synergid e) Micropylar pole f) Filiform apparatus

16. Transfer of pollengrains from the anther to the stigma of a flower is called pollination. Grass plants generally have small inconspicuous flowers while plants belonging to many angiosperm families bear conspicuous coloured flowers.
a) Comment on the type of pollination takes place in these groups
b) What are the salient features present in these two groups for effective pollination (any two)
17. You want to do artificial hybridization on a plant bearing bisexual flowers as part of a crop improvement programme. List out and briefly explain the 3 important steps you need to follow in the programme

Answers

1. Ovule develops into fruits
2. Nucellus
3.Vallisnaria
4.Endodermis
5.Pollengrain
6. Pistillate
7. 8 nucleated 7 celled

8. Chasmogamous flowers are open flowers with exposed anther and stigma. No cross pollination occurs in cleistogamous flowers as these flowers are closed and never open and thus no transfer of pollen from outside to stigma of the flower is possible

9. Sporogenous tissue > Pollen mother cell > Microspore tetrad > Pollen grain > Male gametes

10.a)In apple fruit is not developed from ovary , thalamus grows around the pericarp to produce the fleshy edible part
b)Thalamus
11. The exine of pollen grain is formed of sporopollenin. It is resistant to decay
12.a) Connective
b) Epidermis

c) Sporogenous tissue

d) Tapetum

13. Filiform apparatus

b) Guiding the pollen tube into embryosac

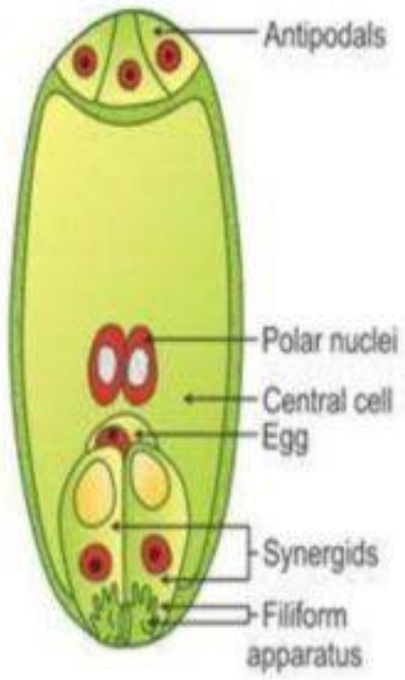
14. a) Integuments

b) Funicle

c) Nucellus

d) Hilum

15.



16. Grass - Wind pollination

- They doesn't screte nectar
- They lack scent
- Flowers are unisexual
- Flowers are packed into an inflorescence

Angiosperm – Entamophily or Insect pollination

- Coloured & attracting flowers
- Pollen grains are sticky
- Flower rich in nectar

17.Emasculation – Removal of anthers from the flower buds of female parents before anther dehisce.

Emasculated flowers are covered with a bag (butter paper) to prevent contamination of stigma with unwanted pollen

Rebagging of flowers

Chapter: 3

STRATEGIES FOR ENHANCEMENT IN FOOD PRODUCTION

Focus points

- **Dairy farm management**
- **Bee keeping**
- **Plant breeding-main steps**
- **Plant breeding for improved food quality**
- **S.C.P**
- **Tissue culture**

DIARY FARM MANAGEMENT

It is the management of animals for milk and its products for human consumption.

Management

- Selection of good breeds (high yielding & disease resistant)
- They have to be housed well.
- Provide adequate water.
- Provide good quality & quantity fodder (feeding in a scientific manner)
- Hygiene is ensured while milking , storage & transport of milk and its products by mechanisation.
- Keep proper records.
- Regular visit by veterinary doctor.

BEEKEEPING / APICULTURE

It is the maintenance of hives of honeybees for the production of honey and beeswax.

Important points for successful beekeeping

- knowledge of nature and habits of bees.
- Selection of suitable location for keeping beehives .
- Catching and hiving of swarms (group of bees).
- Management of beehives during different seasons.
- Handling and collection of honey and beeswax.

Importance of beekeeping

- Honey is used as medicine.

- Honey is used as immediate source of energy (having high nutritive value)
- Honey is used as food
- Beeswax used in cosmetics, creams, ointments, paints & polishes and for smokeless candles.
- Honeybees are major pollinator of many crop plants like sunflower, brassica, apple etc.
- Keeping beehives in crop fields during flowering period increases pollination efficiency and it improves the yield of crop & honey.

Most common species of Bees are ***Apis indica***.

PLANT BREEDING

Steps of plant breeding

1. **Collection of variability** – Collection and preservation of all wild varieties, and species ofcultivated species. The entire collection of diverse alleles for all genes in a given crop is called **Germplasm collection**.

2. **Evaluation and selection of parents-** The germplasm is evaluated to identify plants with desirable combination of characters. One plant is selected as female & other as male after continuous self fertilization and multiplication . Defective plants are discarded during selection process.

3. **Cross hybridisation** – Crossing of two genetically different plants with desired character to produce hybrids .

Steps :-

- Emasculation
- Bagging
- Pollination
- Rebagging
- Tagging
- Collection of seeds

4. **Selection and testing of superior hybrids –** Hybrids are self pollinated for severalgeneration to get homozygosity to avoid segregation in future progeny. Discard defective plants during selection process. Selected hybrid is superior to both parents. This is called **hybrid vigour** or **heterosis.**

5. **Testing Release and Commercialisation of new hybrid -**

- Testing is done by cultivating the crop in the field atleast for three growing seasons ,
  in different parts of the country having different climatic conditions.
- New hybrid is compared with best available local crop
- If it is superior, breeder proposes its release as a new variety
- Proposal is examined by releasing committee.
- The material is given a name and release as a new variety.

PLANT BREEDING FOR IMPROVED FOOD QUALITY

3 billion people suffer from hidden hunger (deficiency of micronutrients, proteins and Vitamins)

BIOFORTIFICATION

Breeding of crops with higher levels of vitamins, minerals proteins , fat etc.

Objectives of biofortification

- Improving protein content and quality
- Improving oil content and quality
- Improving vitamin content
- Improving nutrient and mineral content

Example for biofortified crops

- **Maize hybrid** with twice the amount of aminoacid
- **Atlas 66** – wheat variety with high protein content
- **Iron fortified rice** contain 5 times more iron

Vegetable crops released by **IARI (Indian agricultural Research Institute)**

Carrot, spinach, pumpkin	Enriched Vitamin A
Bittergourd, bathua, mustard, tomato	Enriched Vitamin C
Spinach &bathua	Enriched iron & calcium
Broad bean, lablab, French bean, garden pea	Enriched Protein

SINGLE CELL PROTEIN (SCP)

Protein rich microbial cell biomass which is used as food or feed. Alternate source of protein. e .g., **Spirulina** (blue green algae), ***Methlyophilus. methlyotrophus*** (bacteria), **Chlorella** (algae) , **Mushroom**

Advantage of SCP

- **Easy to grow** – Microbes can be grown on materials like waste water from potato processing units, straw, molasses, animal manure and sewage.
- **Nutrient rich food** – Rich in protein, minerals, fat, vitamins etc.
- **Reduce environmental pollution**
- **High yield –** e.g., 250gm of *Methlyophilus. methlyotrophus* produce 25 tonnes of protein because of its high rate of biomass and growth.

TISSUE CULTURE

It is an *in-vitro* technique of regeneration of whole plant from any part of a plant growing in culture medium under sterile condition.

Totipotency - Capacity to generate whole plant from any part of a plant

Explant - Cell / Plant part from which whole plant is regenerated.

Micropropagation –Method of producing thousands of plants in short time through tissue culture.

Somaclones –Plants produced through tissue culture . (Morphologically & Genetically identical to the plant from which they are grown)

Meristem culture - Disease free / Virus free plants can be obtained (Due to active cell division, meristem is free of virus). e .g., virus free – banana, sugarcane, potato

Contents of nutrient medium

- A carbon source – Sucrose
- Inorganic salts
- Vitamins
- Aminoacids – Glycine
- Growth regulators – Auxin, Cytokinins etc.

Somatic hybridisation – Fusion of protoplasts from two different varieties of plants with desirable characters in a nutrient medium *in-vitro* to get hybrid protoplasts.

Somatic hybrids – Hybrid produced by somatic hybridisation.

Steps

- Select single cell from two plants with desirable characters.

- Cell wall is digested by treating with enzymes like cellulase
- Fusion of naked protoplasts of two varieties induced by **PEG (Poly Ethylene Glycol)**
- Hybrid protoplast regenerate cell wall
- Hybrid cell divide and grown to form **somatic hybrid.**

e.g., **Pomato** - Somatic hybrid developed by fusing Tomato and Potato cells.

Previous questions and answers

1 MARK QUESTIONS

1. Morphologically & Genetically identical plants produced through tissue culture
2. Most common species of honey bees used in apiculture is ……
3. Which part is most suitable for raising virus free plants in tissue culture
Node, Meristem, Bark, Vascular tissues
4. Name a bacterium used as SCP

2 MARK QUESTIONS

5. What is meant by biofortification? Give an example for a biofortified wheat
6. What is somatic hybridization? Give an example of somatic hybrid

3 MARK QUESTIONS

7 .The idea of tissue culture has originated from the concept of totipotency. Briefly describe the following terms related with tissue culture a) Totipotency b) Explant c) Somaclone
8. What are the five major steps in plant breeding?
Give an example for a semi dwarf rice variety developed from IRRI

9. If your family owned a dairy farm, what measures would you undertake to improve the quality and quantity of milk production?

Answers

1. Somaclones
2. Apis indica
3. Meristem
4. *Methylophilus methylotrophus*

5. A plant breeding programme that increases the nutritional quality of a crop variety
Eg: Atlas 66
6.The process of fusion of protoplasts of somatic cells obtained from different varieties species of plants invitro
Eg; pomato
7.a) The capacity of a plant cell to grow in to a whole plant
b) The part of the plant taken out for tissue culture
c) Genetically identical plants produced from tissue culture

8. Collection of variability
   Evaluation and selection of parents
   Cross hybridisation among the selected parents
   Selection and testing of superior recombinants
   Testing,release and commercialisation of new cultivars
   IR-8
9. Selection of good breeds having high yielding potential and resistance to diseases

   Cattle is well housed with adequate water supply
   Cattle is fed in a scientific manner
   Hygiene is maintained while milking, storage andtransport of milk
   Regular inspections along with keeping proper records
   Regular visits by a veterinary doctor

Chapter : 4
BIOTECHNOLOGY - PRINCIPLES AND PROCESSES

Focus points

- Tools of recombinant DNA technology
- Restriction enzymes,Gel electrophoresis
- Process od rDNA technology
- Amplification of gene of interest using PCR
- Obtaining the foreign gene product

Tools of recombinant DNA technology

1. **Enzymes**
   Restriction enzymes
   Polymerase enzymes
   Ligase or Molecular glue
2. **Vectors**
3. **Host**

Restriction enzymes - They belongs to a class of enzymes called nucleases. Nucleases are of two types. Exonucleases and Endonucleases.
Exonuclease - Enzymes that cut DNA at the end.
Endonuclease - Make cut at specific site within the DNA.

