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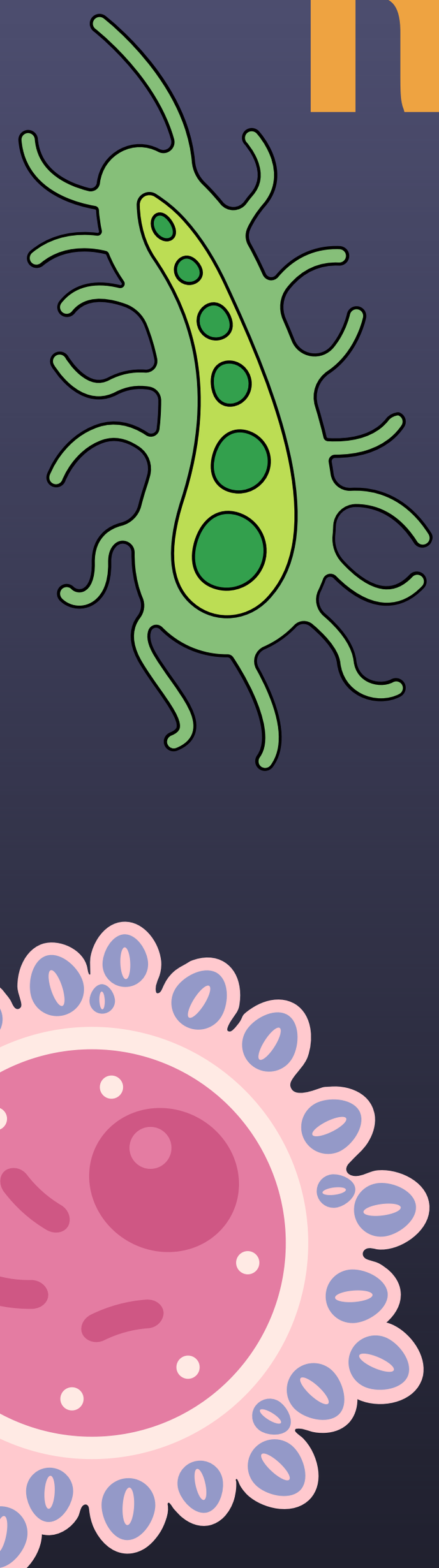
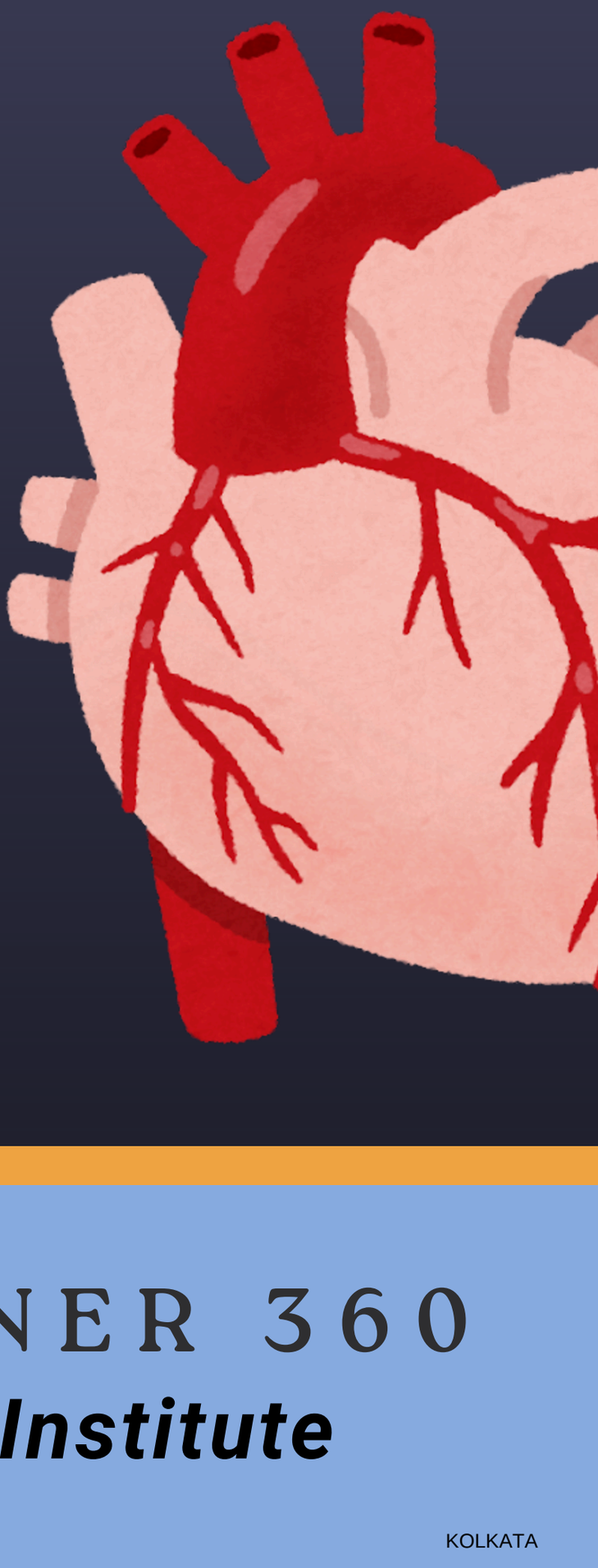
BIOLOGY

REVISION

CLASS 12





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Guidance & Coaching Institute

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CBSE Class 12 Biology
Revision Notes
CHAPTER-01
REPRODUCTION IN ORGANISMS

Reproduction is a biological process of formation of new offsprings from the pre-existing organism.Reproduction becomes a vital process without which species cannot survive for long It ensures continuity of species generation after generations as older individuals undergo senescence and ultimately they die.

Life span - • The period from birth to the natural death of an organism represents its **life span**. Life span of organisms varies from few days (Butterfly-1to 2 weeks) to thousands of years (Banyan tree).

Types of Reproduction:
Based on whether there is one or two organisms taking part in the process of reproduction

- ASEXUAL REPRODUCTON
- SEXUAL REPRODUCTION

When the offspring is produced by single parents with or without the involvement of gamete formation, the reproduction is called **asexual reproduction**.

When two parents (opposite sex) participates in reproduction process and also involves the fusion of male and female gametes, it is called **sexual reproduction**.

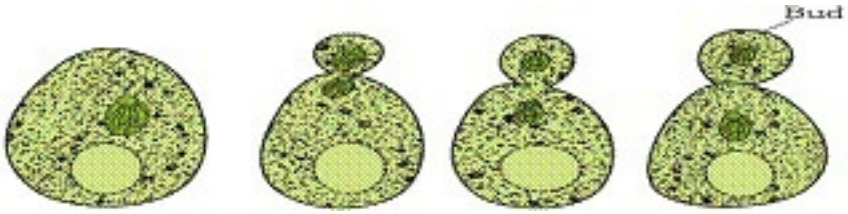
Asexual Reproduction

1. Usually followed by organisms with relatively simpler organizations.
2. Off springs produced by single parent.
3. With/without involvement of gamete formation.
4. Off springs 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 mode of 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.

• **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), conidia (penicillium), buds (hydra) and gemmules (sponges).

• In plants, vegetative reproduction occurs by vegetative propagules like runner, rhizome, sucker, tuber, offset and bulb.

Vegetative part	Example
Roots	*Dahlia*, *Asparagus*, *Dalbergia*, guava and tapioca
Stems	
• Tubers	Potato and artichoke
• Bulbs	Garlic and onion
• Rhizome	Ginger, turmeric, banana and *Dryopteris*
• Corms	*Colocasia*, *Crocus* and *Amorphophallus*
• Suckers	Mint and *Chrysanthemum*
• Runners	*Oxalis* and *Centella*
• Stolons	Jasmine
• Offsets	*Pistia* and *Eichhornia*
Leaves	*Bryophyllum*, *Begonia*, *Kalanchoe* and walking fern
Bulbils	*Agave*, lily and *Dioscorea*
Turions (fleshy buds in aquatic plants)	*Potamogeton* and *Utricularia*

WATER HYACINTH (Terror of Bengal)

- One of the most invasive weeds
- Grows wherever there is standing water
- Drains oxygen from water- leads to death of fishes.
- Introduced in India because of its pretty flowers & shape of leaves
- Vegetative propagation occurs at a phenomenal rate

Asexual reproduction is the most common method of reproduction in organisms having

simpler body like in algae and fungi but during unfavorable condition they shift to sexual reproduction.

SEXUAL REPRODUCTION:

- Involves formation of male and female gamete by two individuals of the opposite sex.
- Offspring produced by fusion of male and female gametes not identical to each other or to the parents.
- All sexually reproducing organisms share a similar pattern of reproduction.

• In sexual reproduction, fusion of male and female gametes results in offspring that are not identical to parents.

DIFFERENT PHASES IN SEXUAL REPRODUCTION:

a. Juvenile phase - The period between birth and sexual maturity is called juvenile phase. In plants it is known as **vegetative phase.**The end of juvenile/vegetative phase marks the beginning of the reproductive phase.

b. Reproductive phase-

• Some plants show flowering in particular season and some other flowers in all seasons. Some other plants like bamboo species flowers once in life time (after 50-100 years), *Strobilanthus kunthiana* (neelakuranji),flowers once in 12 years.

• The female placental animals exhibit cyclic change in activities ovaries and accessary glands as well as hormone during the reproductive phase.

Menstrual cycle

• It occurs in monkeys, apes and human beings.
• Cycle consists of 3 phases-menstrual, proliferative and secretory phase.
• Blood flows in the last few days of the cycle. The broken endometrium is passed out during menstruation.
• Female does not permit copulation during menstrual phase of the cycle.

Oestrous cycle

• It occurs in non primates like cow, sheep, rat, deer, dog, tiger etc.
• It consists of a short period of oestrous or heat. it is 12-24 hours in cow followed by

anoestrous or passive period.
• Blood does not flow in this cycle. The broken endometrium is reabsorbed.
• Female permits copulation only during oestrous period.
• Both in plants and animals, hormones are responsible for the transition between different phases of life cycle. Interaction between hormones and environmental factors regulate the reproductive processes.

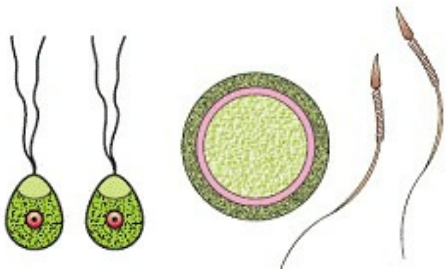
c. Senescent phase -

- It is the end of reproductive phase.
- Old age ultimately leads to death

Events in Sexual Reproduction : Pre-fertilisation, Fertilisation, Post-fertilisation

Pre-fertilisation- all the events prior to fusion of gametes are included in it. It includes gametogenesis and gamete transfer.

a. Gametogenesis 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 called **homogametes (isogametes)**. In higher organism that reproduces sexually, two morphologically distinct gametes are formed called **heterogametes**, male gametes are called **antherozoid or sperm** and female gametes are called **ovum or egg.**



Isogametes. **heterogametes**

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 animals, species which possess both male and female reproductive organs in same

individual are called **bisexual** or **hermaphrodites** (earthworm, sponges, tapeworm etc.) and both having either male or female reproductive organs are called **unisexual** (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.

b. Gamete Transfer – in majority of organisms, male gametes are motile and females gametes are non-motile, except in fungi and algae in which both gametes are motile.

• In simple plants like algae, fungi, bryophytes and pteridophytes water is the medium through which male and female gametes moves. The number of male gametes are much more than number of female gametes as most of male gametes fail to reach the female gametes.

• In higher plants pollen grains are carrier of male gametes and ovule has eggs. Pollen grains must be transferred from anther to stigma to facilitate **fertilisation.** The transfer of pollen grains from anther to stigma is called **pollination**. Pollination may be self (anther to stigma of same flower) or cross (anther to stigma of different flower).

• Pollen grains germinate on stigma to produce pollen tube that delivers the male gametes near the ovule.

c. 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 without fertilisation of female gametes is called **parthenogenesis**. For example honey bee, rotifers, and lizards

EXTERNAL FERTILIZATION	**INTERNAL FERTILIZATION**

Syngamy occurs outside the body of the organism Large numbers of gametes are released in the surrounding medium. **Ex.** Bony fishes and Amphibians.	Syngamy occurs inside the body of the organism Numbers of ova produced are less, but large numbers of male gametes are released and they travel towards the ovum. **Ex.** Birds and Mammals**.**

d. Post Fertilisation Events- events in the sexual reproduction after formation of zygote.

Zygote is the vital link that ensures continuity of species between organisms of one generation and the next. Every sexually reproducing organism, including human beings begin life as a single cell–the zygote.

• In the organisms, having external fertilisation, zygote is formed in external medium (water) and those having internal fertilisation zygote is formed inside the body of female.

• In algae and fungi, zygote develops a thick wall resistant to desiccation and damage. This germinates after a period of rest.

• In the organisms having haplontic life cycle, zygote divides to form haploid spores that germinate to form haploid individual.

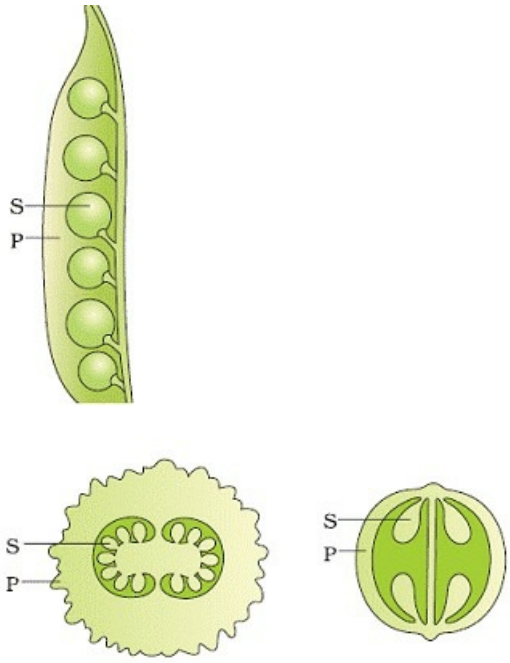
Embryogenesis – the process of development of **embryo** from the zygote. During this, zygote undergoes mitotic division and cell differentiation. Cell division increase the number and cell differentiation help in formation of new group of cells and organs.

Oviparous	**Viviparous**
Development of zygote takes place outside the body of organisms and lay fertilized of unfertilized eggs. Ex - Reptiles and birds.	Development of zygote takes place inside the body of organisms and produces young ones. Ex- Human, dog, horse etc.

• In flowering plants, zygote is formed inside the ovule. After fertilisation, sepals, petals and

stamens of flower fall off. The zygote develops into embryo and ovules into seeds. The **ovary** develops into **fruits** which develop a thick wall called **pericarp**, protective in function.

• After dispersal, seeds germinate under favorable condition to produce new plants.



A few kinds of fruit showing seeds (S) and protective pericarp (P)

CBSE Class 12 Biology

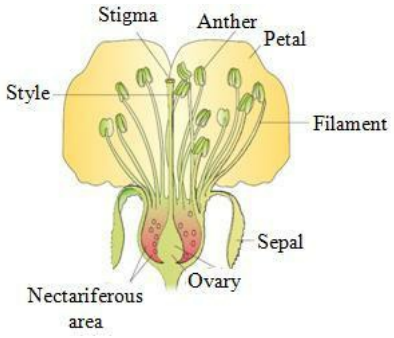
Revision Notes

CHAPTER-02

SEXUAL REPRODUCTION IN FLOWERING PLANTS

Reproduction ensures continuity of species generation after generations as the older individuals undergo senescence and die. Flowering plants shows sexual mode of reproduction and bears complex reproductive units as male and female reproductive units along with accessary structures.

Flower is a modified stem which functions as a reproductive organ and produces ova and/or pollen. A typical angiospermic flower consists of four whorls of floral appendages attached on the receptacle: **calyx, corolla, androecium** (male reproductive organ consisting of stamens) and **gynoecium** (composed of ovary, style and stigma) .



Pre-fertilisation: Structures and Events

• Several structural and hormonal changes lead to formation and development of the floral primordium. Inflorescence is formed that bears floral buds and then flower.