Restriction endonuclease/ Molecular scissors.
It is an enzyme that cut DNA into fragments at specific sites within molecules. The first restriction endonuclease enzyme was named Hind II from *Haemophilus influenzae*.
Recognition sequence - Specific sequence of six base pairs that is recognised by restriction enzymes and they cut DNA at that point.
Today more than 900 restriction enzymes have been isolated from 230 strains of bacteria each of which recognizes different recognition sequences.

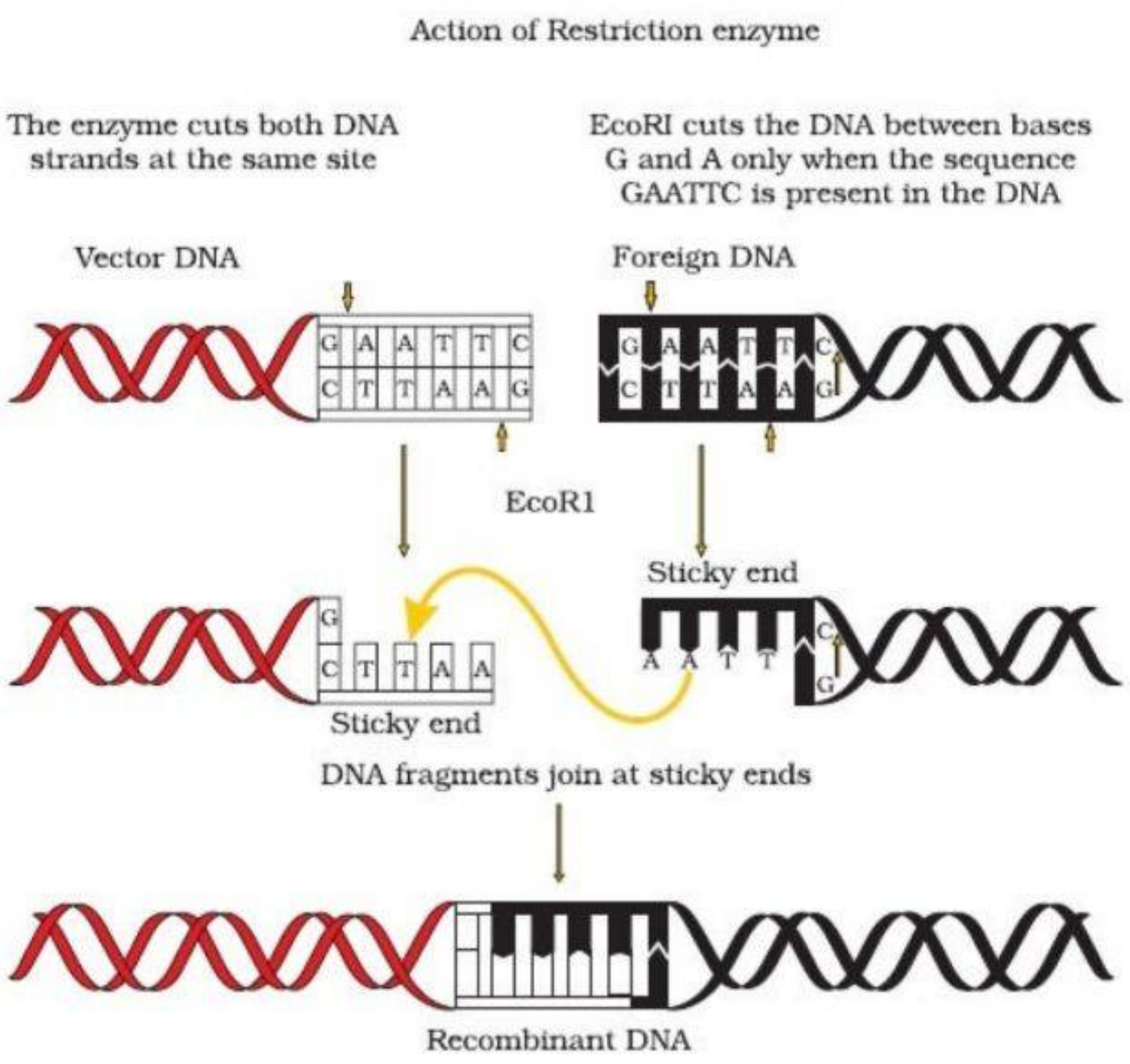
Naming of Restriction Enzyme

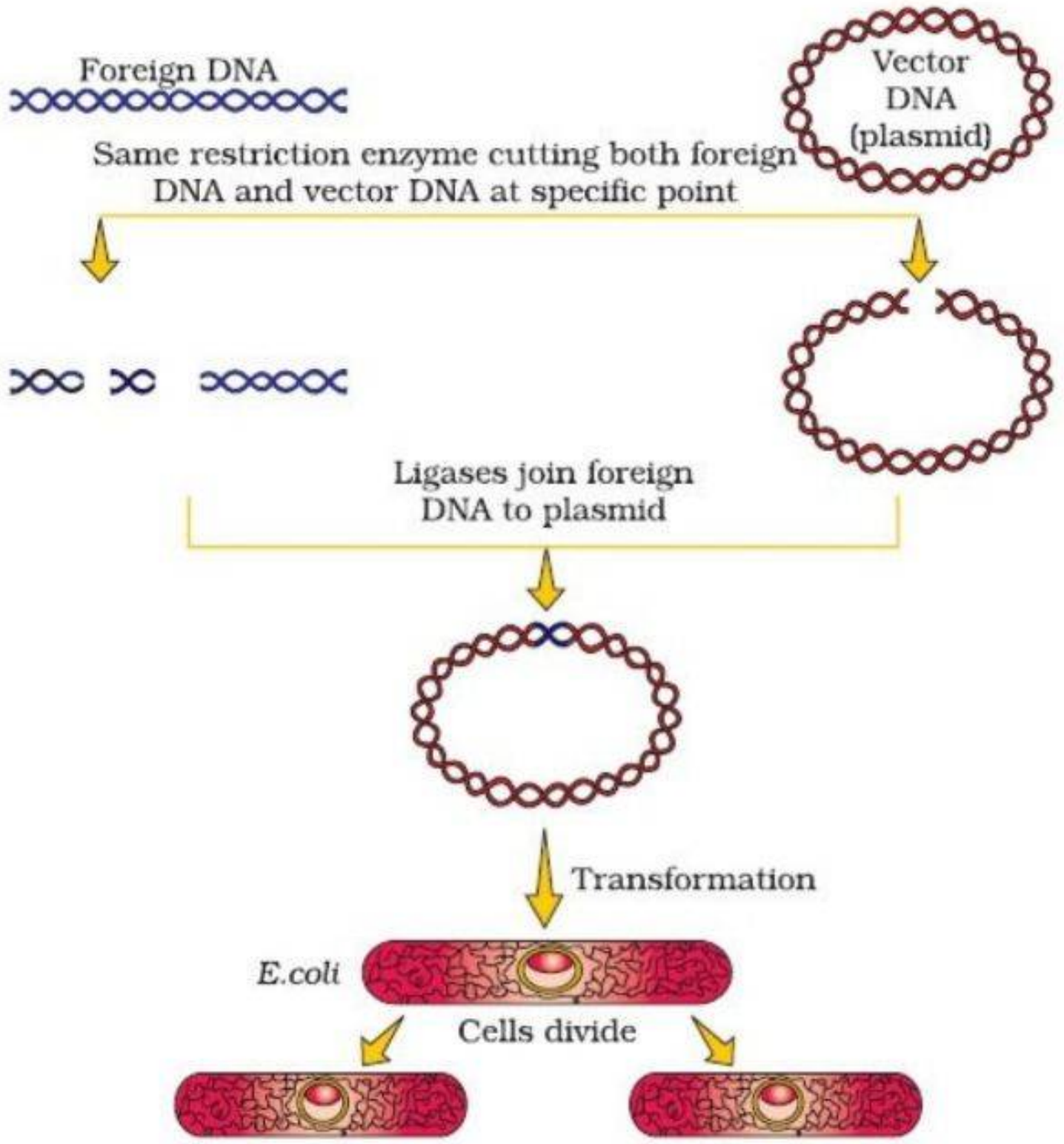
First letter comes from genus name and the second two letters come from the first two letters of species name of the prokaryotic cell from which they were isolated. The fourth letter denotes the strain and the last letter is a romen number which denotes the order in which they are isolated from that strain of bacteria.
Eg. EcoRI isolated from *Escherichia. coli RY 13*

Palindrome in DNA - Palindrome in DNA is a sequence of base pairs that read the same on the two strands when orientation of reading is kept the same.
eg. 5' -GAATTC - 3'
3' -CTTAAG - 5'
Restriction enzymes cut the strand of DNA between the same two bases on the opposite strands. This leaves a short single stranded segment called **sticky ends**. They form hydrogen bonds with their complementary cut counterparts.

Fragmentation of DNA by restriction endonuclease

Purified DNA molecules are incubated with restriction endonuclease . Vector DNA is also cut with same restriction enzymes to get fragments with complementary sticky ends





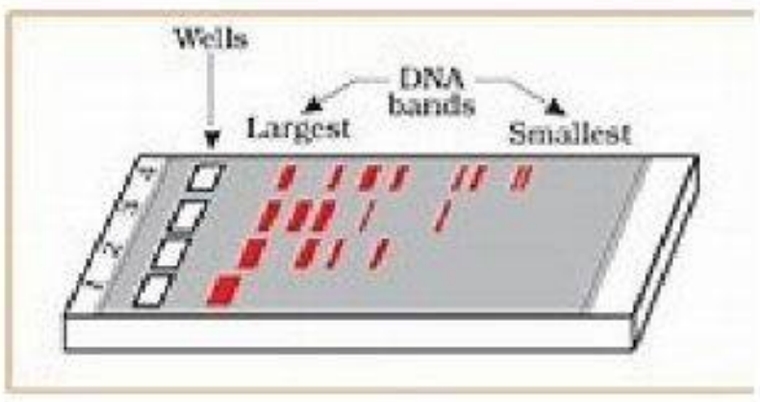
Process of Biotechnology

Steps of recombinant DNA technology

1. Isolation of DNA
2. Fragmentation of DNA by restriction endonuclease.
3. Separation of DNA fragments using Gel electrophoresis
4. Joining of DNA fragments into a vector.
5. Amplification using PCR
6. Recombinant DNA is transferred into the host.
7. Extraction using Bioreactor
8. Downstream processing

Separation using Gel electrophiresis

- Negatively charged DNA molecules are forced to move towards anode under an electric field through **agarose** medium
- DNA fragments are separated according to their size through a sieving effect provided by agarose gel (natural polymer extracted from seaweeds)
- Smaller fragments move farther.
- Separated DNA fragments can be visualised after staining with **ethidium bromide** followed by exposure to **UV radiation**
- DNA appears as bright orange coloured bands.
- Separated bands of DNA are cut out from the agarose gel and extracted from gel piece. This step is called **Elution.**



Amplification using PCR

PCR - Polymerase Chain Reaction is the synthesis of multiple copies of gene *invitro* two sets of Primers and DNA Polymerase enzyme.

Requirements for PCR:

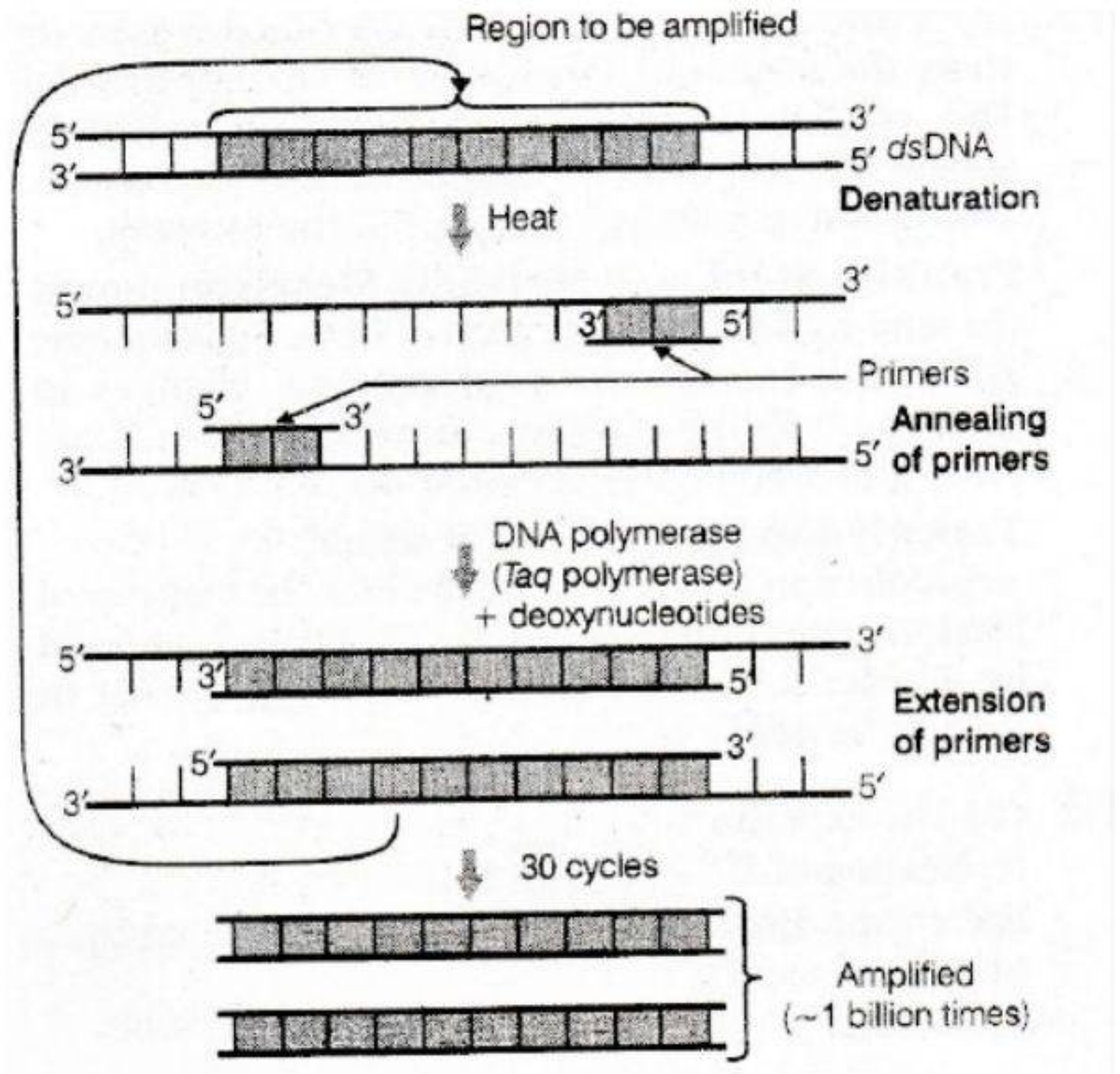
i)DNA template- The double stranded DNA that needs to be amplified

ii) Primers - Chemically synthesised oligonucleotides that are complementary to the regions of DNA.

iii) DNA Polymerase enzyme - Thermostable **Taq DNA Polymerase** is isolated from a bacterium ***Thermus aquaticus***.It remains active in high temperature.

Steps

- **Denaturation -** Treating DNA at high temperature about 94° C. Two strands of DNA separate and each strand act as template.
- **Annealing** - Temperature is lowered about 45° C. Two primers are added. They join with the 3' end of two templates.
- **Extension -**DNA Polymerase enzyme extend the primer by adding nucleotides.
- **Amplification -**the above process repeated many times to get billion copies of target DNA



Extraction of foreign Gene product

When the recombinant DNA is transferred into a cell, the DNA is multiplied, expressed to produce desirable protein.

Recombinant protein - protein formed in a heterologous host (host which carry recombinant DNA)

Host cell with recombinant DNA can be grown on small scale in the laboratory .To produce large quantities of products , **bioreactors** are used..

Bioreactors

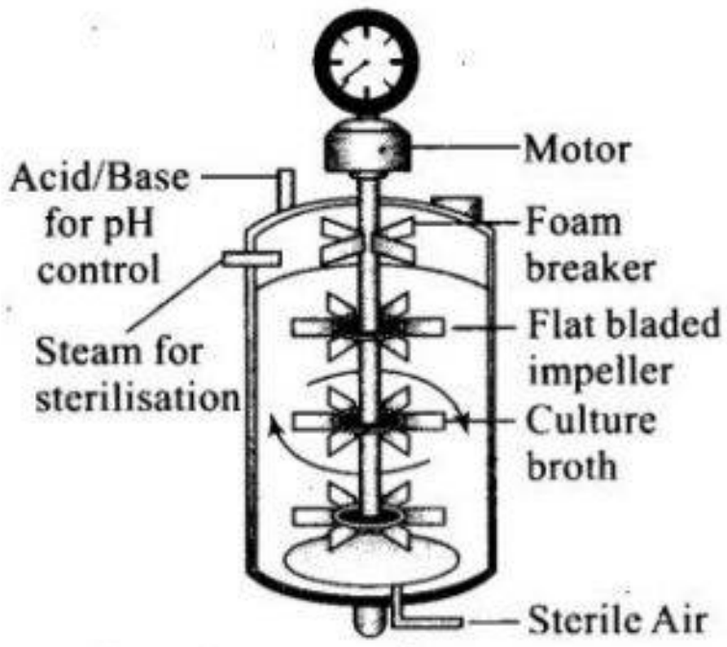
Large vessel in which raw materials are biologically converted into products . they can accommodate about 100-1000litres.They are Cylindrical vessels with curved base which facilitate mixing of the content in the reactor. Stirrer facilitate mixing and oxygen availability. Alternatively air is bubbled through the reactor.

Components of Bioreactor

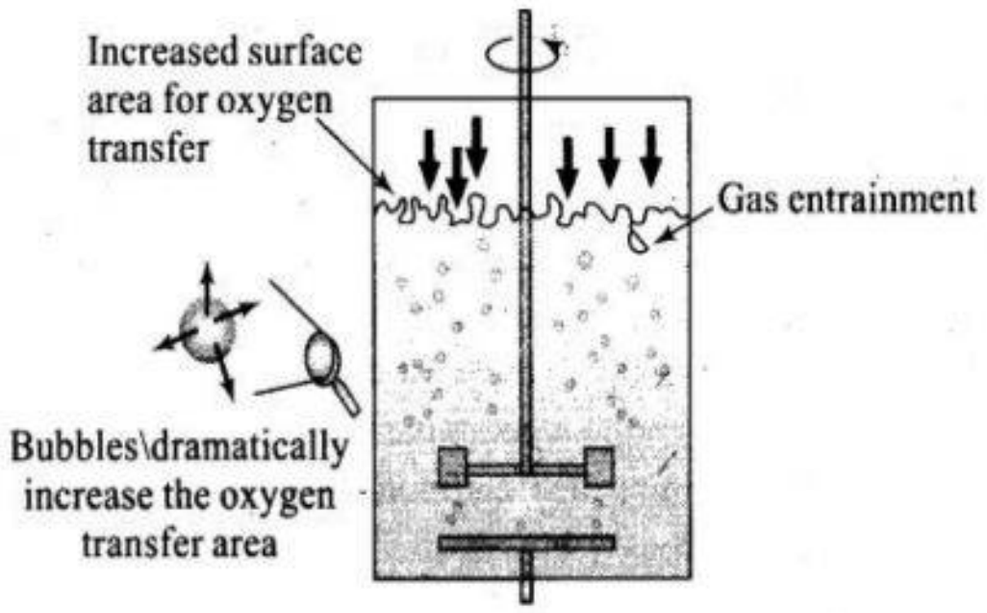
- An agitator system
- Oxygen delivery system
- A foam control system

- A temperature control system
- pH control system
- Sampling ports for periodic withdrawal of culture

Bioractors are of two types. **Stirred tank bioreactors** (Oxygen moves through a delivery system) and **Sparged stirred-tank bioreactor**(surface area of the culture medium is increased by bubbling the sterile air into the system)



Simple stirred-tank bioreactor



Sparged stirred-tank bioreactor through which sterile air bubbles are sparged

Previous questions and answers

1 MARK QUESTIONS

1. The first identified restriction enzyme is……
2. The enzyme used to join DNA fragments …..
3. Name the compound used for staining the isolated DNA in the gel electrophoresis

2 MARK QUESTIONS

4. Some palindromic sequences are given below. Complete the sequences

   a) 5′ AAGCTT-3′
   3′……...-5′
   b) 5′ CTTAAG-3′
   3′ ……...-5′

5. Match the following

i) Plasmid	a) Join DNA fragments
ii) Restriction enzyme	b) DNA synthesis
iii) Ligase	c) Vector
iv) Polymerase	d) Cleaves DNA

6. State the difference between Exonuclease and Endonuclease

7. PCR meant for making multiple copies of a gene of interest

a) Mention the major steps involved in PCR

b) Name an organism from which thermostable DNA Polymerase enzyme is isolated

8. Briefly explain gel electrophoresis

3 MARK QUESTIONS

9 . Some processes of recombinant DNA technology are given below. Arrange them in correct order.

a. Amplication of gene of interest using PCR
b. Cutting of DNA at specific locations
c. Obtaining the foreign gene product
d. Insertion of recombinant DNA into the host cell
e. Isolation of the genetic material (DNA)
f. Downstream processing

10. Read the following base sequence of certain DNA strands & answer the questions

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

a. What is palindromic sequence in a DNA?
b. Write the palindromic sequence nucleotide sequence shown in the DNA strand given
c. Mention the enzyme that will recognise palindromic sequence?