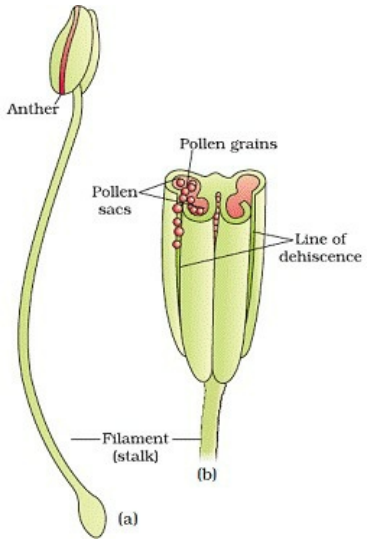
• In flowers, male (androecium) and female (gynoecium) differentiate and develops in which male and female gametes are produced.

Stamen, Microsporangium and Pollen Grain :

• Stamen consists of long and slender stalk called filament and generally **bilobed** anthers. Each lobe contains two theca (**dithecious**).

• 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.

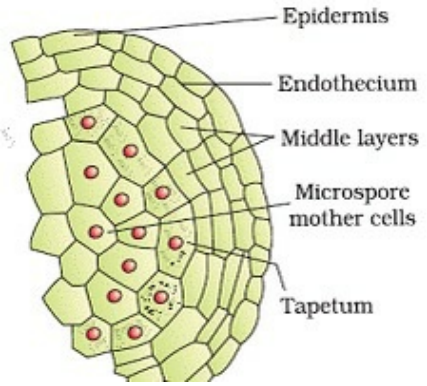


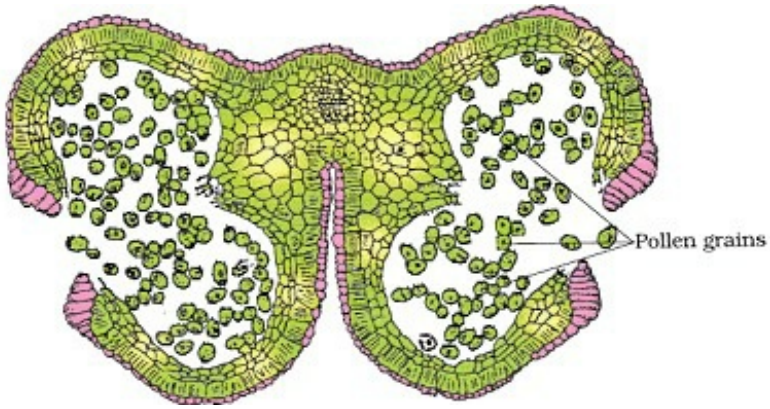
• Microsporangium is generally surrounded by four layered walls- the epidermis, endothecium, middle layer and tapetum. Innermost layer **tapetum** nourishes the developing pollen grains.

• **Sporogenous tissues-** It is compactly arranged homogenous cells which are present at centre of each microsporangium when the anther is young..

Microsporogenesis- The process of the formation and differentiation of microspores (pollen grains) from microspore mother cells (MMC) by reductional division is called microsporogenesis.

• The cells of sporogenous tissues undergo meiotic division to form microspore tetrad. As the anther mature and dehydrate, the microspore dissociate and develops into pollen grains.





Pollen grain represents the male gametophytes. Pollen grains are made of 2 layered Wall,

1. Exine :- Made of sporopollenin- most resistant organic matter known.It can withstand high temperatures and strong acids and alkali. No enzyme can degrade sporopollenin

2. Intine :-
-Thin and continuous layer
- Made of cellulose and pectin

3. Germ pores
- apertures on exine where sporopollenin is absent
- forms pollen tube.

4. A plasma membrane surrounds cytoplasm of pollen grain.

MATURE POLLEN
— A mature pollen consist of 2 cells with nucleus (Vegetative and Generative)

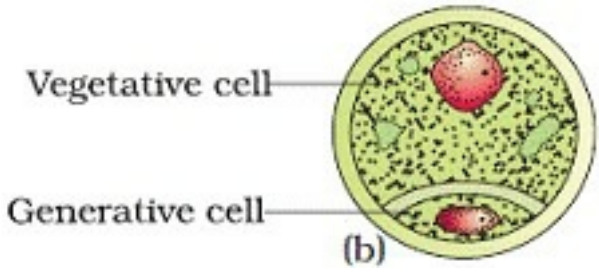
VEGETATIVE CELL

- Bigger
- Abundant food reserve
- Large irregular nucleus
- Responsible for the development of pollen grain

GENERATIVE CELL

- Small
- Involves in syngamy (fuse with an egg)

- Dense cytoplasm and nucleus



- Pollen grains of many species e.g Parthenium cause severe allergies and bronchial diseases in some people and leads to chronic respiratory disorders– asthma, bronchitis, etc.

• Pollen grains are rich in nutrients and are used as pollen tablets as food supplements.

• Viability of pollen grain varies with species to species and should land on stigma before this period to germinate. Pollen grains of large number of species are stored in liquid nitrogen at temperature – 196^0, called pollen bank.

The Pistil, Megasporangium (Ovule) and Embryo sac

• Gynoecium may consists of single pistil (monocarpellary) or more than one pistil (polycarpellary) which may be fused (syncarpous) or free (apocarpous).

e.g Multicarpellary and syncarpous pistil- Papaver

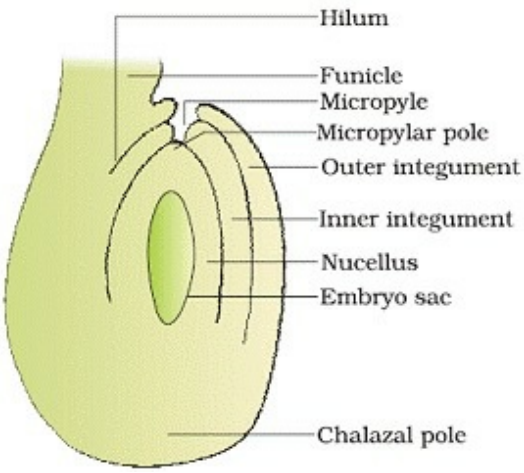
Multicarpellary and apocarpous pistil- Michelia

• Each pistil has three parts the **stigma, style and ovary**. Inside the ovary is ovarian cavity (locule). The placenta is located inside the ovarian cavity. Megasporangia (ovules) arise from placenta.

Megasporangium (ovule)

- Ovule is a small structure attached to placenta.
- Funicle – stalk by which ovule is attached to placenta
- Hilum- junction between ovule and funicle
- Integuments- protective envelops
- Micropyle- small opening at the tip of ovule into where pollen tube enters

- Chalaza- basal part of ovule
- Nucellus (2n)-mass of cells enclosed in integuments. Has abundant food reserve.



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

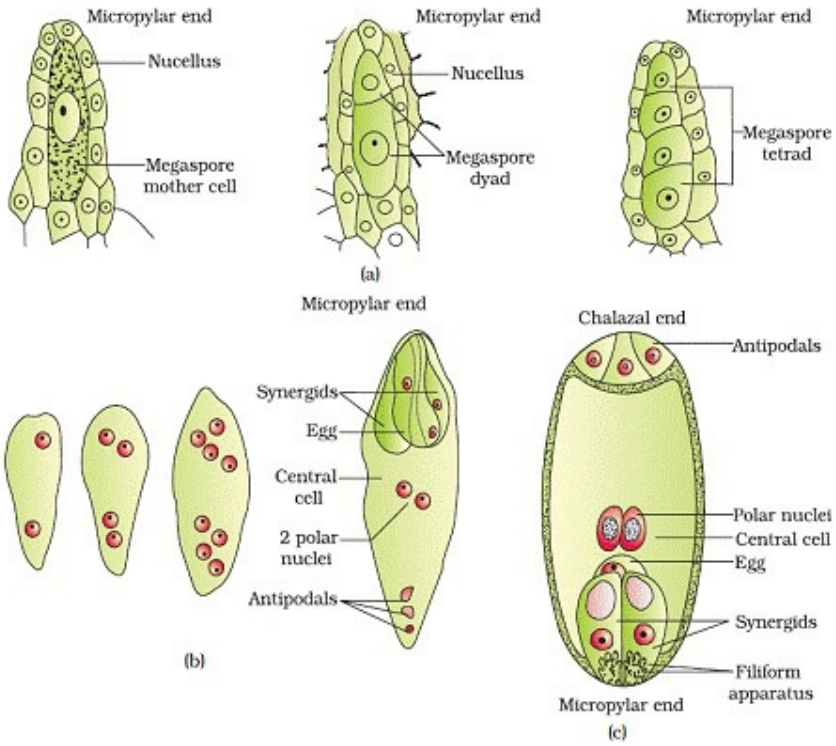
Ovule differentiates a single megaspore mother cell (MMC) in the micropylar region of nucellus. MMC undergoes meiotic division that results into the production of four megaspores.

• In most of the flowering plants three megaspores degenerate. 1megaspore 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.

• Six of the eight nuclei surrounded by cell wall and remaining two nuclei (polar nuclei) are situated below the egg apparatus.

• Three cells are grouped at micropylar end to constitute **egg apparatus** and three cells at chalazal end forms **antipodal cells.** At maturity ,embryosac is **8-nucleate and 7 celled.**



Pollination – transfer of pollen grains from anther to stigma.

a) **Autogamy**- transfer of pollen grain from anther to stigma of same flower.

i. **Cleistogamous** – flower which do not open. cleistogamous flowers are autogamous as there is no chance of cross-pollen landing on the stigma. Cleistogamous flowers produce assured seed-set even in the absence of pollinators. e.g Viola (common pansy), Oxalis, and Commelina.

ii. **Chasmogamous**- exposed anther and stigma.

b) **Geitonogamy** – transfer of pollen grains from anther to stigma of different flower of same plant. Geitonogamy is functionally cross-pollination involving a pollinating agent, genetically it is similar to autogamy since the pollen grains come from the same plant

c) **Xenogamy**- transfer of pollen grain from anther to stigma of different plant's flower of same species.

Agents of pollination 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 as most of pollen grains are wasted during transfer.

Adaptations in flowers for Pollination

I. Wind Pollination

- pollen grains :– light, non- sticky, winged
- anther :- well exposed
- stigma :- large and feathery
- flower :- one ovule, arranged as inflorescence

Ex **:** corn cob**,** cotton, date palm

II. **Water Pollination**
- ***Bryophytes, Pteridophytes, Algae***

- pollen grains : protected by mucilaginous covering

Ex : Fresh water plants- Vallisneria, Hydrilla
Sea grass- Zostera

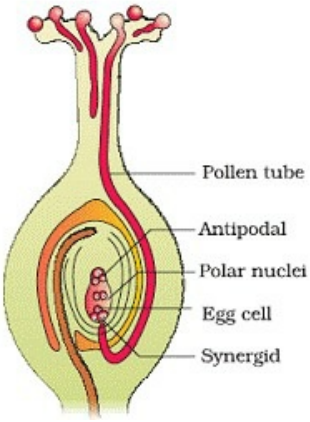
Main features of wind and water pollinated plants
- produce pollen grains in large no.
- do not produce nectar

III. **Insect Pollination**
- Flowers : large, colourful, fragrant, rich in nectar
- Pollen grains : sticky
- Stigma : sticky

Certain rewards to pollinators:

- nectar and (edible) pollen grains as foods
- provide safe place for laying eggs

Ex : Amorphophallus, Yucca



Outbreeding Devices- the various mechanisms take discourage self-pollination and encourage cross pollination as continued self-pollination leads to inbreeding depression. It includes

• Pollen release and stigma receptivity not synchronized.

• Anther and stigma are placed at different position.

• Inhibiting pollen germination in pistil.

• Production of unisexual flowers.

Pollen pistil interaction – the pistil has ability to recognize the compatible pollen to initiate post pollination events that leads to fertilisation. Pollen grain produce pollen tube through germ pores to facilitate transfer of male gametes to embryo sac.

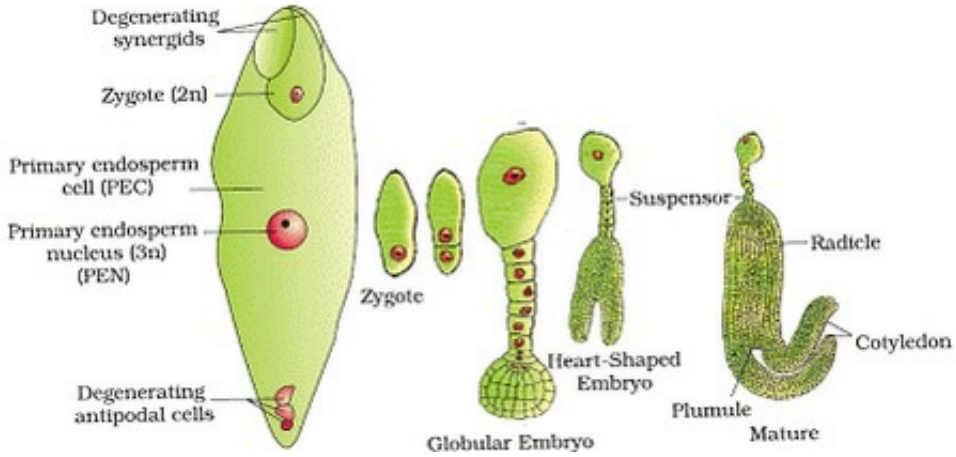
Artificial Hybridization

- Crossing diff varieties of species- hybrid individual- with desirable characters of the parent plants
- desired pollen grains for pollination- stigma protected from contamination
- **Emasculation :** removal of anther
- **Bagging :** flower covered- bag made up of butter-prevent contamination of stigma from unwanted pollen

Bagged flower- attains receptivity- mature pollen grains- dusted on the stigma – rebagged- fruits allowed to develop

Double Fertilisation- after entering the one of the synergids, each pollen grain releases two

male gametes. One male gametes fuse with egg (**Syngamy**) and other male gametes fuse with two polar nuclei (**triple fusion**) to produce 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.



Post fertilisation events include endosperm and embryo development, maturation of ovules into seeds and ovary into fruits.

Endosperm- the primary endosperm cell divides many time to forms triploid endosperm tissue having reserve food materials.

Two types of endosperm development :
(i) Free nuclear type (common method)
(ii) Cellular type

(a) Non-albuminous- endosperm completely utilized- before maturation of seeds. e.g pea, groundnut

(b) Albuminous- a portion of endosperm remain in mature seeds. e.g wheat, maize, castor

Embryo- Embryo develops at the micropylar end of the embryo sac where the zygote is located.

Embryogeny – early stages of embryo development .The zygote gives rise to the proembryo and subsequently to the globular, heart-shaped and mature embryo.

Embryo consists of:

- embryonal axis
- cotyledons
- plumule
- radicle

Monocotyledonous Seed

- Scutellem = Cotyledon
- Coleorrhiza: undifferentiated sheath covering radical & root cap

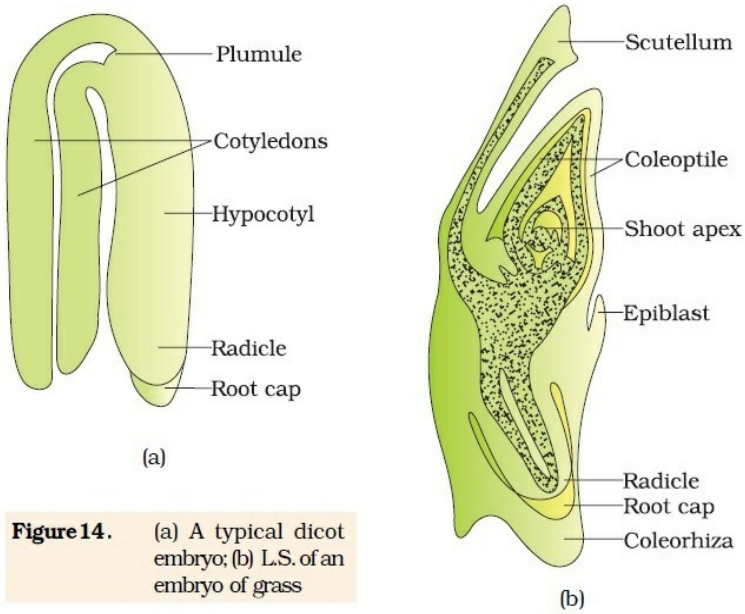


Figure 14. (a) A typical dicot embryo; (b) L.S. of an embryo of grass

- Coleoptile: sheath covering plumule

Seed

- Fertilized and mature ovule develops into seed.