11. Bioreactors are of different types. Stirred tank bioreactors are commonly used over shake flasks. What are the components of a bioreactor?

Answers

1. Hind II
2. Ligase
3. Ethidium bromide

4. a) 5′ AAGCTT-3′
   3′ TTCGAA-5′
   b) 5′ CTTAAG-3′
   3′ GAATTC-5′

5. i) Plasmid a) Vector

ii) Restriction enzyme b) Cleaves DNA
iii) Ligase c) Join DNA fragments
iv) Polymerase d) DNA synthesis

6. **Exonuclease** - Enzymes that cut DNA at the end.
Endonuclease - Make cut at specific site within the DNA.

7. a) Denaturation,Annealing,Extension
b) Thermus aquaticus

8. Negatively charged DNA molecules are forced to move towards anode under an electric field through **agarose** medium .DNA fragments are separated according to their size through agarose gel .Separated DNA fragments can be visualised after staining with **ethidium bromide** followed by exposure to **UV radiation** .DNA appears as bright orange coloured bands. Separated bands of DNA are cut out from the agarose gel and extracted from gel piece. This step is called **Elution.**

9 .
a. Isolation of the genetic material (DNA)
b. Cutting of DNA at specific locations
c. Amplication of gene of interest using PCR
d. Insertion of recombinant DNA into the host cell
e. Obtaining the foreign gene product
f. Downstream processing

10. a.Sequence of base pairs that reads same on the two strands when orientation of reading is kept the same.
b. GAATTC
c. ECoR1

11. An agitator system
Oxygen delivery system
A foam control system
A temperature control system
pH control system
Sampling ports for periodic withdrawal of culture

Chapter: 5
BIOTECHNOLOGY AND ITS APPLICATIONS

Focus points

- Biotechnological applications in agriculture-Uses of GMOs and Bt Cotton
- Genetically engineered Insulin
- Gene therapy

Uses of Genetically Modified Organisms. (GMO)

- It makes crops more tolerant to abiotic stresses
- Reduce the use of 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 IN AGRICULTURE

Bt Cotton:

Some strains of *Bacillus thuringiensis* produce a toxic insecticidal protein that kill insects like coleopterans, lepidopterans &dipterans. The **Bt toxin** is coded by a gene named **'cry'**

The **Bt toxin** protein exist as **inactive protoxins.** So it does not kill Bacillus.

When an insect ingest the inactive toxin, 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 midgut epithelial cells** and **creates pores** that cause **cell swelling** and **lysis** and eventually cause **death of the insect**.

Bt toxin genes were isolated from *B. thuringiensis* and incorporated into the several crop plants such as cotton. They are insect-group specific, for example, the proteins encoded by the genes *cryIAc* and *cryIIAb* control bollworms and *cryIAb* controls corn borer.

APPLICATION IN MEDICINE:

Genetically Engineered Insulin:

Insulin is use as a medicine to manage Diabetes

Insulin extracted from pancrease of pigs causes allergy to some people. So the bacterium *E.coli* is used as a host in genetic engineering process.

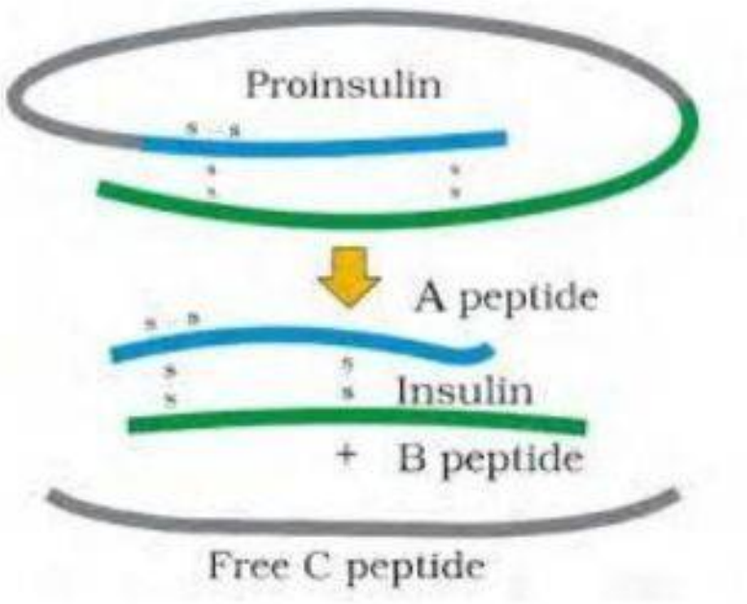
Insulin consists of two short polypeptide chains; **chain A** and **chain B**, that are linked together by **disulphide bonds.**

In mammals, including humans, insulin is synthesized as a **prohormone**, which contains an extra stretch called the **C peptide.** This C peptide is not present in the mature insulin and is removed during maturation into insulin.

In 1983, **Eli Lilly** an American company prepared two DNA sequences corresponding to A and B chains of human insulin

Introduced them in plasmids of *E.coli* to produce insulin chains.

Chain A and B were produced separately, extracted and combined by creating disulfide bonds to form human insulin.



Gene Therapy:

Gene therapy is a collection of methods that allows correction of a gene defect that has been diagnosed in a child / embryo.

Functional genes are inserted into patient's cell t o treat hereditary disease. It compensate for the non-functional gene.

The first clinical gene therapy was given in 1990 to a 4-year old girl with **adenosine deaminase (ADA)** deficiency. This enzyme is crucial for the **immune system to function.**

Steps

- 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 using retroviral vector.
- They are returned to the patient.

- Lymphocytes are not immortal, so periodic transfusion is necessary.

If the gene isolate from marrow cells producing ADA is introduced into cells at **early embryonic stages**, it could be a **permanent cure.**

Alternative methods :-

- Bone marrow transplantation
- Enzyme replacement therapy

But these are not completely curative

Previous years questions and answers

1 mark questions

1. Biotechnology in agriculture will lead to pest resistant plants, which could decrease the amount of pesticides used. For example Bt cotton. Expand the letter 'B' and 't'.
2. Expand GMO

2 mark questions

1. Genetically Modified Organism (GMO) is always a debatable topic among scientists,academicians and public. State any four usefulness of GMOs.
2. Insulin getting assembled into a mature form was the major challenge in commercial insulin production by rDNA technology. How did Eli Lilly company found a solution to this problem?
3. Sophie was born with a genetic disorder –ADA deficiency.
   (a) What is ADA deficiency?
   (b) Can you suggest methods to treat this ADA deficiency?

3 mark questions

1. Bt cotton is an example of genetically engineered cotton.
   (a) What does Bt stands for?
   (b) Name the gene responsible for Bt toxin production.
   (c) How does the toxin kill the insect?
2. Gene therapy is a corrective therapy for a hereditary disease.
   (a) Name the disease which was successfully corrected by gene therapy for the first time.
   (b) How gene therapy is practiced for a permanent cure of the disease?

Answers.

1 mark questions

1.*Bacillus thuringiensis*
2.Genetically Modified Organism

2 mark **questions**

1.Crops are made tolerant to abiotic stresses
Helps to reduce the use of pesticides
Helps to reduce post harvest loss.
Enhanced nutritional value of food

2 Eli Lilly an American company prepared two DNA sequences corresponding to A and B chains of
human insulin.
Introduced them in plasmids of E.coli
Chain A and B were produced separately, extracted and combined by creating disulfide bonds to
form human insulin.

3. Adenosine deaminase (ADA), is an enzyme required for the proper functioning of our immune system.
Lymphocytes from the blood of the patient are grown in a culture.
A functional ADA cDNA is then introduced into these lymphocytes
They are returned to the patients blood.

3 mark questions

1. *Bacillus thuringiensis*
   Cry gene
   When an insect ingest the inactive toxin, it is converted into an active toxin due to the alkaline pH of the gut. The activated toxin binds to the epithelial cells and creates pores . This results in cell swelling and lysis there by death of insect.
2. Adenosine Deaminase deficiency
   For permanent cure, ADA cDNA should be introduced into the bone marrow cells at early embryonic stages.

Chapter 6:

ORGANISMS AND POPULATIONS

Focus points

- **Adaptations-In organisms of deserts,Polar regions and high altitudes**
- **Population attributes- Age pyramids and population density**
- **Population growth(Up to population growth equation)**
- **Population interactions- Parasitism,Commensalism and Mutualism**

ADAPTATIONS

Any physiological, morphological and behavioural adjustments of the organisms that enable the organism to survive and reproduce in its habitat is called Adaptation

1.Adaptations of desert animals

Kangaroo rat in North American desert adapts to waterless conditions.

- Internal fat oxidation to produce water is a by product(Metabolic water).
- concentrated urine(Solid urine) (So minimual volume of water is used to remove excretory products)

Desert lizards maintain their body temperature constant by **behavioural means.**

- Desert lizards expose their body to sunlight and absorb heat when their body temperature is low. They move into shade when the body temperature is high.
- Some rodents hide in their burrows and escape from the above ground heat.

Adaptations of. desert plants:

- **Thick cuticle**
- **Sunken stomata** - stomata in deep pits to minimize transpiration
- **CAM Pathway** - special photosynthetic pathway called **Crassulacean Acid Metabolism (CAM) .**Stomata remain close during day to reduce transpiration, open at night to receive CO2.
- **Spine leaves** to reduce transpiration. Photosynthesis is done by green coloured flattened stems. Eg: Opuntia

2.Adaptations of mammals in cold climates.

- **Short ears and limbs** to reduce surface area. So they can **minimize heat loss**. This is called **Allen's Rule** .
- Seals have **thick layer of fat (blubber)** below the skin as **insulator** to **reduce body heat.**

3.Adaptations in high altitude

At a high altitude (above 3500 m) we feel **altitude sickness.** This is due to low atmospheric pressure & low availability of O_2.

Symptoms

Nausea, Fatigue, Heart palpitation

Gradually we acclimatize the situation by following adaptations.

- Increasing RBC production
- Increasing breathing rate
- Decreasing binding affinity of haemoglobin

POPULATION

A population is a group of individuals living together in a common area at a particular time.
Examples: Lotus plants in a pond, Teak wood trees in a forest,

Bacteria in a culture plate

POPULATION ATTRIBUTES

A population has certain attributes that an individual organism does not. Eg.an individual may have births and deaths, but a population has birth rates and death rates

Age pyramid

It is a graphical representation of properties of various age groups of a population. (% of individuals of a given age or age group).

There are 3 age groups, **pre- reproductive, reproductive and post -reproductive**.

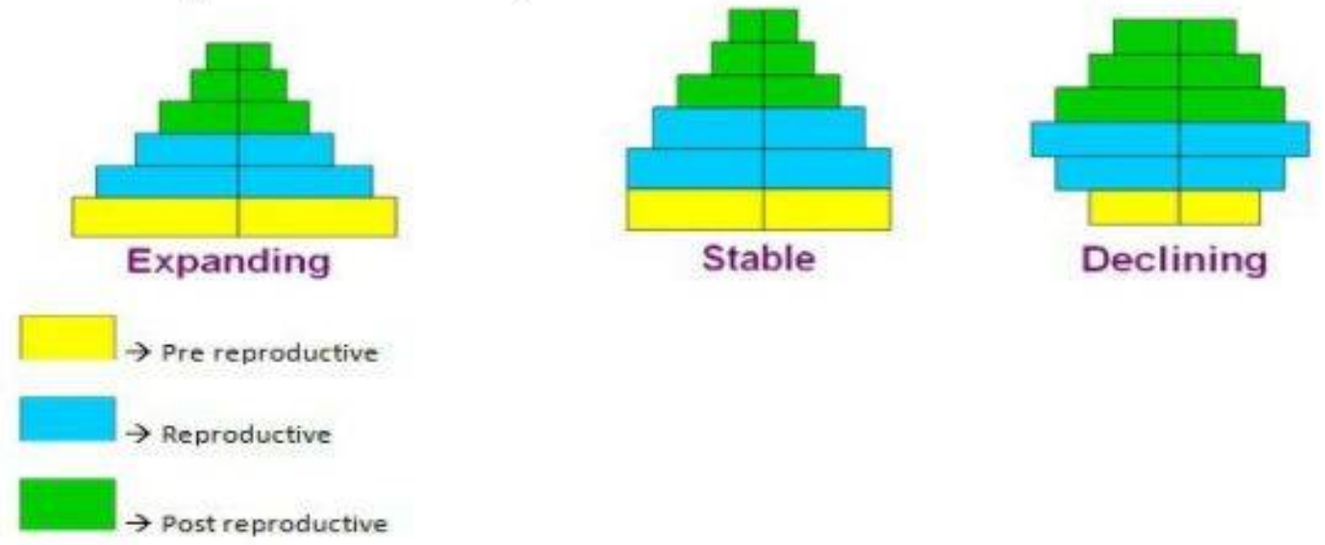
Pre- reproductive group is at the base, reproductive group in the middle and post –reproductive group at the top.

- Age pyramid shows age distribution of males & females in a combined diagram.
- Age pyramid shows nature of population, whether it is growing, stable or declining.

Age pyramids are of 3 types. They are

- **Expanding (Triangular age pyramids)** – More number of pre-reproductive individuals. Population is growing.
- **Stable (Bell shaped age pyramids)** Pre-reproductive & reproductive individuals are almost equal. No increase or decrease in population.

- **Declining (Urn shaped age pyramids)** Pre-reproductive individuals are lesser in number. Large number of reproductive individuals



POPULATION DENSITY/ POPULATION SIZE(N)

Total number of individuals present per unit area at a given time. It is indicated by the letter N.

Population density = Number of individuals in an area / Number of unit areas in a region

Population density is measured ,

- **In number of individuals of a population**
- **In % cover / biomass** (e.g., 200 parthenium plant and one huge banyan tree in an area. The role of banyan tree in that community is greater than parthenium)
- **Relative population density**. (eg., The number of fish caught / trap is used to measure total population density of fish in the lake)
- **Counting the colonies** in a bacterial culture
- Indirect method – In tiger reserves tiger census is done on **pug marks (foot prints)and fecal matter**

POPULATION GROWTH

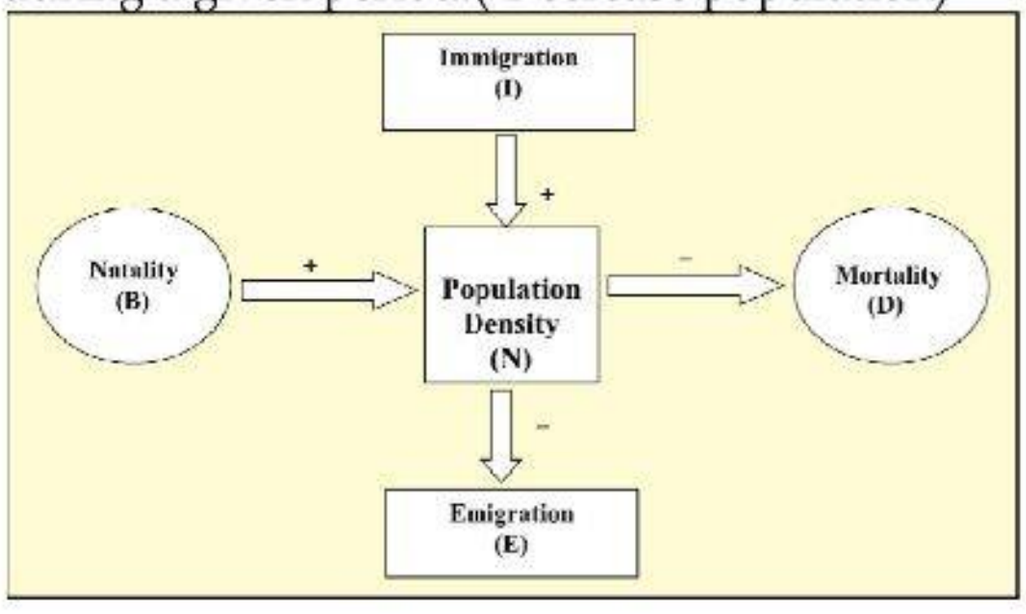
Factors affecting change in population density

1. Food availability
2. Predation pressure
3. Weather

Density changes by change in four basic processes

- **Natality (B) –** Number of births in a population during a population. (Increase population)
- **Immigration (I)** – Number of individuals of the same species that have come into the habitat from elsewhere during a given period. (Increase population)

- **Mortality (D)** – Number of deaths in the population in a given period. (Decrease population)
- **Emigration (E)** – Number of individuals of the population who left the habitat during a given period.(Decrease population)



If **N** is the population density at time '**t**', then its density at time **'t+1'**

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

- Population density will increase if **(B+I) > (D+E)**
- **Change in population size = (Births + Immigration) – (Deaths + Emigration)**

POPULATION INTERACTIONS

In nature organisms cannot live in isolation. They interact in different ways to form a biological community.

Types of Interactions:

Name of Interaction	**Species A**	**Species B**
Mutualism	+	+
Parasitism	+	-
Commensalism	+	0

+ Positive effect, - Detrimental effect ,0 Neutral effect

PARASITISM (+ -)

It is the interaction where one species (parasite) depends on the other species (host) for food and shelter, the parasite is benefitted and host is harmed.

Adaptations of parasites

- Both host and parasite tend to co-evolve
- Loss of unnecessary sense organs
- Presence of Hooks and suckers to cling on the host
- Loss of digestive system
- High Reproductive capacity

Due to the attack of Parasites host is harmed in different ways.

- Reduce the survival of host
- Growth and reproductive rate of host reduced
- Render the host vulnerable to its predators by making them weak
- Reduce the population density of host

Types of parasite

a) Ectoparasites –Lives on external surface of host
Example -

- Head lice on humans,
- Ticks on dogs
- Copepods on marine fish
- Cuscuta – Total stem parasite .

Female mosquito is not a parasite. It acts as a vector. It needs blood only for reproduction, not as food.

b)Endoparasites –Lives within the body of the host organism
Example -

- Liverfluke,
- Plasmodium

Brood parasitism – seen in parasitic bird e.g,Between cuckoo & crow

Cuckoo lays its eggs in the nest of its host, Crow for incubation, hatching & rearing of young ones.The eggs of cuckoo resembles the eggs of crow in size, shape & colour, Crow cannot detect the foreign egg.

MUTUALISM (+ +)
It is interaction in which both the interacting species are benefited

Examples

- **Lichen** – Symbiotic association between fungi and algae. Algae prepare food &give it to the fungus. Fungus give shelter & protection.

- **Micorrhiza –** Association between fungi& roots of higher plants. Fungus absorbs moisture and nutrients from the soil and give it to root. Root gives food to fungus.

- **Pollination & seed dispersal**. Examples are
  1) **Fig tree & wasp** .Female wasp , while searching for suitable place for egg laying, it pollinate the inflorescence of fig tree. In return fig gives some developing seeds as food.
  2) **Mediterranean orchid, Ophrys & bees. Sexual deceit** for pollination. One petal of its flower resembles female bees in size, colour & markings. So male bee **pseudocopulate** with the flower & dusted with pollen. When this bee pseudocopulate with another flower, it transfers pollen to it.

  If the female bee's colour pattern change slightly during evolution, pollination success will be reduced, unless orchid flower co-evolves to maintain the resemblance of its petals to the female bee.

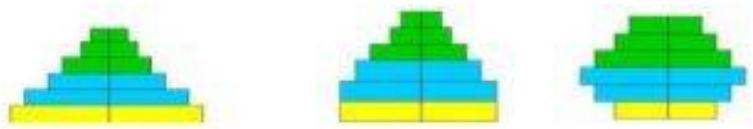
COMMENSALISM - (+ 0)

Interaction between two organisms in which one is benefitted and other is neither harmed nor benefitted. Examples are

- Orchid (+) growing on mango tree (0)
- Barnacles (+) grow on the back of the whale(0)
- Cattle egret (+) and grazing cattle(0) . The egret forage close to where the cattle are grazing. As the cattle move, the vegetation insect come out. Otherwise it is difficult for egrets to find and catch insects.
- Sea anemone (0) and clown fish(+). Stinging tentacles of sea anemone gives protection to fish from predators.

Previous Questions and Answers:

1. Differentiate Natality and Mortality? Write letters to denote them?
2. Write the interaction between sea anemone and clown fish. Justify your answer with suitable explanation?
3. Natality, mortality, immigration ,emigration are the four factors that affect the population density in an area. Explain any two of them?
4. Aquatic mammals like seal have a thick fat layer below the skin. Name this layer and identify the function?
5. Given below is the bar diagram showing age structure of three different populations. Observe the diagram carefully and answer the following questions



A B C

a) Select the stable population

b) Compare the nature of population growth in A,B and C

6.How is a Cactus adapted to survive in its habitat?

7.Sucker fish and Shark live in close association .This interaction is called commensalism. Explain commensalism?

8. Identify the following interactions

a) Barnacles on whale b) Wasp on fig. c) Mychorrhiza

Answers:

1. Natality - the number of births during a given period in the population (B)
   Mortality - the number of deaths in the population during a given period.(D)
2. Commensalism.Sea anemone that has stinging tentacles So fish gets protection from predators. The anemone has no benefit or harm. [Sea anemone-'0' effect] [Clown fish- '+' effect]
3. Immigration- inward movement of organisms to population.
   Emigration - outward movement of organisms from population.
4. a) blubber
   b) act as heat insulator
5. (a) B

(b)

A	B	C
Expanding	Stable	Declining
Positive growth	0- growth	-ve growth

6. a) thick cuticle on their leaf
   b) Sunken stomata
   c) Photosynthetic pathway is (CAM)
   d) Leaves are reduced to spines.
7. One species gets benefit and the other has no benefit or harm
8. a) Commensalism, b) Mutualism, c) Symbiosis

Chapter : 7 ECOSYSTEM

Focus Points

Productivity
Decomposition
Energy flow : Food chain, Food web and Trophic levels
Ecological pyramids
Nutrient cycling-Phosphorus cycle

The sum total of interaction between living and non-living components , capable of independent existence is called Ecosystem.