Seed consists of:

- cotyledon(s)
- embryonal axis
- Seed coat- double layered- formed by integuments

- **Testa** (outer coat)
- **Tegmen** (inner coat)

- ***Micropyle***:- small opening on seed coat, it facilitates entry of H_2O & O_2 into seeds (for germination)

- ***Hilum***:- scar on seed coat
- ***Seed*** - Albuminous / Non-Albuminous
- ***Perisperm*** : remnants of nucellus that is persistent. Ex: Black pepper
- ***Dormancy*****:** state of inactivity

• The wall of ovary develops into wall of fruit called **pericarp.** In true fruits only ovary contributes in fruit formation by in false fruit thalamus also contributes in fruit formation.

Apomixis

- Form of asexual reproduction- mimics sexual reproduction- seed formed without fertilisation
- Formation of apomictic seeds :

• diploid cell (formed without meiosis)- develop into embryo without fertilization

• cells of nucellus (2n) surrounding embryo sac- protrude into embryo sac- develop into embryos. Ex. Citrus and Mango.

Polyembryony

- Occurrence of more than one embryo in a seed
- Often associated with apomixes. Ex: Citrus, groundnut

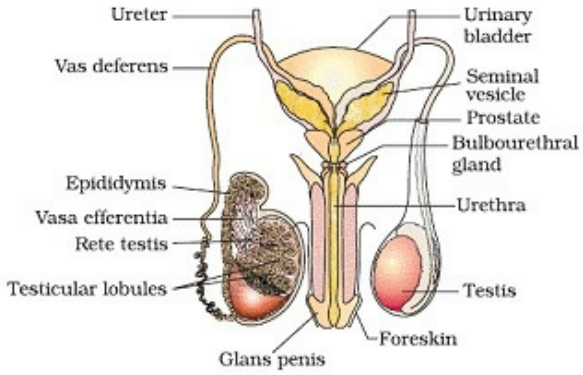
CBSE Class 12 Biology
Revision Notes
Chapter-03 Human Reproduction

Humans are sexually reproducing and viviparous. The reproductive events in humans include formation of gametes (gametogenesis), i.e., sperms in males and ovum in females, transfer of sperms into the female genital tract (insemination) and fusion of male and female gametes (fertilisation) leading to formation of zygote. This is followed by formation and development of blastocyst and its attachment to the uterine wall (implantation), embryonic development (gestation) and delivery of the baby (parturition)

The Male Reproductive System: It consists of:

i. Primary sex organs i.e. a pair of testes suspended in a scrotum.
ii. Secondary sex organs i.e. a pair of ducts each differentiated into rete testis, vasa efferentia, epididymis and vas deferens ,ejaculatory duct and the associated glands
iii. External genitalia

- The testes are situated outside the abdominal cavity in a pouch called **scrotum,** which help in maintaining the low temperature of testes necessary for spermatogenesis.
- Each testes has about 250 testicular lobules and each lobule contain highly coiled **seminiferous tubules** in which sperms are produced. Each seminiferous tubules is lined by two types of cells, **spermatogonia** (male germ cell) and **Sertoli cells**.
- **Leydig cells** or interstitial cells present around the seminiferous tubules synthesize and secrete androgen hormone.



- Ejaculatory duct store and transport the sperm from testes to outside through urethra which originate from urinary bladder and extend through penis to its external

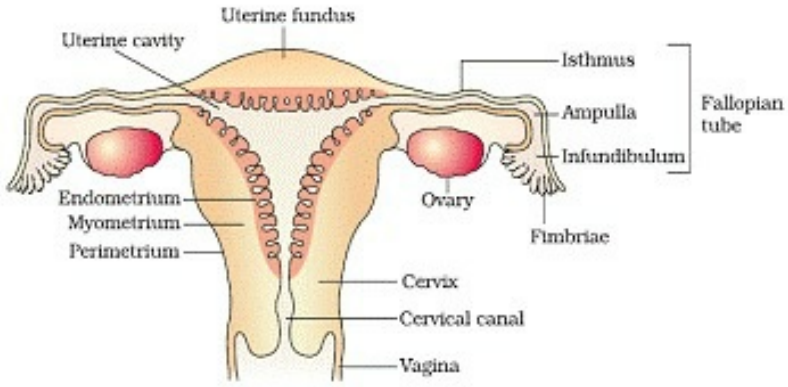
opening **urethral meatus.**

- The penis is male external genitalia. The enlarged end of penis is called the **glans penis** is covered by a loose fold of skin called **foreskin**.
- Male accessary glands include paired **seminal vesicles, prostrate** and **paired bulbourethral glands**. Secretion of these glands forms the seminal plasma which contains fructose, calcium and enzymes. The secretion of bulbourethral glands also helps in lubrication of the penis.

The Female Reproductive System: It consists of :

a. The primary sex organ that is a pair of ovaries
b. Secondary sex organs- the duct system consisting of a pair of fallopian tube , a uterus , cervix and vagina
c. External genitalia
d. Mammary glands

- Ovaries are primary female sex organ that produce the female gamete and several steroid hormones. Each ovary is covered by thin epithelium which encloses the ovarian stroma, which is divided into a peripheral cortex and an inner medulla.
- Fallopian tube extends from periphery of ovary to the uterus. The part closer to ovary is a funnel shaped structure called **infundibulum** having finger like projection called **fimbriae.**
- Infundibulum leads to **ampulla** and join with uterus with **isthmus**. Uterus is pear shaped structure also called womb.
- Uterus open vagina through a narrow cervix. The cavity of cervix **(cervical canal)** along with vagina forms the birth canal.
- The wall of uterus has three layers of tissue:



I. Perimetrium- external membrane.
II. Myometrium – middle thick layer of smooth muscles which exhibit strong contraction during delivery of baby.
III. Endometrium - line the uterine wall and undergo cyclic changes during menstrual cycle.

Female external genitalia includes

- Mons pubis – cushion of fatty tissues covered by skin and pubic hair.
- Labia majora- fleshy fold that surround the vaginal opening.
- Labia manora – paired fold of tissue under labia majora.
- The opening of vagina is often partially covered by a membrane called **hymen**. The tiny finger like projection present at the upper junction of two labia manora above the urethral opening is called **clitoris**.

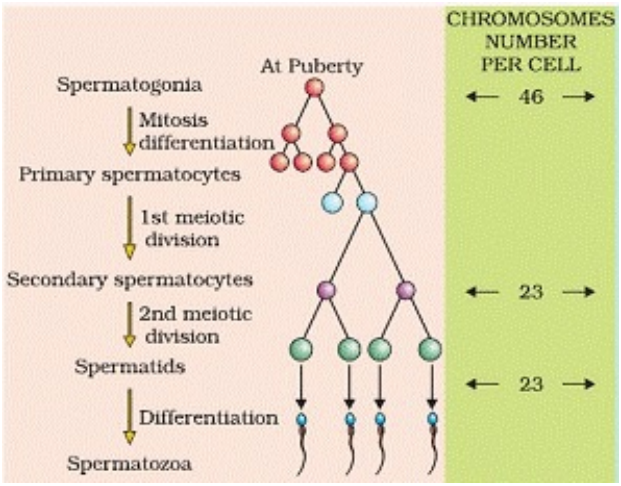
Mammary glands are paired structures that contain glandular tissues and variable fats. Each glandular tissue contains 15-20 mammary lobes containing alveoli that secrete milk. Mammary ducts join to form mammary ampulla.

Gametogenesis: The process of formation of male and female gametes in testes and ovary respectively is called gametogenesis.It is of two types:

1. **Spermatogenesis** in males
2. **Oogenesis** in females

Spermatogenesis- in testes immature, male germ cells (spermatogonia) produce sperm by spermatogenesis that begin at puberty.

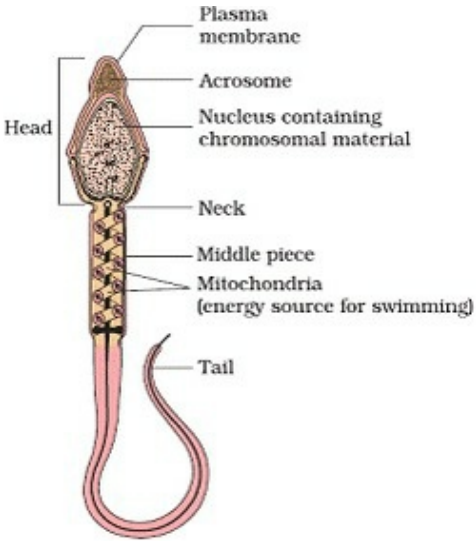
- The spermatogonia present at the inner side of seminiferous tubules multiply by mitotic division and increase in number. Each spematogonium contain 46 chromosomes.
- Spermatogonia forms spermatocyte that undergo meiotic division to reproduce secondary spermatocytes having 23 chromosomes.
- The spermatids are transformed into spermatozoa by the process called **spermiogenesis**. The sperm heads remain embedded in sertoli cells and are released from seminiferous tubules by the process of **spermiation.**



Hormonal control of spermatogenesis

- Spermatogenesis initiated due to increase in secretion of gonadotropin releasing hormone by hypothalamus
- Increase in GnRH act on anterior pituitary and stimulate secretion of two gonadotropins, LH and FSH
- LH acts on Leydig cells and stimulates them to secrete androgens.
- FSH acts on Sertoli cells, stimulates secretion of some factors which help in spermiogenesis

Structure of sperm- sperm is a microscopic structure composed of a **head, neck,** a **middle piece** and a **tail.** The sperm head contain elongated haploid nucleus, anterior portion of which is covered by cap like structure **acrosome**.

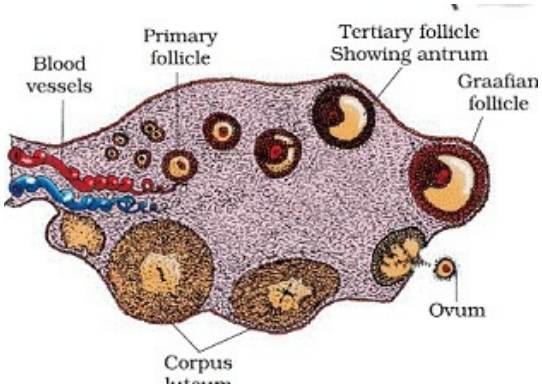


Human male ejaculates about 200-300 million sperms during a coitus. The seminal plasma along with the sperms constitutes the semen. The function of male sex secondary ducts and

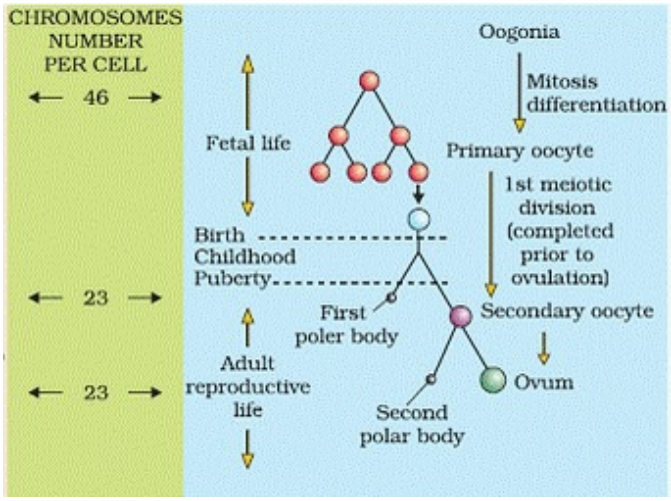
glands are maintained by androgen hormones.

Oogenesis : The process of formation of mature female gametes is called oogenesis. It started during embryonic development stage when millions of ogonia (gamete mother cells) are formed in each fetal ovary.

- The gametes mother cells start division and enter into prophase-I of meiotic division and get temporally arrested at that stage called **primary oocytes**.
- Each primary oocyteget surrounded by a layer of granulosa cell than it is called the **primary follicle**.
- At puberty, about 60,000- 80,000 primary follicles are left in each ovary.



- Primary follicle gets surrounded by more layers of granulosa cells called secondary follicle that transform into tertiary follicle that contain fluid filled cavity called **antrum.**



- The tertiary follicles further changes into the mature follicle called **Graafian follicle**, which rapture to release secondary oocytes (ovum) from the ovary by the process of ovulation.

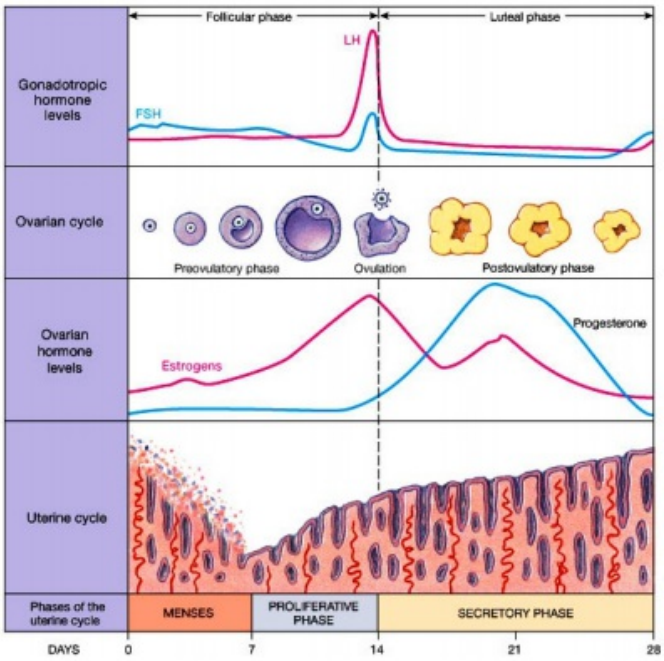
Menstrual cycle: The reproductive cycles in female primates is called menstrual cycle. It

start at puberty and is called **menarche**.

Phases of Menstrual Cycle

The menstrual cycle consists of following four phases:

1. **Menstrual Phase:**
   i. In a 28 days menstrual cycle,the menses takes place on cycle days 3-5.
   ii. The production of LH from the anterior lobe of the pituitary gland is reduced.
   iii. The withdrawal of this hormone causes degeneration of the corpus luteum and, therefore progestrone production is reduced.
   iv. Production of oestrogen is also reduced in this phase.
   v. The endometrium of uterus breaks down & menstruation begins.
   vi. The cells of endometrium secretions, blood & unfertilised ovum constitutes the menstrual flow.
2. **Follicular Phase:**
   i. This phase usually includes cycle days 6-13 or 14 in a 28 days cycle.
   ii. The follicle stimulating hormone (FSH) secreted by the anterior lobe of the pituitary gland stimulates the ovarian follicle to secrete oestrogens.
   iii. Oestrogen stimulates the proliferation of the endometrium of the uterine wall.
   iv. The endometrium becomes thicker by rapid cell multiplication and this is accompanied by an increase in uterine glands & blood vessels.



3. **Ovulatory Phase:**

i. Both LH & FSH attain a peak level in the middle of cycle (about 14^{th} day).
ii. Oestrogen concentration in blood increases.
iii. Rapid secretion of LH induces rupturing of graffian follicle and thereby the release of ovum.
iv. In fact LH causes ovulation.

4. **Luteal Phase:**
   i. Includes cycle days 15 to 28.
   ii. Corpus luteum secretes progestrone.
   iii. Endometrium thickens.
   iv. Uterine glands become secretory.

Hormonal Control of MC

i. FSH stimulates the ovarian follicles to produce oestrogens.
ii. LH stimulates corpus luteum to secrete progestrone.
iii. Menstrual phase is caused by the increased production of oestrogens.
iv. LH causes ovulation
v. Proliferative phase is caused by the increased production of oestrogens.
vi. Secretory phase is caused by increased production of progestrone.