Fuctional components of ecosystem are

I.Productivity
II.Decomposition
III.Energy flow
IV.Nutrient cycling

I. PRODUCTIVITY - Rate of biomass /Organic matter produced per unit area during a given period of time. It is expressed in $g^{-2}yr^{-1}$ or $kcal\ m^{-2}year^{-1}$

1. PRIMARY PRODUCTIVITY – Rate of biomass produced per unit area during a given period of time by plants through photosynthesis **(Rate of biomass production at producer level**) It is divided into two.

- **Gross primary productivity (GPP)** – Rate of total biomass production by plants through photosynthesis.
- **Net primary productivity (NPP)** – Producer use some biomass for life processes, balance energy is NPP.

NPP = GPP – R (Respiratory loss)

Primary productivity varies in different ecosystems. It depends on **Sunlight, temperature, moisture, plants in that area, photosynthetic capacity, availability of nutrients etc**.

2.SECONDARY PRODUCTIVITY – Rate of biomass production at consumer level.

Annual NPP of **biosphere** is **170billion tons** .Productivity of **ocean** is low - **55 billion tons. (**Light can penetrate up to 250m depth from water surface).

II.DECOMPOSITION –Breakdown of organic materials into inorganic materials by decomposers. Oxygen requiring process. **Detritus** – Dead remains of plants (leaves, barks etc) and animals including fecal matters. Detritus are raw material for decomposition. **Detritivores** Organism which breakdown detritus. e .g., Earth worm.

Steps of Decomposition

- **Fragmentation** – Breakdown of organic matter into small fragments by detritivores.
- **Leaching** – Water soluble substances penetrate into the deeper layers of soil and get precipitate as unavailable salts.
- **Catabolism** – Enzymatic breakdown of detritus into inorganic materials. Enzymes are released by micro organisms.
- **Humification** – Formation of **partially decomposed dark coloured amorphous substance** called Humus **from** detritus. Humus is **resistant to microbial action** and it is **colloidal** in nature. So It undergoes **slow decomposition**. Humus is **Reservoir of nutrients.**
- **Mineralisation** – Humus is degraded by micro organisms and release inorganic nutrients.

Factors affecting decomposition –

- Warm and moist environment favour decomposition
- Decomposition rate becomes high if detritus rich in nitrogen and water soluble substances.
- Decomposition rate is slow in detritus rich in lignin & chitin.
- Low temperature and lack of Oxygen inhibit decomposition .

III.ENERGY FLOW - Unidirectional flow of energy from sun to producers, consumers ,and decomposers .**Ultimate source of energy – Sun.** 50% of the incident solar radiation – **Photosynthetically active radiation (PAR).** 10% of PAR is captured by plants. 10% energy is transferred to next level (10 % law). because 90% energy is utilized for life activities and released as heat energy. Flow of energy is controlled by first & second thermodynamic laws.

FOOD CHAIN – Linear sequence of energy transfer in an ecosystem by eating and being eaten.

Producer – Organism which produce food using sunlight.
Consumer – Depend on plants for their food directly or indirectly.
Primary consumer – Herbivores which eat plants.

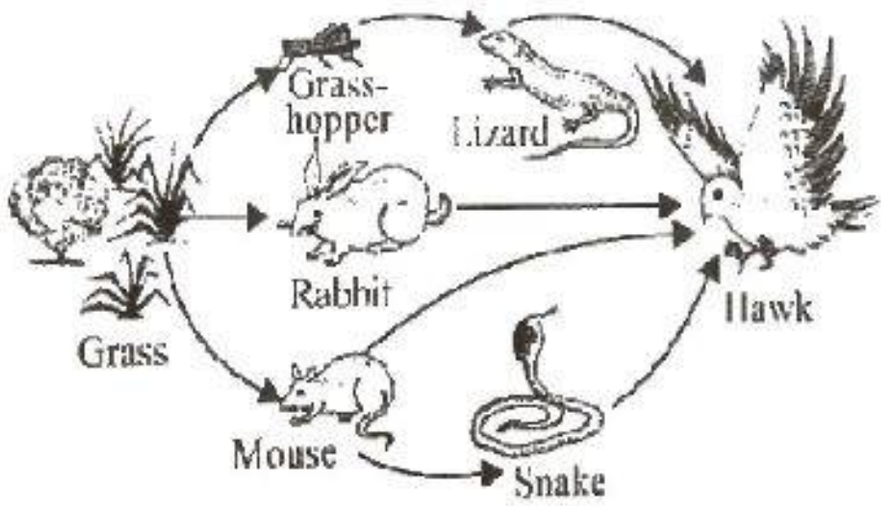
Secondary consumer – Animals which eat primary consumer.
Teritiary consumer – Animals which eat secondary consumers.

a) **Grazing food chain(GFC)** – Begins from plants. Takes place in major aquatic ecosystems. Less fraction of energy flow.

e.g., **Grass ——————> Goat——————> Lion——————> Hawk**

b)Detritus food chain (DFC)– Energy transfer begins from detritus. It includes **Saprophytes** which take food from detritus. Takes place in major terrestrial ecosystem. Large fraction of energy flow takes place.

FOOD WEB – Interconnected food chain.

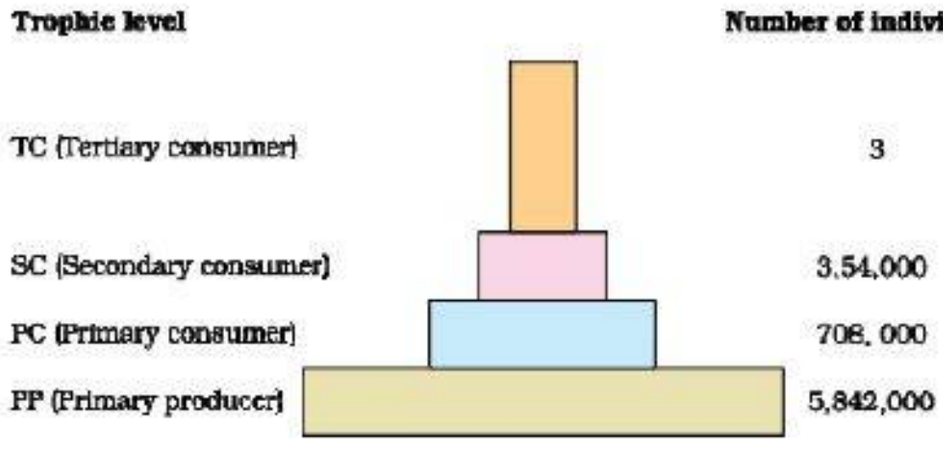


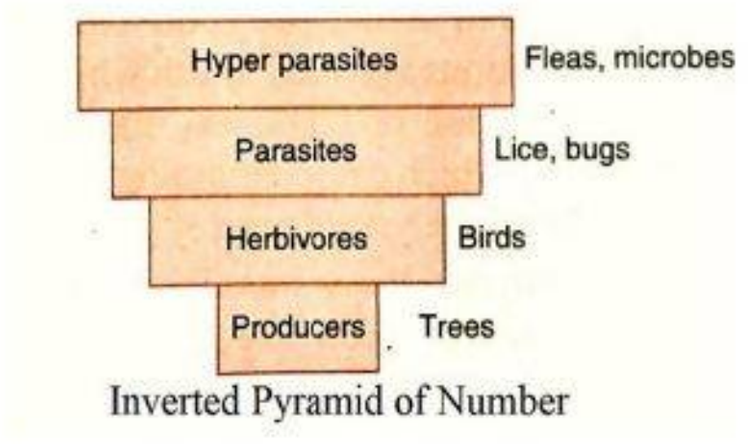
TROPHIC LEVELS - Based on the source of food, organisms occupy a specific place in the food chain. **First trophic level –** Producer. **Second trophic level –** Herbivores/ primary consumers. **Third trophic level –** Carnivores / secondary consumers. **Fourth trophic level** – Teritiary consumers.

Standing crop: The total amount of living material present in different trophic levels at a given time is called standing crop

ECOLOGICAL PYRAMIDS – Representation of food chain in the form of pyramid.

a)Pyramid of number –Representation of number of organisms in different trophic levels.



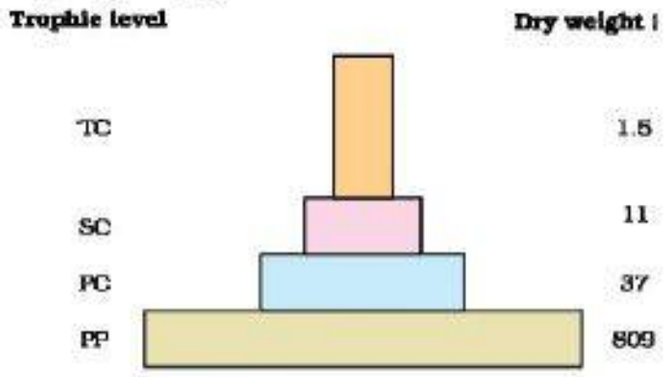


Upright pyramid – Grass land ecosystem

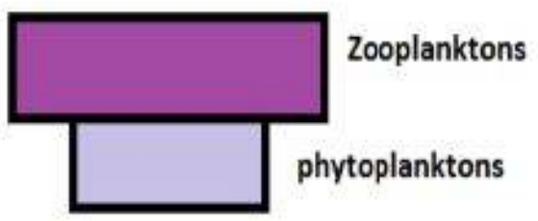
Inverted pyramid-Tree ecosystem

b)Pyramid of biomass – Representation of biomass of organisms of successive trophic levels.

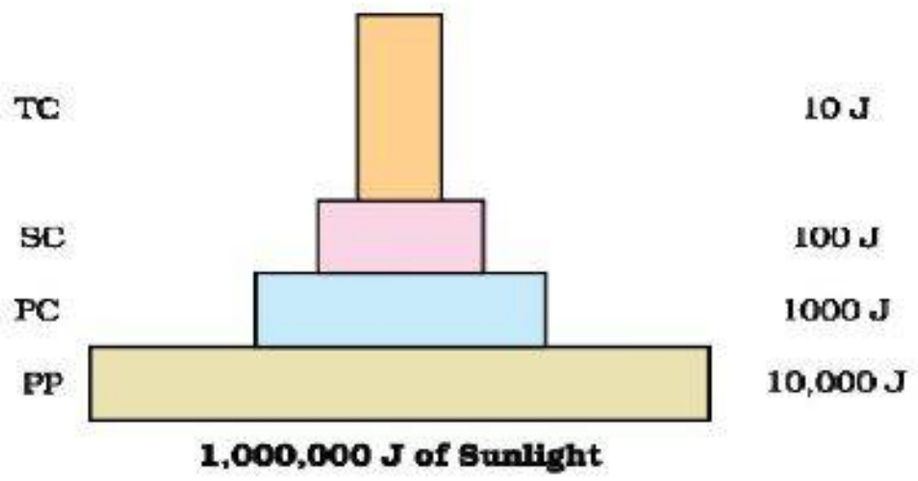
Upright pyramid of biomass



Inverted pyramid of biomass



c)Pyramid of energy – Representation of energy used by organisms of successive trophic levels. **Always upright**.



Limitations of Ecological pyramids

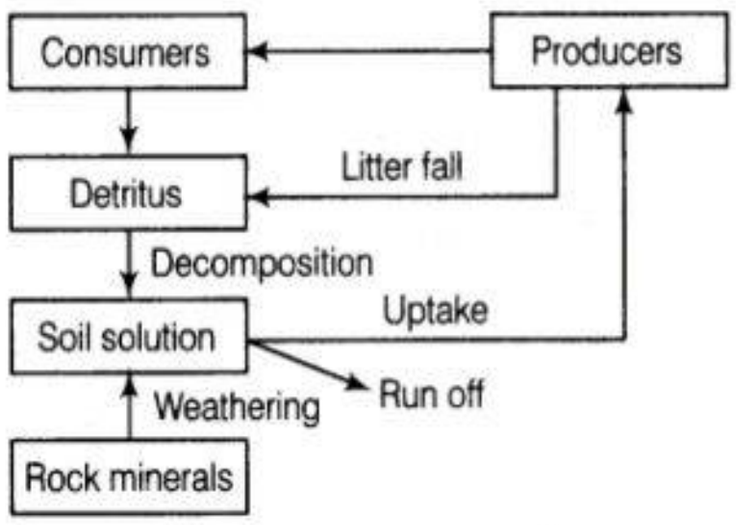
- Ecological pyramid does not accommodate food web
- Do not take into account same species belonging to two or more trophic levels.
- Assumes simple food chain, which never exist in nature,
- Saprophytes are not included.

IV.NUTRIENT CYCLING – Movement of nutrients through various components of ecosystem, also called **Biogeochemical cycle**. Decomposers play a vital role in

nutrient cycling. **Gaseous cycle** (rapid and more perfect)– reservoir of nutrients is located in atmosphere as gas. e.g. Nitrogen cycle & Carbon cycle. **Sedimentary cycle** (slow & less perfect)– reservoir of nutrients located in standing state of the sediments of earth crust. e .g., Sulphur & Phosphorous cycle.

Phosphorous cycle

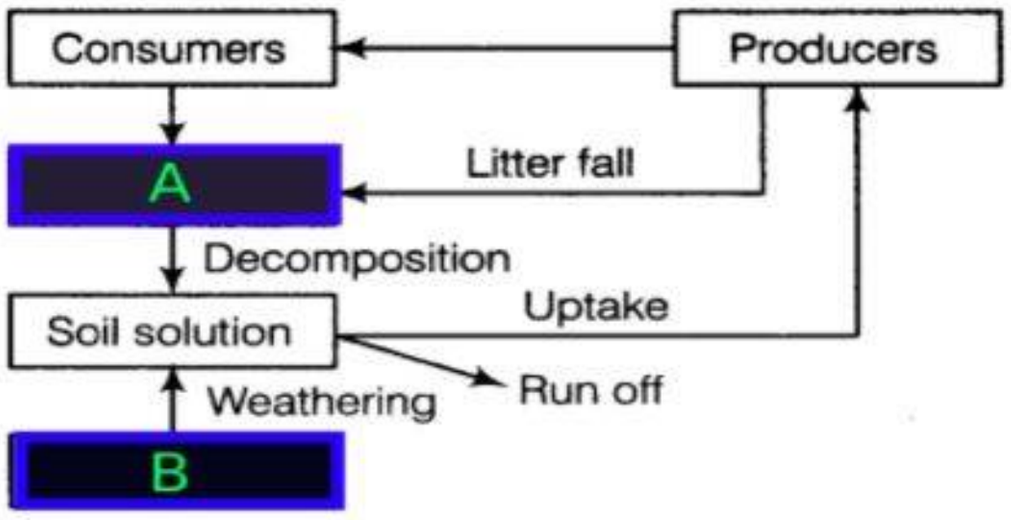
Reservoir – rocks, which contain phosphorous in the form of **phosphate**. Phosphorous is released into atmosphere through (a) **Weathering of rocks** –minute amount of phosphate dissolve in the soil solution and are absorbed by plants. Animals obtain phosphorous from plants. (b) Waste products and dead organisms are decomposed by phosphate solubilising bacteria releasing phosphorous. Phosphorous is a constituent of Nucleic acids & ATP. Animals use phosphorous to make bones, teeth etc.



Previous Questions and answers:

1. Decomposition takes place through different steps. The first is fragmentation. Write the following four steps?

2. Observe the figure given below. Identify that nutrient cycle and fill in the **A, B**?



A simplified model of phosphorus cycling in a terrestrial ecosystem

3. Nutrients never lost from ecosystem and are recycled. Write about sedimentary cycle
4. The natural reservoir of phosphorus is rock where phosphorus is present in the form of phosphates. How Phosphorus is cycled in ecosystem?
5. Pyramid of energy is never been inverted. Why?
6. Grasshopper, snake, bird, frog, grass. Draw a food chain representing each of the above?
7. NPP = GPP – NPP
    a) What are GPP and NPP?
    b) Define secondary productivity?

Answers:

1. Leaching, Catabolism, Humification, Mineralization
2. a. Detritus
   b. Rock minerals

3. Reservoir for the sedimentary cycle (e.g., sulphur and phosphorus cycle), exists in rocks
4. When rocks are weathered, phosphates dissolve in soil solution and are absorbed by the plants. Herbivores obtain this element from plants. The waste products and the dead organisms are decomposed to phosphorus.
5. Because when energy flows from one trophic level to the next trophic level from producers to consumers, some energy is always lost as heat at each step.
6. Grass→grasshopper→frog→ snake→ bird
7. a. GPP=Gross Primary Productivity
      NPP=Net Primary Productivity
   b.Productivity at consumer level is secondary productivity

Chapter 8:

ENVIRONMENTAL ISSUES

Focus Points

- **Water pollution and its control,BOD,Algal bloom and Eutrophication**
- **Green house effect and Global warming**
- **Ozone depletion in the stratosphere**
- **Deforestation**

WATER POLLUTION

Undesirable change in the physical, chemical or biological composition of water.

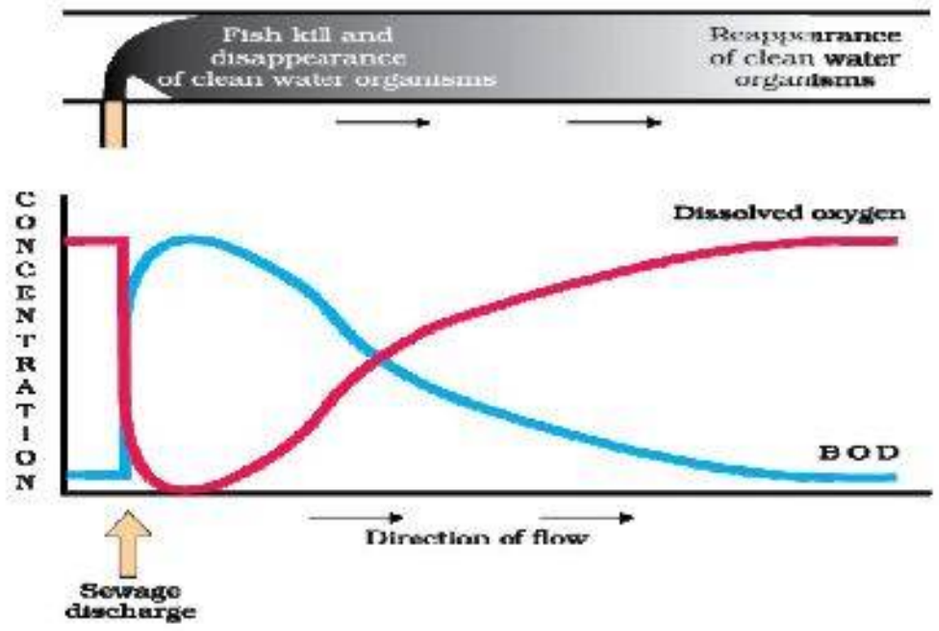
Sources of water pollution.

1) Domestic sewage
   - Detergents used to wash clothes. It contains Phosphates, Nitrates, Ammonium compounds etc.
   - Sewage – contains decomposable organic matter which increases oxygen demand. These water bodies contain pathogens.
2) Industrial waste water
   - Contains variety of organic and inorganic materials.
   - Hot water is returned by industries like electricity generating unit, thermal power plant etc.

Effects of water pollution

1) Causes Outbreak of **serious diseases** such as dysentery, typhoid, jaundice, cholera etc.

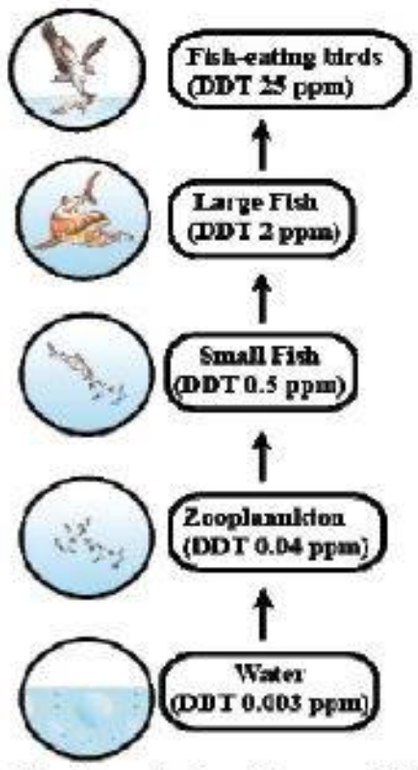
2) **Increase Biochemical Oxygen Demand (BOD) and decreases Dissolved Oxygen (DO).**
   - Sewage contain biodegradable organic matter→ decomposed by micro organisms→Decomposers use dissolved oxygen in water →Sharp decline of dissolved oxygen (DO)→Death of fish
   - **Biochemical Oxygen Demand (BOD)** – Amount of biodegradable organic matter in sewage is measured as BOD.



3) **Algal bloom** – Over production of Planktonic (free floating) algae.
   - It Imparts distinct colour to water bodies.
   - Fish mortality
   - Deterioration of water quality
   - Toxic to human beings and animals
   - e .g., **water hyacinth,** also called **Terror of Bengal** grow at a rapid rate in water bodies & leads to water pollution.

4 **Biomagnification – Increase in the concentration of toxic materials at successive trophic level.** The toxic substance cannot be metabolized or excreted and passed on to the next higher trophic level. e .g., DDT & Mercury.