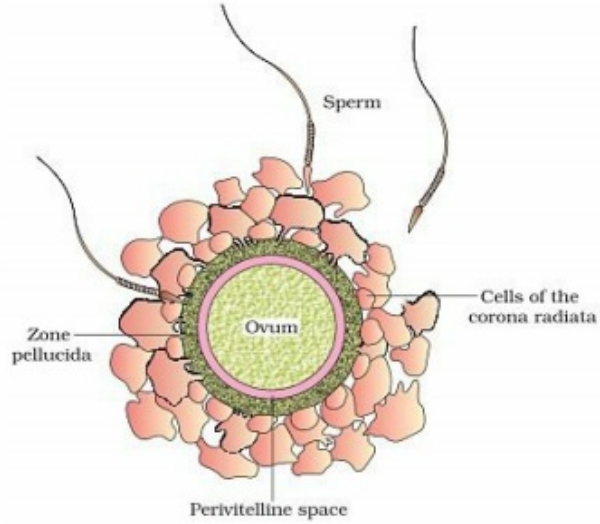
Fertilisation and Implantation

The process of fusion of sperm with ovum is called fertilisation.

- During coitus (copulation) semen is released into vagina. The motile sperms swim rapidly to reach the junction of isthmus and ampulla of fallopian tube. The ovum also reaches there and fusion of gametes takes place in at ampullary-isthmic junction.
- In this acrosome of sperm undergoes acrosomal reaction and releases certain sperm lysins which dissolve the egg envelopes locally and make the path for the penetration of sperm.
- These sperm lysins contain a lysing enzyme hyaluronidase which dissolves the hyaluronic acid polymers in the intercellular spaces which holds the granulosa cells of corona radiata together; corona penetrating enzyme (that dissolves the corona radiata) and acrosin (which dissolves the zona pellucida). Then it dissolves the zona pellucida.

Cortical reaction:

1. (a) Immediately after the entry of a sperm into the egg, the later shows a cortical reaction to check the entry of more sperms.
2. (b) In this reaction, the cortical granules present beneath the egg's plasma membrane release chemical substance between the ooplasm and the plasma membrane (vitelline membrane).
3. (c) These substances raise the vitelline membrane above the egg surface. The elevated vitelline membrane is called fertilization membrane.
4. (d) The increased space between the ooplasm and the fertilization membrane and the chemical present in it effectively check the entry of other sperm.
5. (e) If polyspermy occurs, that is more than one sperm enter the secondary oocyte, the resulting cell has too much genetic material to develop normally



- The haploid gametes fuse together to form diploid zygote. As the zygote moves towards the uterus, the mitotic division starts and form cleavage to change into 2, 4,8,16 celled blastomeres.
- The blastomeres with 8 to 16 cells are called morula. Morula divide to change into blastocysts .The blastomeres in the blastocyst are arranged into an outer layer called **trophoblast** and an inner group of cells attached to trophoblast called the **inner cell mass**.The outer layer of blastocyst is called trophoblast that attach with endometrium of uterus, called **implantation** that leads to pregnancy.

Pregnancy and embryonic development

The finger-like projections on trophoblaste after implantation called is called **chronic villi** that along with uterine wall forms functional unit between developing embryo and maternal body called **placenta**. Placenta is attached with fetus with an umbilical cord that transport food and oxygen to embryo.

- Hormones **hCG (human chorionic gonadotropin), hPL (human placental lactogen) and relaxin** are produced in woman only during pregnancy by placenta.
- After implantation, the inner cell mass (embryo) differentiates into an outer layer called **ectoderm** and an inner layer called **endoderm**. A **mesoderm** soon appears between the ectoderm and the endoderm. These three layers give rise to all tissues (organs) in adults. It is important to note that the inner cell mass contains certain cells called stem cells which have the potency to give rise to all the tissues and organs
- In human, after one month of pregnancy the embryo's heart is formed. By the end of 2^{nd} month limbs and digits are formed. By the end of 12 months, major organs and external genital organs are well developed. The first movement of foetus is observed in 5 months. By the end of 24 weeks body is covered with fine hair, eye lids and eyeless are formed. At the end of 9 months fetus is fully developed.

PARTURITION AND LACTATION

Parturition-the process of delivery of fully developed foetus is called parturition.

- Signals for parturition originate from the fully developed fetus and placenta inducing mild uterine contractions called **Foetal ejection reflex**
- It triggers the release of oxytocin from maternal pituitary

The mammary glandsof female, start producing milk, to the end of pregnancy by the process of **lactation**. The milk produced during the initial few days of lactation is called **colostrum**, which contain several antibodies.

CBSE Class 12 Biology
Revision Notes
CHAPTER- 04
REPRODUCTIVE HEALTH

According to WHO, reproductive health means total well-being in all aspects of reproduction i.e. physical, emotional, behavioral and social.

Reproductive Health: Problem and Strategies

- India was amongst the first countries in the world to initiate to the programme "family planning" initiated in 1951.
- Reproductive health in a society forms a crucial part of general health.
- Improved programs covering wider reproduction-related areas are currently in operation under the popular name 'Reproductive and child health care (RCH) program.'
- Health and education of young people and marriage and child bearing during more mature stages of life are important attributes to the reproductive health of a society.

Measures taken by Goverenment :

- Through the help of audio-visuals & print media.
- Even family members, close relations are involved in the awareness.
- Sex education was introduced in schools to provide awareness
- Proper information about reproductive organs, adolescence & related changes , safe & hygienic sexual practices, sexually transmitted diseases, AIDS etc.

Amniocentesis - It is a technique used to find out chromosomal abnormalities in developing embryo by using amniotic fluid.

- It is also misused to check foetal sex determination based on the chromosomal pattern in the amniotic fluid surrounding the developing embryo.

Population Explosion and Birth Control

Improved quality of life of people, increased health facilities and better living condition had

an explosive impact on explosion of population.

- Rapid decline in death rate, MMR (**maternal mortality rate)** and IMR (**infant mortality rate**) along with increase in population of reproductive age is the main reason for population explosion.
- Steps to overcome population explosion-
  1. Using various contraceptive methods.
  2. Educating people about the demerits of large family.
  3. Increasing the marriageable age of female and male
  4. Providing incentive to parents having 1or 2 children.

- **Contraceptive methods** are used to prevent the unwanted pregnancy and modifying the menstrual cycle.
- An ideal contraceptive should be-
  1. User friendly
  2. Easily available
  3. Effective
  4. Reversible
  5. No side effects
  6. No way interferes with sexual desire and sexual act.

Contraceptive methods could be divided into following categories-

a) Natural or traditional methods
b) Barrier methods
c) IUDs
d) Oral contraceptive methods
e) Injectable
f) Implants
g) Surgical methods.

- **Natural methods** works on the principle of avoiding chances of ovum and sperm meeting. It includes-
  a) Periodic abstinence- the couples avoid coitus from day 10 to 17 of menstrual cycle as chances of fertilisation are very high during this period, it is called the fertile

period.

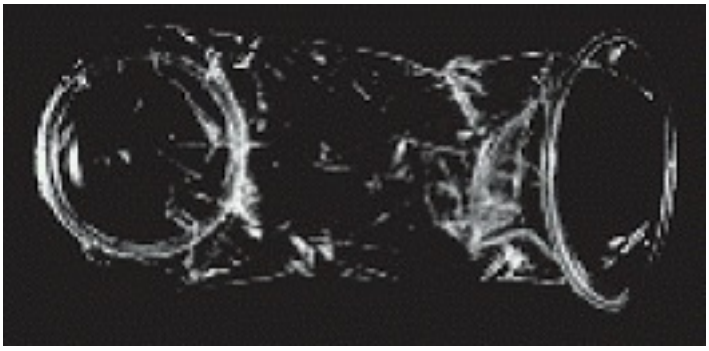
b) Withdrawal or coitus interruptus – male partner withdraws penis from vagina just before ejaculation to avoid insemination .

c) Lactational Amenorrhea – absence of menstruation after parturition and due to intense milk feeding and no ovulation in this period , chances of fertilisation is nil.

- **In Barrier methods**, ovum and sperms are prevented from physical meeting with help of barrier. This includes-

  a) Condoms- used by male, barrier made of rubber or latex sheet used to cover penis or vagina and cervix of female. It also prevents from STDs.

Condom for male



condom for female

b) Diaphragms, cervical cap and vaults are barrier made of rubber that is inserted into the female reproductive tract during coitus.

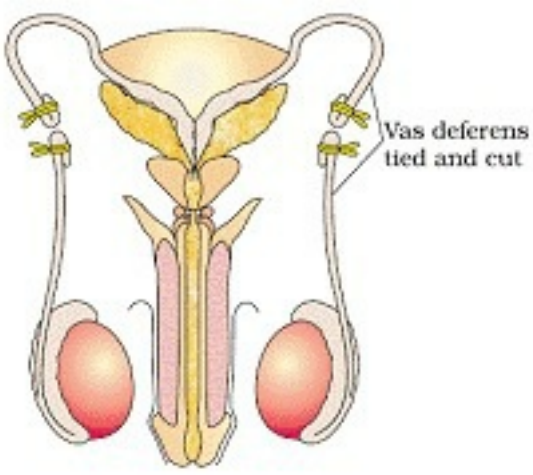
- .Spermicidal creams, jellies and foams are usually used alongwith these barriers to increase their contraceptive efficiency.
- Advantages of barrier methods:
  1. They are disposable.
  2. They can be self –inserted.
  3. They are reusable.

4. Prevents conception by blocking entry of sperm through cervix.

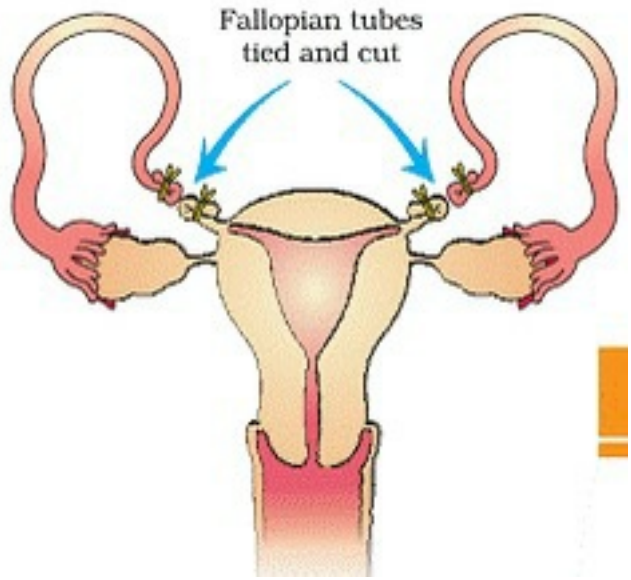
- **Intra uterine Devices**- inserted by doctor or trained nurse into the female uterus through vagina. IUCDs may be non-medicated IUDs (e.g., Lippes loop), copper releasing IUDs (CuT, Cu7, Multiload 375) and the hormone releasing IUDs (Progestasert, LNG-20)
- IUCDs increase the phagocytosis of sperm in uterus and copper reduce the motility and fertility capacity of sperms .The hormone releasing IUDs make the uterus unsuitable for implantation and the cervix hostile to the sperms. It is ideal for female who wants to delay pregnancy and spacing between two children.

- **Oral Pills** are progesterone or progesterone-estrogen combination used by females in form of tablets. They inhibit ovulation and implantation as well as change the quality of cervical mucus to prevent/ retard entry of sperms.Administration of progesterone or progesterone-estrogen combination within 72 hours of coitus is found to be very effective as emergency contraceptive.

- **Surgical method** - This method is also called **sterilisation.**
- It is used as terminal method of contraception in male and female to prevent any more pregnancy.



Vasectomy



Tubectomy

- **Vasectomy** is the surgical method in male; a small part of the vas deferens is removed or tied up through a small incision on the scrotum to prevent release of sperms.
- **Tubectomy** is the surgical method in females in which small part of fallopian tube is removed surgically.
- These techniques are highly effective but their reversibility is very poor

Side effects of contraceptive method:

• It is very important that the selection of contraceptive method should be taken under the consultation of the doctors.

• They have ill-effects like nausea, abdominal pain, breakthrough bleeding, irregular menstrual bleeding or even breast cancer.

Medical Termination of Pregnancy

Voluntary termination of pregnancy before full term is called MTP (medical termination of pregnancy) or induced abortion. It plays important role in decreasing population by aborting unwanted pregnancy.

- In India, MTP is legalized in 1971 with some restriction to prevent its misuse such as indiscriminate and illegal female foeticides.
- MTP is used to
- Get rides of unwanted pregnancy due to unprotected intercourse or failure of

contraceptives used during coitus or rapes.

- When pregnancy continuation could be harmful or even fetal to mother or foetus.
- MTPs are considered relatively safe during first trimester or up to 12 weeks of pregnancy. Second trimester MTPs are much more riskier.

Sexually Transmitted Disease (STDs)

Diseases or infections which are transmitted through sexual intercourse are collectively called sexually transmitted disease or venereal disease (VD) or reproductive tract infection (RTI).

- Some common STDs are Gonorrhea, syphilis, genital herpes, chlamydiasis, genital warts, trichomoniasis, hepatitis-Ba and AIDS.
- Hepatitis-B and HIV is also transmitted by sharing of injection needles, surgical instruments with infected person, transfusion of blood, or from infected mother to foetus.
- Except genital herpes, HIV and hepatitis-B are completely curable if detected earlier and treated properly.
- Timely detection and proper treatment of STDs are very important otherwise it could lead to complications later, which include pelvic inflammatory diseases (PID), abortions, still births, ectopic pregnancies, infertility or even cancer of the reproductive tract.
- Infections of STDs can be prevented by-

a) Avoid sex with unknown partners/multiple partners.

b) Always use condoms during coitus.

c) Go to a qualified doctor in case of doubt for early detection and get complete treatment if diagnosed.

Infertility : The couples which are unable to reproduce children inspite of unprotected sexual cohabitation are called infertile.The reasons for this could be many-physical, congenital, diseases, drugs, Immunological or even Psychological.

- Infertile couples can be assisted to have children through certain special techniques commonly called **assisted reproductive technologies (ART)** ,which includes-

In vitro fertilisation (IVF)-fertilisation outside the body followed by embryo transfer, which is commonly called test tube baby program. The ovum from wife/donor and sperms from husband/ donor are collected and induced to fertilize in laboratory conditions. The zygote or early embryo (8 blastomeres) could be transferred into fallopian tube called **ZIFT** (zygote infra fallopian transfer) and embryo with more than 8 blastomeres **IUT** (intra uterine transfer) into the uterus to complete the further development.

GIFT (gamete intra fallopian transfer) –transfer of gametes collected from a donor into fallopian tube of another female who do not produce ovum.

Intra cytoplasmic sperm injection (ICSI)-specialized procedure to form an embryo in laboratory in which sperm is directly injected into ovum.

Artificial insemination- infertility cases in which male partner is unable to produce healthy sperms are treated by this technique in which semen collected from donor is artificially introduced into vagina or into uterus, **IUI (intra uterine insemination)** of the female.

All these techniques require extremely high precision handling by specialized professional and expensive instruments. . Therefore, their benefits are limited to certain countries and people.

Emotional, religious and social factors also prevent the adoption of these methods.

CBSE Class 12 Biology

Revision Notes

CHAPTER- 05

PRINCIPLES OF INHERITANCE AND VARIATION

Genetics is the study of principles and mechanism of heredity and variation. Gregor Johann Mendel is known as 'father of Genetics'.

- **Inheritance** is the process by which characters are passed on from parent to progeny. It is the basis of heredity.
- **Variation** is the degree by which progeny differ from their parents. Variation may be in terms of morphology, physiology, cytology and behavioristic traits of individual belonging to same species.
- Variation arise due to
    - Reshuffling of gene/chromosomes.
    - Crossing over or recombination
    - Mutation and effect of environment.

Mendel's Law of Inheritance : Mendel conducted hybridization experiments on garden pea (*Pisum sativum*) for seven years and proposed the law of inheritance in living organisms.

Selection of pea plant: The main reasons for adopting garden pea (Pisum sativum) for experiments by Mendel were –

- Pea has many distinct contrasting characters.
- Life span of pea plant is short.
- Flowers show self pollination, reproductive whorls being enclosed by corolla.
- It is easy to artificially cross pollinate the pea flowers. The hybrids thus produced were fertile.

Working method: Mendel's success was also due to his meticulous planning and method of work –

- He studied only one character at a time.
- He used all available techniques to avoid cross pollination by undesirable pollen

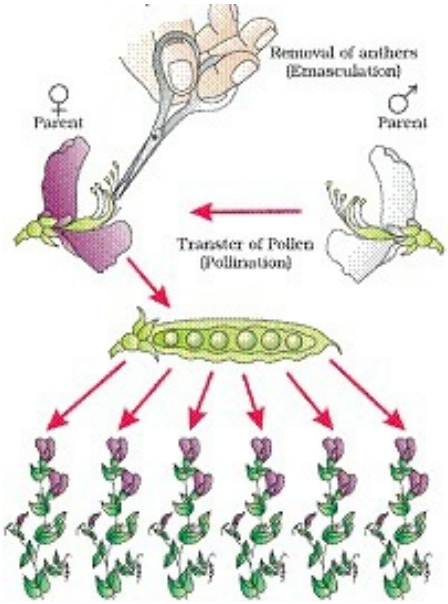
grains.

- He applied mathematics and statistics to analyse the results obtained by him.
- Mendel selected 7 contrasting characters of garden pea for his hybridization experiments

Contrasting Characters Studied by Mendel in Pea

Character	Contrasting character (Dominant/Recessive)
Stem height	Tall/Dwarf
Flower colour	Violet/White
Flower position	Axial/Terminal
Pod shape	Inflated/Constricted
Pod colour	Green/Yellow
Seed shape	Round/wrinkled
Seed colour	Yellow/Green

- Mendel conducted artificial hybridization/cross pollination using true breeding pea lines. True breeding lines are those that undergo continuous self-pollination and shows stable trait inheritance.
- Hybridization experiment includes emasculation (removal of anther) and transfer of pollen (pollination).



Inheritance of one gene (Monohybrid cross)

Mendel crossed tall and dwarf pea plant and collected all the seeds obtained from this cross. He grew all the seeds to generate plants of first hybrid generation called F1 generation. He observed that all the plants are tall. Similar observation was also found in other pair of traits.

Mendel self-pollinated the F1 plants and found that in F2 generation some plants are also dwarf. The proportion of dwarf plants is 1/4th and tall plants of 3/4th.

P	Pure *Tall*	x	Pure *Dwarf*
(Genotypes)	TT		tt
Types of gametes	T		t
F_1	Monohybrid	Tt	Hybrid *Tall*
Types of gametes by F_1	T		t

Selfing/ Inbreeding

Female gametes → / Male gametes ↓	T	t
T	TT *Tall*	Tt *Tall*
t	Tt *Tall*	tt *Dwarf*

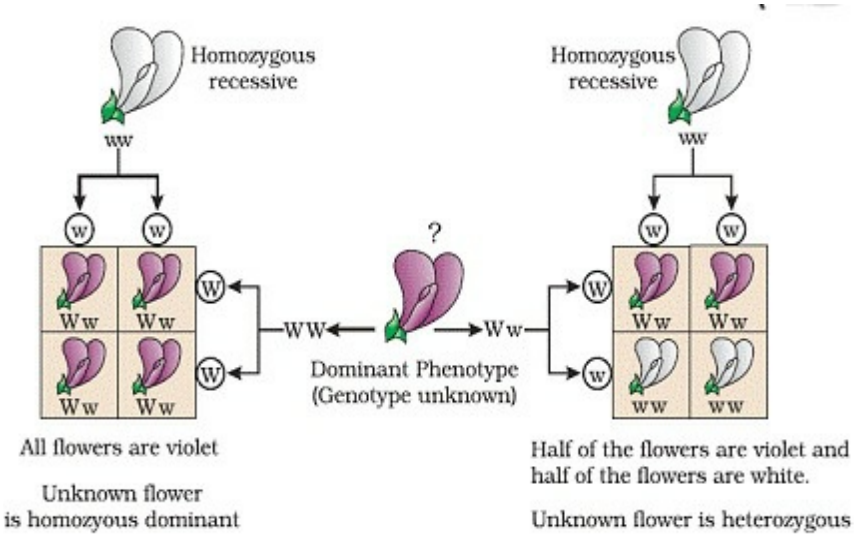
F_2 — *Punnet's square* or *Checker board*

Phenotypic ratio
3 *Tall* : 1 *Dwarf*
75% : 25%

Genotypic ratio in F_2
Pure *Tall* : Hybrid *Tall* : Pure *Dwarf*
1 TT : 2 Tt : 1 tt

- Mendel called the '**factors**' that passes through gametes from one generation to next generation. Now a day it is called as genes (unit of inheritance).
- Genes that code for a pair of contrasting traits are known as **alleles**.
- Alphabetical symbols are used to represent each gene, capital letter (TT) for gene expressed in F1 generation and small letter (tt) for other gene.
- Mendel also proposed that in true breeding tall and dwarf variety allelic pair of genes for height is **homozygous** (TT or tt). TT, Tt or tt are called **genotype** and tall and dwarf are called **phenotype**.
- The hybrids which contain alleles which express contrasting traits are called **heterozygous** (Tt).
- The monohybrid ratio of F2 hybrid is 3:1(phenotypic) and 1:2:1(genotypic).

Test cross is the cross between an individual with dominant trait and a recessive organism in order to know whether the dominant trait is homozygous or heterozygous.



Principle or Law of Inheritance

Based on observations of monohybrid cross, Mendel proposed two law of inheritance-

1. **Law of dominance**- states that –

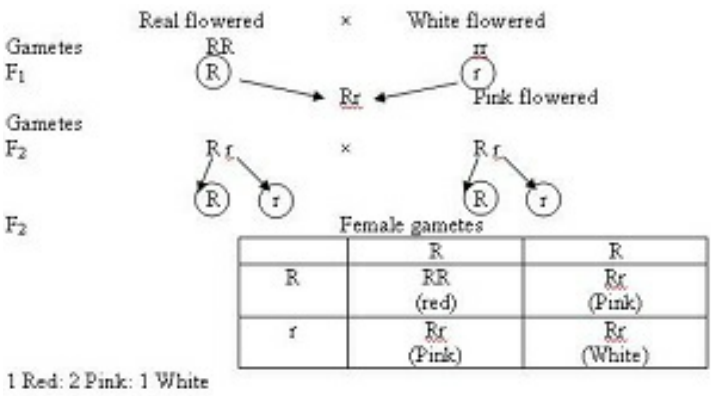
a. Characters are controlled by discrete units called factors.
b. Factors always occur in pair.
c. In a dissimilar pair of factors one member of pair dominate the other.

	Dominance	Recessive
(i)	When a factor (allele) expresses itself in the presence or absence of its dominant factor called dominance.	It can only express itself in the absence of or its recessive factor allele.
(ii)	It forms a complete functional enzyme that perfectly express it.	It forms a incomplete defective enzyme which fails to express itself when present with its dominant allele, i.e., in heterozygous condition.

2. **Law of Segregation-** alleles do not blends and both the characters are recovered during gametes formation as in F2 generation. During gametes formation traits segregate (separate) from each other and passes to different gametes. Homozygous produce similar kinds of gametes but heterozygous produce to different kinds of gametes with different traits.

Incomplete dominance

- It is a post Mendelian discovery. Incomplete dominance is the phenomenon of neither of the two alleles being dominant so that expression in the hybrid is a fine mixture or intermediate between the expressions of two alleles.
- In snapdragon (Mirabilis jalapa), there are two types of pure breeding plants, red flowered and white flowered. On crossing the two, F1 plants possess pink flowers. On selfing them, F2 generation has 1red: 2 pink: 1white. The pink flower is due to incomplete dominance.



Co-dominance

- It is the phenomenon of two alleles lacking dominance-recessive relationship and both expressing themselves in the organism.
- Human beings, ABO blood grouping are controlled by gene *I*. The gene has three alleles I^A, I^B and *i.* Any person contains any two of three allele I^A, I^B are dominant over *i.*
- The plasma membrane of the red blood cells has sugar polymers that protrude from its surface and the kind of sugar is controlled by the gene.
- When I^A and I^B are present together, both express their own types of sugars because of co-dominance.

Incomplete Dominance		Co-Dominance	
1.	Effect of one of the two alleles is more conspicuous.	1.	Effect of both the alleles are equally conspicuous.
2.	It produces a mixture of the expression of two alleles.	2.	There is no mixing of the effect of the two alleles.
3.	The F1 does not resemble either of the parents.	3.	The F1 resembles both the parents.
	E.g.: Flower colour in dog flower.		E.g.: ABO blood grouping in humans,

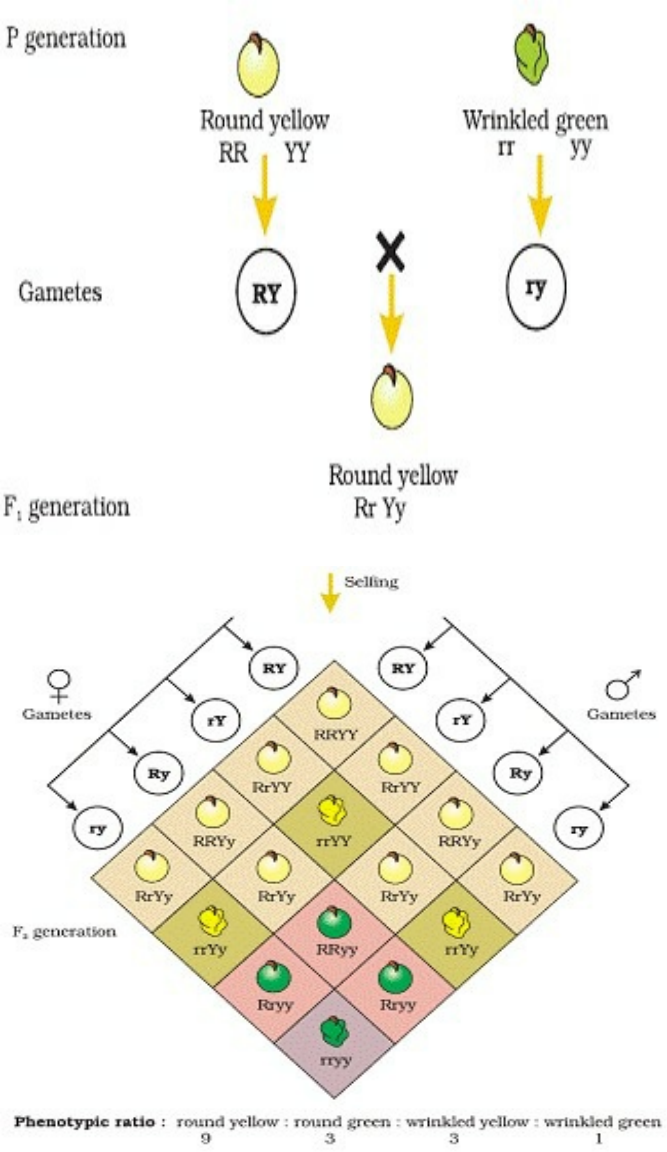
Multiple Alleles

They are multiple forms of a medelian factor or gene which occur on the same gene locus distributed in different organisms in the gene pool with an organism carrying only two alleles and a gamete only one allele. ABO blood grouping also provides a good example of multiple alleles.

Inheritance of Two genes (Dihybrid Cross)

A cross made to study simultaneous inheritance of two pairs of mendelian factors of genes.

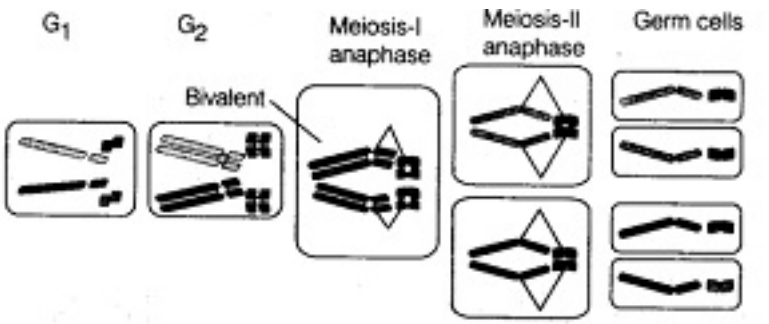
Law of independent Assortment – The law states that 'when two pairs of traits are combined in a hybrid, segregation of one pair of characters is independent of the other pair of characters'.In Dihybrid cross two new combinations, round green & wrinkled yellow are formed due to independent assortment of traits for seed shape i.e round, wrinkled and seed color i.e , yellow and green.



The ratio of 9:3:3:1 can be derived as a combination series of 3 yellow: 1 green, with 3 round : 1 wrinkled. This derivation can be written as follows: (3 Round : 1 Wrinkled) (3 Yellow : 1 Green) = 9 Round, Yellow : 3 Wrinkled, Yellow: 3 Round, Green : 1 Wrinkled, Green

Chromosomal Theory of Inheritance

- Chromosome as well as gene both occurs in pair. The two alleles of a gene pair are located on the same locus on homologous chromosomes.
- Sutton and Boveri argued that the pairing and separation of a pair of chromosomes would lead to segregation of a pair of factors (gene) they carried.
- Sutton united the knowledge of chromosomal segregation with mendelian principles and called it the chromosomal theory of inheritance.



Meiosis and germ cell formation in a cell with four chromosomes

Linkage and Recombination

- When two genes in a Dihybrid cross were situated on same chromosome, the proportion of parental gene combination was much higher than the non-parental type. Morgan attributed this due to the physical association or the linkage of the two genes and coined the **linkage** to describe the physical association of genes on same chromosome.
- The generation of non-parental gene combination during Dihybrid cross is called recombination. When genes are located on same chromosome, they are tightly linked and show very low recombination.

Difference between crossing over and linkage

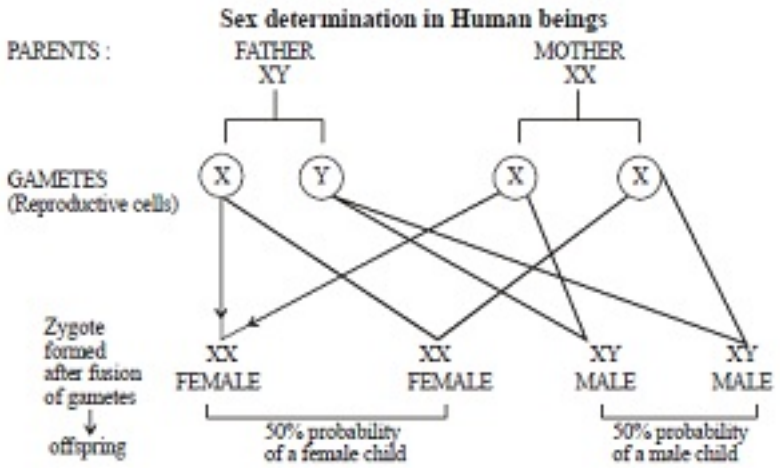
Crossing over	Linkage
1. It leads to separation of linked genes	1. keeps the genes together
2. It involves exchange of segments between	

non-sister chromatics of homologous chromosomes.	2. It involves individual chromosomes.
3. The frequency of crossing over can never exceed 50%.	3. The number of linkage group can never be more than haploid Chromosome number.
4. It increases variability by forming new gene combinations.	4. It reduces variability.

Sex Determination

- Henking in 1891 observed a trace of specific nuclear structure in few insects. He also observed that this specific nuclear structure is located on 50% of sperms only. He called this **x body**. He was not able to explain its significance.
- Latter it was observed that the ovum that receive the sperms with x body become female and those not becomes males, so this x body was called as **sex chromosome** and other chromosomes are called **autosomes.**
- In humans and other organisms **XY types** of sex determination is seen but in some insects like Drosophila **XO type** of sex determination is present.
- In both types of sex determination, male produce two different types of gametes either with or without X chromosome or some with X chromosome and some with Y chromosomes. Such types of sex determination are called male heterogamety.
- In birds **ZW type** of sex determination is present., two different types of gametes are produced by females in terms of sex chromosomes; this type of sex determination is called **female heterogamety**.
- **Sex determination in human beings** XY type. Out of 23 pairs of chromosomes, 22 pairs are exactly same in male and female called autosomes. A pair of X chromosome is present in female and XY in male. During spermatogenesis, male produce two type of gametes (sperms), 50% carries Y chromosome and remaining 50% contain X chromosome. Female, produce only one kind of gamete (ovum) having X chromosomes only.

- When sperm having Y chromosome the sex of baby is male and when sperm carrying X chromosome fertilse the egg, the sex of baby is female.