<u>Effect of DDT Accumulation</u> –
- Disturbs calcium metabolism in birds.
- Thinning and pre mature breaking of egg shell.
- So bird population declines.



5 **Eutrophication – Natural aging** of a lake by nutrient enrichment.
   - Young lake is cold → Later converts into warm water →Sewage & fertilizers run off from farms increase fertility of water → Plant & animal life grow rapidly →Organic remains deposited →Decomposers use DO →Fish mortality.

- With the time, lake grow shallower and warmer → cold water organisms are replaced by warm water organisms →Marsh plants take root in the shallows →Give way to large masses of floating plants →Lake converts into land .
- Depending on the climate, size of lake etc natural aging take thousands of years.

Cultural / Accelerated **Eutrophication –** Aging process is speeded up by man's activity .

Reasons – Addition of pollutants , Industrial waste water, Sewage, Fertilizer run off, Hot water from thermal power plant.

Greenhouse effect and global warming

Greenhouse is a glass house which is used for growing plants during winter, glass panel lets the light in and does not allow heat to escape. So greenhouse always warms up.

Greenhouse effect – Natural phenomenon that cause heating of Earth surface and atmosphere. It maintain average temperature of Earth (15°C) .Otherwise temperature of Earth would have been -18°C.

- Clouds & gases reflect about ¼ of the incoming solar radiation and absorb some of it.
- Half of incoming solar radiation falls on Earth surface heating the atmosphere, small amount is reflected
- Earth surface re-emits heat in the form of infrared radiation.
- Atmospheric gases absorb major part of this infrared radiation. So it does not escape from the atmosphere
- Gases radiate heat energy and come to the Earth surface , heating it up again.

Greenhouse gases – CO2, Methane, Nitrous oxide, Chloroflourocarbons (CFC)

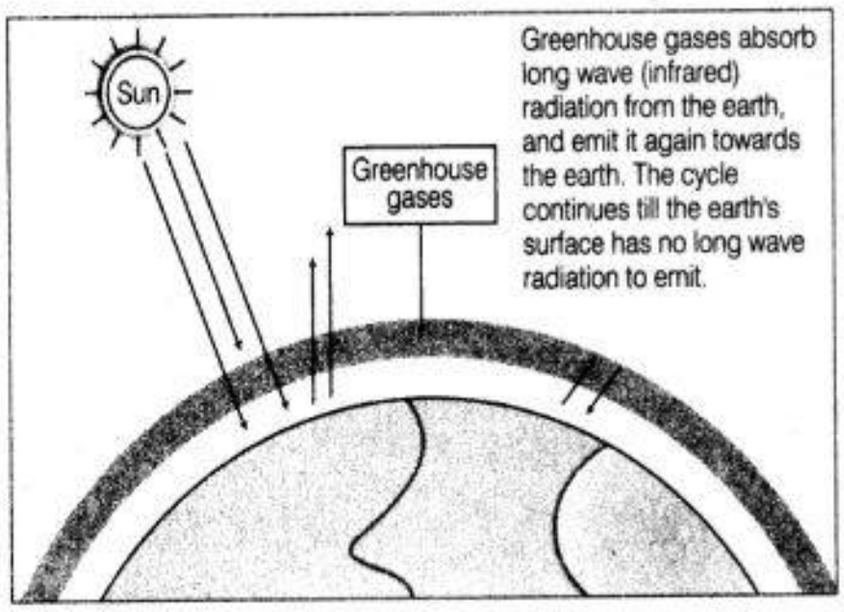
Global Warming – Increase in the temperature of Earth due to the increased concentration of greenhouse gases.

Effect of Global Warming

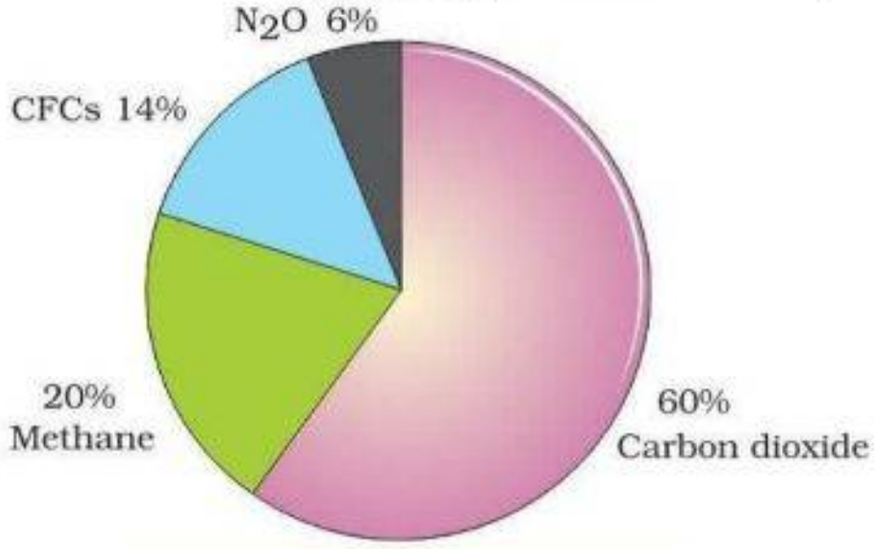
- Affects weather & climate (El Nino effect)
- Melting of polar ice caps & Himalayan snow caps over many years leads to rise in sea level
- Affect crop productivity.

Control Measures

- Reduce the use of fossil fuels.
- Reduce deforestation
- Afforestation & Reforestation
- Slowing down the human population growth.
- International initiatives to control and reduce the emission of greenhouse gases.
- Improve efficiency of energy usage.



Sunlight energy at the outermost atmosphere



Relative contribution of various greenhouse gases to total global warming

OZONE DEPLETION IN THE STRATOSPHERE

- Ozone is a tri atomic gas.
- **Bad Ozone** is found in troposphere (harmful to plants and animals)
- **Good Ozone** is formed in stratosphere (act as shield and absorbs UV rays)
- The thickness of Ozone is measured in **Dobson unit(DU)**

Ozone Formation

$$O_3 \xleftrightarrow{\text{UV ray}} O_2 + O$$

Ozone hole – Thinning of stratospheric Ozone layer (First detected in Antartic region).

Reasons – Unbalanced Production and degradation of Ozone in the stratosphere.

$$CFCl_2 \xrightarrow{\text{UVray}} CFCl_2 + Cl$$

$$Cl + O_3 \longrightarrow ClO + O_2$$

$$ClO + O \longrightarrow Cl + O_2$$

Effect of Ozone depletion –

- UV- B radiation enter into earth, it **damage DNA** and cause **Mutation.**
- **Aging of skin** and **skin cancers**
- Cause **Snow- blindness** (inflammation in cornea).
- Cause **Cataract**
- **Destruction to Monuments.**

Montreal protocol – International initiative signed at Montreal (Canada) in 1987 to control

the emission of Ozone depleting substances.

DEFORESTATION

Conversion of forested areas to non- forested areas by Man. Almost 40% of forests have been lost in the tropics compared to only 1% in the temperate region.

Reasons

- Urbanisation & industrialization
- Jhum cultivation or Slash & burn agriculture –Nowadays.
- Construction of hydroelectric project
- For timber, firewood etc

Jhum cultivation / Slash & burn agriculture

- Traditional agricultural practice in north- east states
- Farmers cut down the trees of forest and burn the plant remains.
- Ash is used as fertilizer and forest land for farming or cattle grazing.
- After cultivation, land is left for several years for its recovery.
- Farmer moves to another forest & repeat the process.
- In earlier days there is enough time for recovery. But today there is no time for recovery.

Consequences of deforestation

- Loss of biodiversity
- Soil erosion
- Desertification
- Global warming
- Increase CO2 concentration in the atmosphere.

Reforestation – Process of restoring a forest that once existed.

Afforestation – Planting trees in an area where there was no previous tree cover.

People's participation in forest conservation

- **Bishnoi movement** – In 1731 Bishnoi women Amritha devi showed extra ordinary courage by hugging a tree and challenged King's men . Amritha devi and her daughters sacrificed their life .
  In India **Amrita Devi Bishnoi Wildlife Protection Award** is given **to individuals or organizations** that show **courage & dedication towards biodiversity**.
- **Chipko movement** – The local women showed courage to protect trees from the axes of contractors by hugging the tree . Movement started in march 1974 from Garhwal Himalayas.
- **Joint Forest Management (JFM) – Forest conserved in a sustainable manner**. Govt of India introduced this concept in 1980s. Local communities involved in the protection and management of forest . They get benefit of various products like fruits, medicine, rubber etc.

Previous years questions and answers.

1mark questions

1.Name the award given by the Government of India to individuals or communities from rural area

for protecting wild life.

2. Increased concentration of toxicants at successive trophic level is called ----------
3. Which among the following is not a green house gas
   N_2O, Methane, Carbon dioxide, Ozone

2mark questions

1. Environmentalists says: ' There are many causes for biodiversity losses'. Illustrate four major causes of biodiversity loss.
2. An aquatic ecosystem having luxurious growth of cyanobacteria (Algal bloom) leads to eutrophication.
   a)What kind of pollutants cause algal bloom to colonize the aquatic ecosystem?
   b)What are the consequences of eutrophication?
3. Suggest any two control measures that will reduce global warming?
4. A common cause of deforestation is slash and burn agriculture.
   a)What is the common name attributed to such type of cultivation?
   b)Explain how this type of cultivation is practised

3mark questions

1. Natural aging of lake by nutrient enrichment is called eutrophication.
   a) Name the enhanced aging process due to human activity.
   b) Write down two consequences of eutrophication in water bodies.
2. Ammu read in the newspaper that, BOD of a water body in a nearby village was high and there is algal bloom.
   a) What is BOD?
   b) What is algal bloom?
   c) Can you give possible reason for these phenomenon?

Answers

1mark questions

1. Amrita Devi Bishnoi Wildlife Protection Award
2. Biomagnification
3. Ozone

2mark questions

1. Urbanisation and Industrialization
   Jhum cultivation
   Construction of hydroelectric project
   Deforestation for timber and firewood
2. Domestic sewage containing phosphates and nitrates
   Industrial wastes containing organic and inorganic materials.
   Eutrophication encourages aquatic life. It makes water shallower and warmer.
   Gradually the lake is converted into a land.
3. Reduce the use of fossil fuels, reduce deforestation,afforestation and reforestation, slow down human population growth (any two).
4. Jhum cultivation
   Farmers used to cut and burn trees . This ash is used as fertilizer for farming in that area,After cultivation, the land is left for many years for its recovery. Farmers move to another place and repeat the process.

3 mark questions

1. Cultural eutrophication/ Accelerated eutrophication
   Eutrophication encourages aquatic life. It makes water shallower and warmer. Gradually the lake is converted into a land.
2. Biochemical Oxygen Demand
   The excessive growth of planktonic algae in a water body is called algal bloom
   Domestic sewage containing phosphates and nitrates
   Industrial wastes containing organic and inorganic materials.