Mutationis a phenomenon which results in alternation of DNA sequence and consequently results in the change in the genotype and phenotype of an organism. The mutations that arise due to due to change in single base pair of DNA are called **point mutation** e.g Sickle cell anaemia.

Pedigree Analysis

- The analysis of traits in several of generation of a family is called the **pedigree analysis**. The inheritance of a particular trait is represented in family tree over several generations. It is used to trace the inheritance of particular trait, abnormality and disease.

Genetic Disorders

Broadly, genetic disorders may be grouped into two categories – Mendelian disorders and Chromosomal disorders.

Mendelian Disorders	Chromosomal disorders
These are due to alteration in a single gene.	These are caused due to absence or excess of one or more chromosomes or abnormal arrangement of one/more chromosomes.

They are transmitted into generations through Mendelian principles of inheritance.	They are transmitted as the affected individual is sterile.
They may be recessive or dominant in nature.	This is always dominant in nature.
Examples: Colour blindness Pheffykenonia.	Examples: Downs syndrome, Turner's syndrome

Medelian disorder includes-

a. **Haemophilia-** sex linked recessive disease in which, in an infected individual, a minor cut leads to non-stop bleeding. Heterozygous female (carrier) can transmit the disease to their son. The possibility of a female becoming a haemophilic is extremely rare because mother of such a female has to be at least carrier and the father should be haemophilic (unviable in the later stage of life).

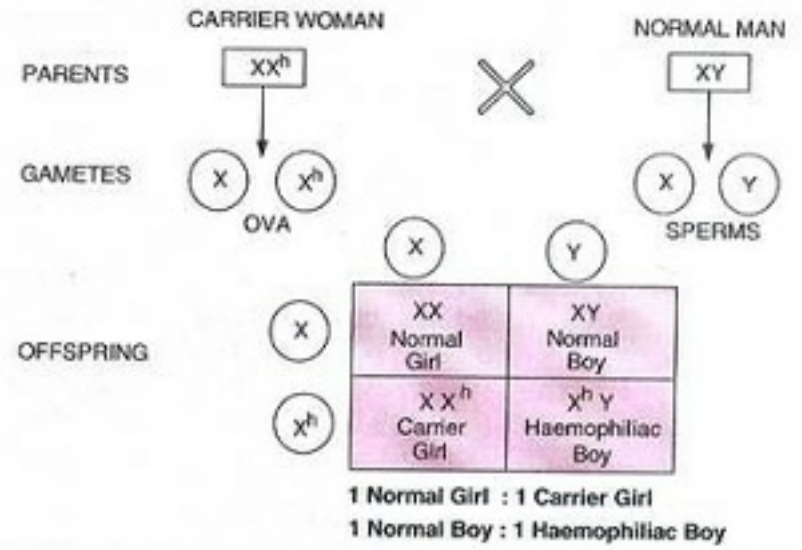
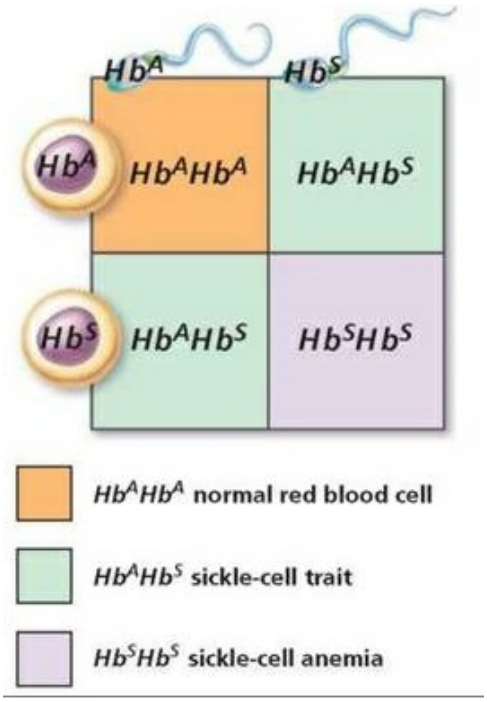


Fig. 5.50. Inheritance of haemophilia by 50% of the male children when the mother is carrier and the father is normal.

b. **Sickle cell anemia-** an autosome linked recessive trait in which mutant haemoglobin molecules undergo polymerization under low oxygen tension causing change in shape of the RBC from biconvex disc to elongated sickle like structure. The defect is caused by the substitution of Glutamic acid (Glu) by Valine (Val) at the sixth position of the beta globin

chain of the haemoglobin molecule. The substitution of amino acid in the globin protein results due to the single base substitution at the sixth codon of the beta globin gene from GAG to GUG



c. **Phenylketonuria-** inborn error of metabolism inherited as autosomal recessive trait. The affected individual lacks an enzyme that converts the amino acids phenylalanine to tyrosine . . As a result of this phenylalanine is accumulated and converted into phenylpyruvic acid and other derivatives that results into mental retardation.

Chromosomal Disorders-Failure of segregation of chromatids during cell division results in loss or gain of chromosome called **aneuploidy**. The failure of cytokinesis leads to two sets of chromosome called **polyploidy**.

a. **Down's Syndrome**- is due to presence of additional copy of the chromosome number 21. The affected individual is short statured with small rounded head, furrowed tongue and partially opened mouth. Mental development is retarded.

b. **Klinefleter's Syndrome**- due to presence of an additional copy of X-chromosome (XXY). Such persons have overall masculine development however, the feminine development (development of breast, i.e., Gynaecomastia) is also expressed. They are sterile.

c. **Turner's Syndrome**– caused due to the absence of one of the X chromosome. 45 with XO,

such females are sterile as ovaries are rudimentary. They lack secondary sexual characters.

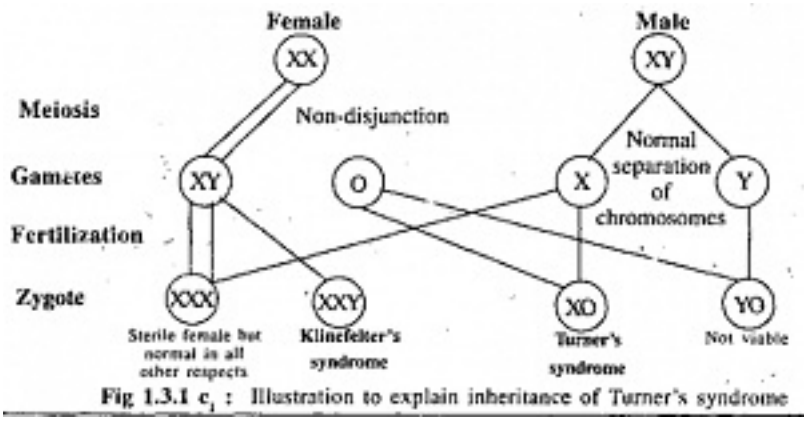


Fig 1.3.1 c_1 : Illustration to explain inheritance of Turner's syndrome

CBSE Class 12 Biology

Revision Notes

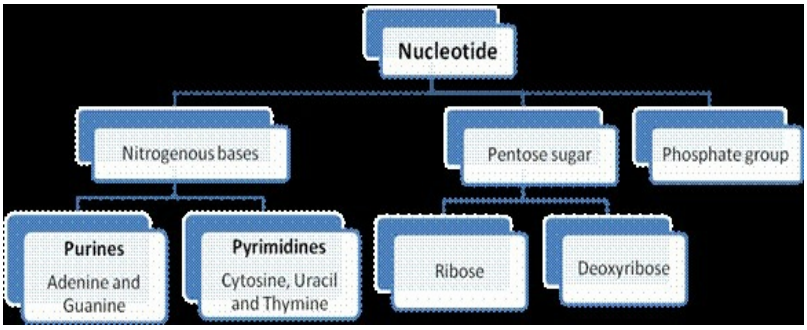
CHAPTER- 06

MOLECULAR BASIS OF INHERITANCE

DNA (Deoxyribonucleic Acid) and RNA (Ribonucleic Acid) are two types of nucleic acid found in living organisms. DNA acts as genetic material in most of the organisms. RNA also acts as genetic material in some organisms as in some viruses and acts as messenger. It functions as adapter, structural, and in some cases as a catalytic molecule

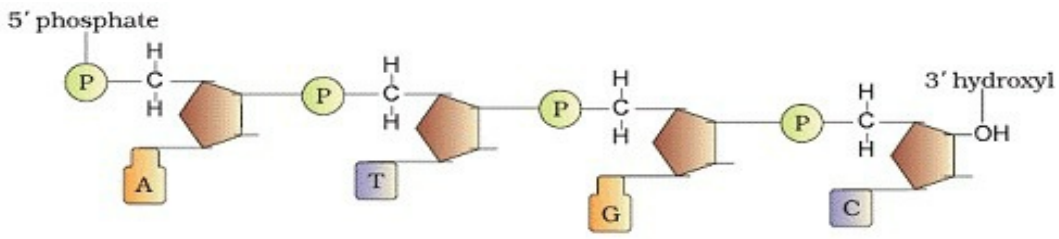
The DNA - it is a long polymer of deoxyribonucleotides. A pair of nucleotide is also known as base pairs. Length of DNA is usually defined as number of nucleotides present in it. Escherichia coli have 4.6 x 106 bp and haploid content of human DNA is 3.3 × 109 bp.

Structure of Polynucleotide Chain



- A nucleotide has three components – a nitrogenous base, a pentose sugar (ribose in case of RNA, and deoxyribose for DNA), and a phosphate group. There are two types of nitrogenous bases – Purines (Adenine and Guanine), and Pyrimidines (Cytosine, Uracil and Thymine).

Cytosine is common for both DNA and RNA and Thymine is present in DNA. Uracil is present in RNA at the place of Thymine.



A polynucleotide chain

A nitrogenous base is linked to pentose sugar with N-glycosidic linkage to form to form a nucleoside. When phosphate group is linked 5'-OH of a nucleoside through phosphoester linkage nucleotide is formed. Two nucleotides are linked through 3'-5' phosphodiester linkage to form dinucleotide. More nucleotide joins together to form polynucleotide.

In RNA, nucleotide residue has additional –OH group present at 2'-position in ribose and uracil is found at the place of Thymine.

Structure differences

DNA	RNA
(a) The sugarpresent in DNA is 2-deoxy-D - (-) -ribose.	(a) Thesugar present in RNAis D- (-)- ribose.
(b) DNA contains cytosine and thymine as pyrimidine bases and guanine and adenine is purine bases.	(b) RNA contains cytosine and uracilpyrimidine bones and guanine and adenine as purine bases.
(c) DNA has double strand α-helix structure.	(c) RNA has a single stranded α-helix structure.
(d) DNA molecules are very large their molecular mass may vary from $6 \times 10^6 - 16 \times 10^6 u$	(d) RNA molecules are comparatively much smaller with molecular mass ranging from 20,000 – 40,000.

Functional differences

(a) DNA has uniqueproperty of replication.	(a) RNA usually does not replicate.

(b) RNA controls the transmission of hereditary effects.	(b) RNA controls the synthesis of proteins.

Double Helix Model for Structure of DNA-James Watson and Francis Crick, based on X-ray diffraction data produced by Wilkin and Rosalind proposed this model of DNA.

The silent features of this model are-

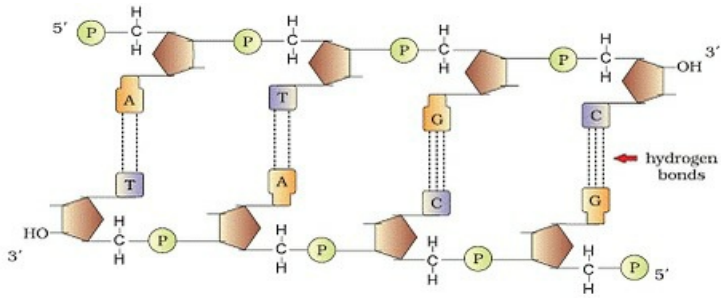
a) DNA is made of two polynucleotide chains in which backbone is made up of sugar-phosphate and bases projected inside it.

b) Two chains have anti-parallel polarity. One 5'à3' and with 3'à5'.

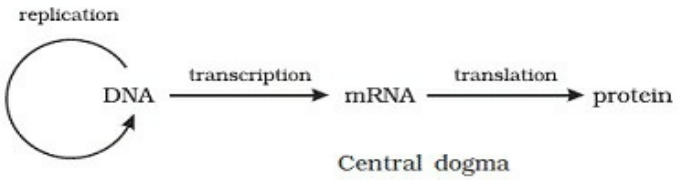
c) The bases in two strands are paired through H-bonds. Adenine and Thymine forms double hydrogen bond and Guanine and Cytosine forms triple hydrogen bonds.

d) Two chains are coiled in right handed fashion. The pitch of helix is 3.4 nm and roughly 10 bp in each turn.

e) The plane of one base pair stacks over the other in double helix to confer stability.



- Francis Crick proposed the Central dogma in molecular biology, which states that the genetic information flows from DNA -----> RNA ------> Protein.

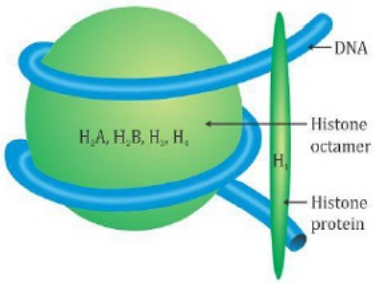


Packing of DNA helix-

In prokaryotes, well defined nucleus is absent and negatively charged DNA is combined with some positively charged proteins called nucleoids.

In eukaryotes, histones, positively charged protein organized to form 8 molecules unit called histone octomer. Negatively charged DNA is wrapped around the histone octomer to form nucleosome. . Histones are rich in the basic amino acid residues lysines and arginines. Both the amino acid residues carry positive charges in their side chains.

- Single nucleosome contains about 200 base pairs. Chromatin is the repeating unit of nucleosome.



Structure of Nucleosome

- In nucleus, some region of chromatin are loosely packed (and stains light) and are referred to as euchromatin. The chromatin that is more densely packed and stains dark are called as Heterochromatin. Euchromatin is transcriptionally active chromatin, whereas heterochromatin is inactive.

The search for Genetic Material

Transforming principle – Frederick Griffith in 1928 conducted experiment on bacteria Streptococcus pneumoniae (bacterium responsible for pneumonia). There are two types of strain of this bacteria, some produce smooth shiny colonies (S) and others produce rough colonies(R). Mice infected with the S strain (virulent) die from pneumonia infection but mice infected with the R strain do not develop pneumonia.

S strain → Inject into mice → Mice die

R strain → Inject into mice → Mice live

S strain (heat-killed) → Inject into mice → Mice live

S strain (heat-killed) + R strain (live) → Inject into mice → Mice die

Griffith concluded that R strain bacteria have somehow transformed by heat killed S strain bacteria. Some transforming principles transferred from S strain to R strain and enabled the R strain to synthesise a smooth polysaccharide coat and become virulent. This must be due to the transfer of the genetic material.

Biochemical Characterisation of Transforming Principle

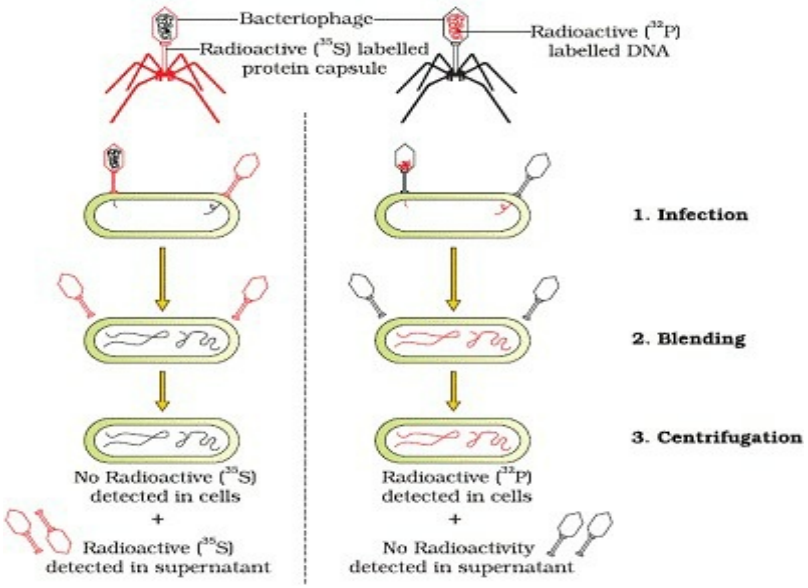
- Oswald Avery, Colin MacLeod and Maclyn McCarty worked out to determine the biochemical nature of transforming principle of Griffith.
- They purified biochemicals (proteins, DNA, RNA, etc.) from the heat-killed S cells to see which ones could transform live R cells into S cells. They discovered that DNA alone from S bacteria caused R bacteria to become transformed.So, they concluded that DNA is the genetic material.

Experimental proof that DNA is the genetic material

Alfred Hershey and Martha Chases (1952) worked with virus that infect bacteria called bacteriophages.

- In one preparation, the protein part was made radioactive and in the other, nucleic acid (DNA) was made radioactive. These two phage preparations were allowed to infect the culture of E.coli. Soon after infection, before lysis of cells, the E.coli cells were gently agitated in a blender, to loosen the adhering phage particles and the culture was centrifuged.
- The heavier infected bacterial cells pelleted to the bottom and the lighter viral particles were present in the supernatant. It was found that when bacteriophage containing radioactive DNA was used to infect E.coli, the pellet contained radioactivity.
- If bacteriophage containing radioactive protein coat was used to infect E.coli, the supernatant contained most of the radioactivity.

His experiment shows that protine does not enter the bacterial cell and only DNA is the genetic material.



Properties of Genetic Material:

a) It should be able to generate its replica (replication)

b) It should chemically and structurally be stable.

c) It should provide the scope for slow changes (mutation) that are required for evolution.

d) It should be able to express itself in the form of 'Mendelian Characters'.

• DNA is chemically less reactive but strcturely more stable as compare to RNA. So, DNA is better genetic material.

• RNA used as genetic material as well as catalyst and more reactive so less stable. Therefore, DNA has evolved from RNA.

Replication of DNA

Watson and Crick suggested that two strands of DNA separate from each other and act as template for synthesis of new complementary strands. After the completion of replication each DNA molecule would have one parental and one newly synthesised strand, this method is called semiconservative replication.

• Messelson and stahl's shows experimental evidence of semiconservative replication by growing E .coli on nutrient media containing nitrogen salts (15NH4Cl) labeled with radioactive 15N.

- 15N was incorporated into both the strands of DNA and such a DNA was heavier than the DNA obtained from E.coli grown on a medium containing 14N. Then they

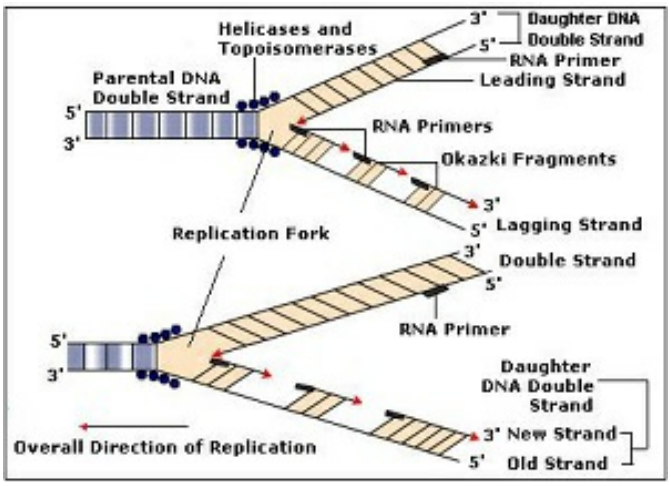
transferred the E.coli cells on to a medium containing 14N.

- After one generation, when one bacterial cell has multiplied into two, they isolated the DNA and evaluated its density. Its density was intermediate between that of the heavier 15N-DNA and the lighter 14N-DNA.
- This is because during replication, new DNA molecule with one 15N-old strand and a complementary 14N-new strand was formed (semi-conservative replication) and so its density is intermediate between the two.

Replication : Replication of DNA require Enzyme DNA polymerase that catalyse the polymerisation in one strand 5'à3' only after unwinding with the help of Helicase enzyme . So, replication in one stand is continuous and other strand it is discontinuous to synthesise okazaki fragments that are joined together by enzyme DNA ligase.

Differences between leading and Lagging strands for DNA replication.

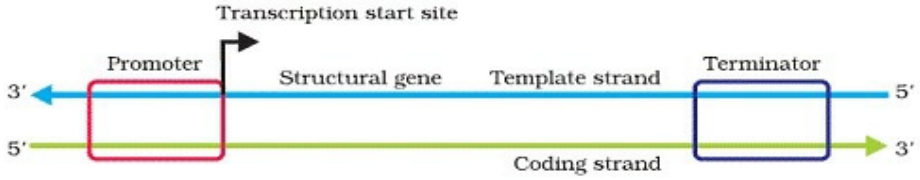
Characters	Leading strand	Lagging strand
1. Fragments	It is formed continuously as single fragment.	In the beginning it is formed in the form of small fragments called okazaki segments.
2. RNA primer	It requires only one primer to initiate the growth.	Every fragment requires separate RNA primer to initiate.
3. DNA ligase	Not required.	Required to join DNA fragments.
4. Direction of growth	$5' \rightarrow 3'$	Of complete strand it is $3' \rightarrow 5'$. However for okazakifragments it is $5' \rightarrow 3'$.



Transcription

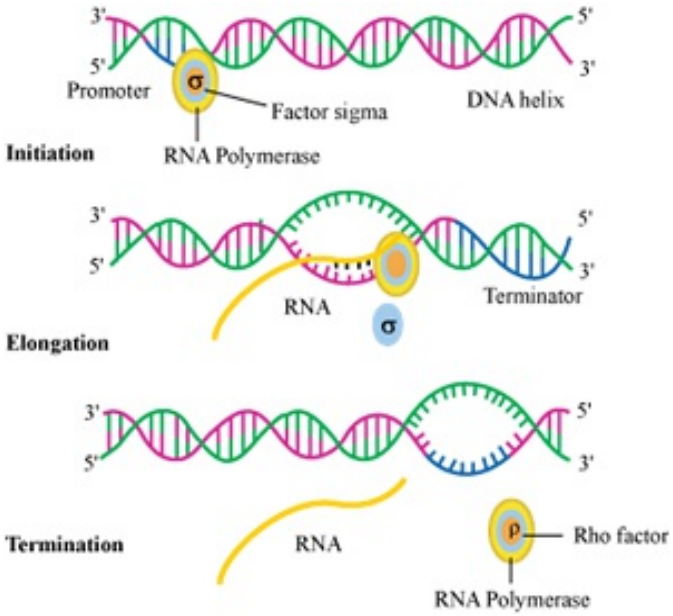
- It is the process of copying genetic information from one strand of DNA into RNA. In transcription only one segment of DNA and only one strand is copied in RNA. The Adenosine forms base pair with Uracil instead of Thymine.

• Transcription of DNA includes a promoter, the structural gene and a terminator. The strands that has polarity 3'à5 act as template and called template strand and other strand is called coding strand.



Template Stranc	Coding Strand
It is a DNA strand with 3'→ 5' Polarity.	DNA Strand with 5' → 3' Polarity
Acts as template for transcription and codes for RNA	Does not code for any region of RNA during transcription.

Promoter is located at 5' end and that bind the enzyme RNA polymerase to start transcription. Sigma factor also help in initation of transcription .The terminator is located at 3'end of coding strand and usually defines the end of transcription where rho factor will bind to terminate transcription.



Exons are those sequences that appear in mature and processed RNA. Exons are interrupted by introns. Introns do not appear in mature and processed RNA.

- In eukaryotes, there are three different RNA polymerase enzymes I, II and III, they catalyse the synthesis of all types of RNA.

RNA polymerase I – rRNAs
RNA polymerase II - mRNA
RNA polymerase III – tRNA

The m-RNA provide the template, t-RNA brings the amino acids and read the genetic code, the r-RNA play structural and catalytic role during translation.

DNA Replication	RNA Transcription
Two new molecules of double-stranded DNA are produced.	One new molecule of single-stranded RNA is produced.
Adenine on one strand binds to thymine on the new DNA strand being created.	Adenine on DNA binds to uracil on the new RNA strand being created.

The entire chromosome is replicated.	Only a small portion of the DNA molecule is transcribed to RNA, and this varies based on the cell's needs at the time.
Enzymes: DNA polymerase	Enzymes: RNA polymerase
Occurs in nucleus.	Occurs in nucleus.

The primary transcript contains both exon and intron and is non-functional. It undergoes the process of splicing in which introns are removed and exons are joined in a defined order.

The hnRNA (heterogeneous nuclear RNA) undergo additional processing called as capping and tailing. In capping in unusual nucleotide (methylguanosine triphosphate) to the 5'end of hnRNA. In tailing polyadenylatelate tail is added at 3'end in a template at independent manner.

Genetic Code : Genetic Code is the relationship of amino acids sequence in a polypeptide and nucleotide/base sequence in mRNA. It directs the sequence of amino acids during synthesis of proteins.

George Gamow suggested that genetic code should be combination of 3 nucleotides to code 20 amino acids.

H.G. Khorana developed chemical method to synthesising RNA molecules with defined combination of bases.

Marshall Nirenberg's cell free system for protein synthesis finally helped the code to be deciphered.

Salient features of Genetic Code are-

i. The code is triplet. 61 codons code for amino acids and 3 codons do not code for any amino acids called stop codon (UAG, UGA and UAA).

ii. Codon is unambiguous and specific, code for one amino acid.

iii. The code is degenerate. Some amino acids are coded by more than one codon.

iv. The codon is read in mRNA in a contiguous fashion without any punctuation.

v. The codon is nearly universal. AUG has dual functions. It codes for methionine and also act as initiator codon.

Mutations and Genetic code

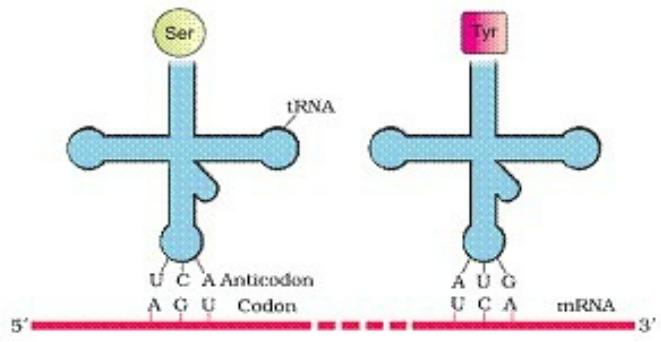
A change of single base pair (point mutation) in the 6th position of Beta globin chain of Haemoglobin results due to the change of amino acid residue glutamate to valine. These results into diseased condition called sickle cell anaemia.

Insertion and deletion of three or its multiple bases insert or delete one or multiple codons hence one or more amino acids and reading frame remain unaltered from that point onwards. Such mutations are called frame-shift insertion or deletion mutations.

tRNA– the Adapter Molecule

The t-RNA called as adaptor molecules. It has an anticodon loop that has bases complementary to code present on mRNA and also has an amino acid acceptor to which amino acid binds. t-RNA is specific for each amino acids.

The secondary structure of t-RNA is depicted as clover-leaf. In actual structure, the t-RNA is a compact molecule which look like inverted L.



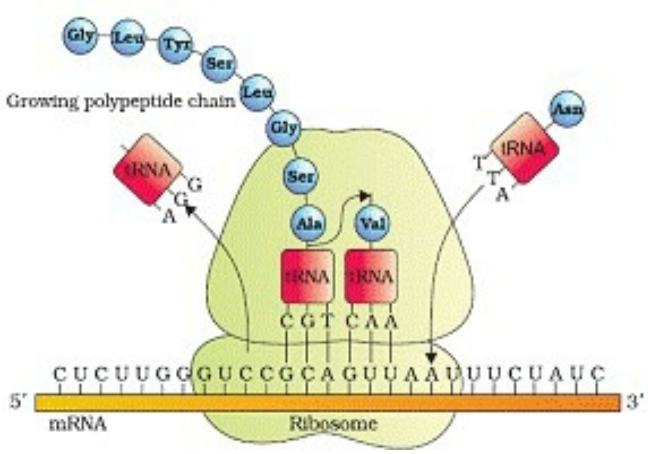
Translation process: Translation is the process of polymerisation of amino acids to form a polypeptide. The order and sequence of amino acids are defined by the sequence of bases in the mRNA. Amino acids are joined by peptide bonds. It involved following steps-

a) Charging of t-RNA.

b) Formation of peptide bonds between two charged tRNA.

• The start codon is AUG. An mRNA has some additional sequence that are not translated called untranslated region (UTR).

• For initiation ribosome binds to mRNA at the start codon. Ribosomes moves from codon to codon along mRNA for elongation of protein chain. At the end release factors binds to the stop codon, terminating the translation and release of polypeptide form ribosome.

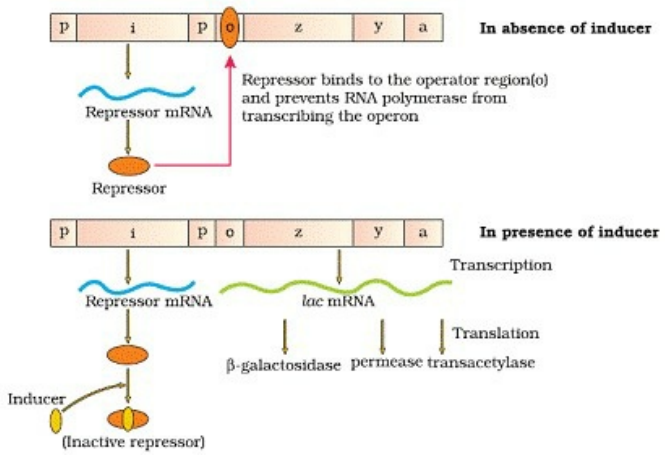


Regulation of Gene Expression:

All the genes are not needed constantly. The genes needed only sometimes are called regulatory genes and are made to function only when required and remain non-functional at other times. Such regulated genes, therefore required to be switched ‘on’ or ‘off’ when a particular function is to begin or stop.

The Lac Operon

Lac operon consists of one regulatory gene (i) and three structural genes (y,z and a). Gene i code for the repressor of the lac operon. The z gene code for beta-galactosidase, that is responsible for hydrolysis of disaccharide, lactose into monomeric units, galactose and glucose. Gene y code for permease, which increases permeability of the cell. Gene a encode for transacetylase.



Lactose is the substrate for enzyme beta-galactosidase and it regulates switching on and off of the operon, so it is called inducer.

Regulation of Lac operon by repressor is referred as negative regulation. Operation of Lac operon is also under the control of positive regulation.

Human Genome Project was launched in 1990 to find out the complete DNA sequence of human genome using genetic engineering technique and bioinformatics to isolate and clone the DNA segment for determining DNA sequence.

Goal of HGP-

a) Identify all the genes (20,000 to 25,000) in human DNA.
b) Determine the sequence of the 3 billion chemical base pairs that make up human DNA.
c) Store this information in data base.
d) Improve tools for data analysis.
e) Transfer related information to other sectors.
f) To address the legal, ethical and social issues that may arise due to project.

• The project was coordinated by the US Department of Energy and the National Institute of health.
• The method involved the two major approaches- first identifying all the genes that express as RNA called Express sequence tags(EST).The second is the sequencing the all set of genome that contained the all the coding and non-coding sequence called sequence Annotation.

Salient features of Human Genome:
a) The human genome contains 3164.7 million nucleotide bases.

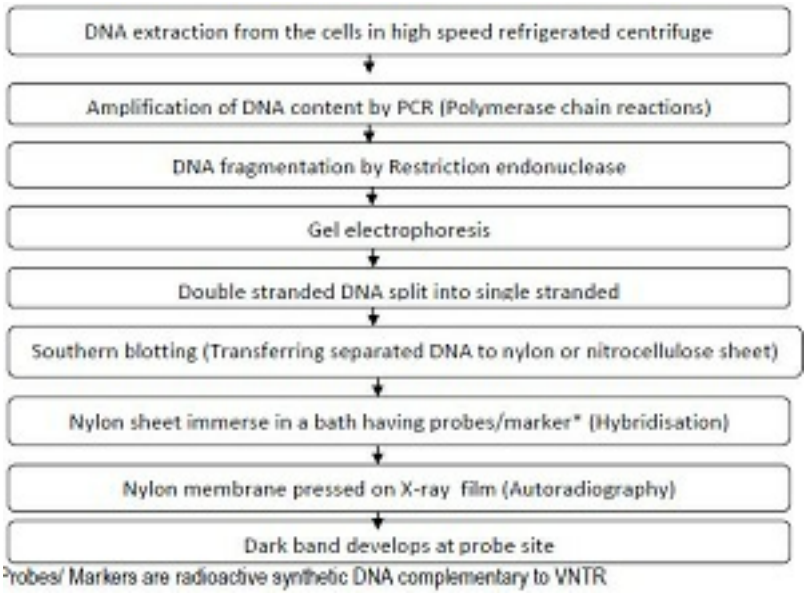
b) The average gene consists of 3000 bases, but sizes vary greatly, with the largest known human gene being dystrophin at 2.4 million bases.
c) Less than 2 per cent of the genome codes for proteins.
d) Repeated sequences make up very large portion of the human genome.
e) Repetitive sequences are stretches of DNA sequences that are repeated many times, sometimes hundred to thousand times.
f) Chromosome 1 has most genes (2968), and the Y has the fewest (231).
g) Scientists have identified about 1.4 million locations where single base DNA differences (SNPs – single nucleotide polymorphism) occur in humans.

DNA finger printing is a very quick way to compare the DNA sequence of any two individual. It includes identifying differences in some specific region in DNA sequence called as repetitive DNA because in this region, a small stretch of DNA is repeated many times.

Depending upon the base composition, length of segment and number of repetitive units satellite DNA is classified into many categories.

Polymorphism in DNA sequence is the basis for genetic mapping of human genome as well as fingerprinting.

The technique of fingerprinting was initially developed by Alec Jeffrey. He used a satellite DNA as probe to so high polymorphism was called Variable Number of Tendon Repeats (VNTR).



CBSE Class 12 Biology
Revision Notes
CHAPTER- 07
EVOLUTION

Evolutionary biology is the study of history of life forms on earth. The evolution of life on earth, different changes in flora and fauna around earth that co-exist along with human beings also forms parts of evolution.

Origin of Life

The origin of life is considered unique events in the history of universe. Huge cluster of galaxies comprises the universe. Galaxies contain stars and clouds of dust and smoke.

Big Bang Theory attempts to explain the origin of universe. According to this theory, a huge explosion occurs that forms the different galaxies.

In solar system of Milky Way galaxies, earth has been supposed to be formed about 4.5 billion years ago. There was no atmosphere in early earth. Water vapour, methane, carbon dioxide and ammonia released from molten mass covered the earth surface.

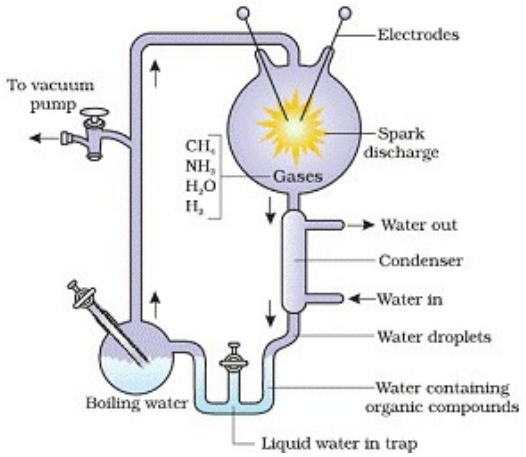
UV rays from sun splits the water into hydrogen and oxygen. Life appeared 500 million years after the formation of earth.

There are different theories regarding the origin of life on earth-

- Some scientist believes that life comes from other planets. Early Greek thinker thoughts that unit of life is called spores transferred from other planets.
- According to other theory, life comes out of dead and decaying matters like straw and mud. This theory is called theory of spontaneous origin.
- Louis Pasture experimentally proved that life arises only from pre-existing life. Spontaneous theory of origin of life is dismissed after that.
- Oparin and Haldane proposed that the first form of life could have come from pre-existing non-living organic molecules like RNA and protein etc. The formation of life preceded by chemical evolution. At that time condition on earth were- high

temperature, volcanic eruption, reducing atmosphere containing CH4and NH3.

Miller experiment of Origin of Life- S.L. Miller in 1953, conducted an experiment to show the origin of life on earth in the physical environment similar to condition prevails at that time.



Miller created similar condition of temperature and pressure in laboratory scale. He created electric discharge in a flask containing CH4, H2 and NH3 and water vapour at 8000C.

He observed formation of amino acids in flask after 15 days of electric discharge. Similar experiment by other scientist found formation of sugars, nitrogen bases, pigments and fats.

Analysis of meteorite content also reveals similar compounds that reveal that similar process are occurring elsewhere in the space. This experimental evidence about the origin of life is called chemical evolution of life.

Experimental representation of Miller's experiment

The first non-cellular forms of life could have originated 3 billion years back. They could have been giant molecules like RNA, Protein, and Polysaccharide etc.

The cellular form of life was probably single cell and originates in water medium. The theory that first form of life arose slowly through evolutionary forces from non-living molecules is called biogenesis.

Evidence of Evolution: Evidence that evolution of life forms has taken place on earth have many proofs as mentioned below-

1. Paleontological evidence- different aged rock sediments contain fossils of different life

forms that probably died during the formation of particular sediment. Fossils are remains of hard parts of life-forms found in rocks .The study showed that different form varied over time and certain life forms are restricted geological time span. Hence, new forms of life have arisen at different times in history of earth.

2. Homologous organs- those organs that perform different function but have similar origin and structure are called homologous organs. For example human, cheetah, bat and whales share similarities in pattern of bones of forelimbs although these forelimbs perform different functions in these animals. In these animal similar structure developed along different directions due to adaptation of different needs. This is called divergent evolution.

Homologous structures	**Analogous structures**
Similar in anatomy	Dissimilar in anatomy
Doing dissimilar functions	Doing similar functions
Develop in related animals	Develop in unrelated animals
Inherited from a common ancestor	Not inherited from common ancestor
Similar developmental pattern	Developmental pattern is not similar
Similar structure and Origin	Dissimilar in structure and origin

3. Analogous structures-they are not anatomically similar organs but perform similar function. For example eyes of mammals and octopus or flippers of penguin and dolphins. This is due to similar habitat that resulted in similar adaptive features in different groups of organisms. This that of evolution is called convergent evolution.

4. Biochemical evidences - similarities in proteins and genes performing a given function among diverse organisms give hints to common ancestry. These biochemical similarities

point to the same shared ancestry as structural similarities among diverse organisms.

DIVERGENT EVOLUTION	CONVERGENT EVOLUTION
1. Development of different functional structures from a common ancestral form is called divergent evolution.	Development of similar adaptive functional structures in unrelated groups of organisms is called convergent evolution.
2. Homologous organs show divergent evolution.	Analogous organs show convergent evolution.
Examples.: Darwin's Finches, Australian Marsupials, locomotion in mammals.	examples. Australian Marsupials and Placental mammals, various equatic vertebrate and wings of insect bird and bat.

Evolution by natural selection- Industrial melanism
A case of natural selection was seen in England in 1850s, i.e., before industrialisation in a peppered moth (Biston betularia). This moth had two forms: grey colour and black colour (Carbonaria). In the early part of the nineteenth century , before industrialization only the grey coloured forms of moths were present; the dark forms were rare. The grey coloured moths were seen on the tree trunks covered with lichens and so they were able to escape from their enemies. Later on in 1920, due to the development of industries, post industralization, the lichens were killed and the tree trunks looked dark due to the deposition of industrial soot. Birds, now were able to spot these moths and feed upon them. So the grey coloured moths were eaten by the birds and the dark coloured moths escaped from the birds. Then now the coal is replaced by the industries and oil and electricity is used. This has reduced the soot production and ultimately less deposition of soot on the tree trunks. These tree trunks have, now, again become grey in colour. Consequently, grey coloured moths have again increased in number. This example clearly brings out the action of natural selection.

Evolution by anthropogenic action - Resistance of mosquitoes to pesticides.

When DDT was introduced to control mosquitoes it was tremendously successful. Most of the mosquitoes were sensitive to DDT and were therefore killed. In that population of mosquitoes, few mosquitoes became resistant to DDT and survived. They multiplied and now almost total population of mosquitoes became resistant to DDT.

Same pattern has been observed in bacteria which are multidrug resistant due to excess use of drugs and medicines.

Adaptive Radiation- the process of evolution of different species in given geographical area starting from a point and radiating to other areas of geography (habitat) is called adaptive radiation. Darwin's finches represent one of the best examples of adaptive radiation. Australian marsupials, each with different from other evolved from one ancestral stock, but all within Australian island continents.

When more than one adaptive radiation appeared to have occurred in an isolated geographical area (representing different habitats), we can call this convergent evolution e.g Placental mammals and Australian marsupials.

Biological Evolution – the nature select for fittest and fitness is based on characteristics which are inherited. Some organisms are better adopted to survive in otherwise hostile environment. Fitness is the end result of the ability to adopt and get selected by nature.

Lamarck had said that evolution of life form had occurred but driven by use and disuse of organs. He gave the example of giraffe to evolve their neck by foraging leaves on tall trees and had to adapt by elongation of their necks.

Branching descent and natural selection are the two key concepts of Darwinian Theory of Evolution .Darwin theory of natural selection was based on certain observations like-

- Limited natural resources.
- Over population
- Competition for resources
- Struggle for existence
- Survival of the fittest.

Mechanism of Evolution

Hugo deVries based on his work on evening primrose brought forth the idea of mutation. Mutation is the large difference arising suddenly in a population.

Mutations are random and directionless while Darwin variations are small and directional. Hugo deVries believed that mutation causes speciation and hence called saltation (single step

large mutation).

Difference Amongst Lamarckism, Darwinism and Mutation Theory

Properties	Lamarckism	Darwinism	Mutation Theory
Vital force	The theory believes that every organism has an internal vital force that tends to increase its size upto a certain limit.	Darwinism does not believe in internal vital force.	No internal vital force is involved.
Conscious Reaction	Animals with well developed nervous system react consciously to any change in environments	Darwinism does not involve any conscious reaction.	No conscious reaction is believed to take part in the process of evolution.
Appetency	The theory considers appetency or desires on the part of animals an important force in the development of modifications.	It is not a constituent of the theory.	Appetency in not involved.
Use and Disuse	The organs put to more use are believed to develop more while organs not used begin to degenerate.	The theory is silent about use and disuse of organs.	The theory is silent about it.

Inheritance of Acquired Characters	The characters acquired by an organism during its life are believed to get transferred the next generation.	According to Darwin, all the living cells produce minute particles or pangenesis, which pass into germ cells for transmission to the offspring.	Only those variations are transferred to the offspring which originate in germ cells or in the cells which form germ cells.
Struggle for Existence	The theory does not clearly spell out struggle for existence in relation to high biotic potential.	Organisms produce more offspring than the available food and space so that a struggle for existence ensues amongst them.	The theory believes in the struggle for existence.
Origin of Variations	Variations appear in organisms in response to change in environment, conscious reaction, desire r use and disuse of organs.	Variations appear automatically.	Variations appear due to change in genetic make up.
Continuous Variations	The theory is silent about them though it believes in a continuous modification of organs in a particular direction.	It is based on the origin and selection of continuous variations.	The theory is based on discontinuous variations or mutations.
Natural Selection	The theory does not take into account natural selection or survival of the fittest.	Darwinism is based on natural selection or survival of the fittest.	Mutations theory believes in natural selection or survival of the fittest.

Progress of Evolution	Evolution is a continuous process which moves in a direction governed by environment and appentency.	Evolution is a continuous process, the direction of which is governed by nature.	Evolution is a jerky process, the direction of which is unpredictable though ultimately it is governed by nature.

Hardy- Weinberg Principle- in a given population, frequency of occurrence of alleles or genes can be finding out. These frequencies remains fixed and even remain the same through generation. This fact was represented by Hardy-Weinberg principles using algebraic equation.

This principle states that allele frequencies in a population are stable and is constant from generation to generation. The gene pool remains constant. This is called genetic equilibrium and sum total of all the allelic frequencies is 1.

Binomial expansion of (p+q)2 = p2+2pq+q2=1 where p and q represent the frequency of allele A and allele a in a population . The frequency of AA individuals in a population is simply p2 . This is simply stated in another ways, i.e., the probability that an allele A with a frequency of p appear on both the chromosomes of a diploid individual is simply the product of the probabilities, i.e., p2 . Similarly of aa is q2 , of Aa 2pq. Hence, p2+2pq+q2=1.

When frequency is measured, the actual value varies that indicates the extent of evolutionary changes. Change of frequency in a alleles (Hardy-Weinberg equilibrium) in a population resulted due to evolution.

The factors that affect Hardy-Weinberg equilibrium are-
• Gene migration or gene flow.
• Genetic drift
• Mutation
• Genetic recombination
• Natural selection.

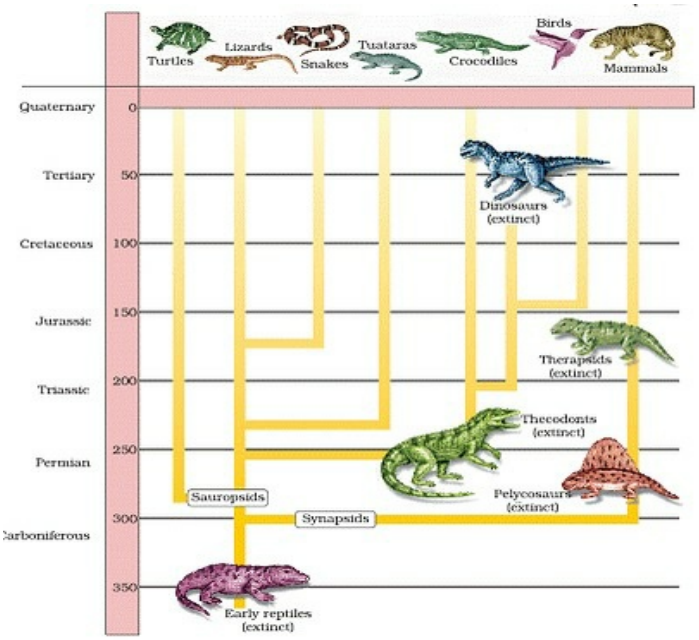
During genetic drift ,sometimes change in alleles frequency is so different in a sample of population that they become a different species. The original drifted population becomes

founder and that effect is called founder effect.

Brief Account of evolution

About 2000 million ago first cellular form of life appeared on earth.

- Slowly single-celled organisms became multi-cellular forms and by the time 500 mya, invertebrates were formed and active.
- Jawless fish evolved around 350 mya.
- Organisms started to invade from water to land. Fish with stout and strong fins could move on land and go back to water These animals called lobefins evolved into the first amphibians.
- Later, these amphibians evolved into reptiles. They lay shelled eggs. Then reptiles of different shapes and sizes dominated on earth , fish like reptiles e.g. Ichthyosaurs and the land reptiles e.g dinosaurs. The biggest of them was Tyrannosaurus rex.
- Some of the reptiles evolved into birds and later some of them to mammals. Mammals were viviparous and more intelligent in sensing and avoiding danger .



CBSE Class 12 Biology
Revision Notes
CHAPTER- 08
HUMAN HEALTH AND DISEASE

The state of complete physical, mental and social well beings is called health. Health simply does not simply means disease free condition or physical fitness. Health is affected by-
a. Genetic disorders – the defect which child inherits from it parents.
b. Infection from microbes or other organisms.
c. Life style- includes food and water we take, exercise and rest.

Good health can be maintained by

- Balanced diet.
- Personal hygiene
- Regular exercise
- Awareness about the disease and their effect
- Immunization against the infectious disease
- Proper disposal of wastage
- Control of vectors
- Maintenance of hygienic food and water.

Disease - Diseases can be broadly grouped into infectious and non-infectious.

a) Infectious disease -Diseases which are easily transmitted from one person to another, are called infectious diseases e.g AIDS, common cold, malaria, tuberculosis etc

b) Non-infectious disease – Diseases which cannot transmitted from one person to another, are called non- infectious diseases e.g cancer, hypertension, diabetes etc.

Common Diseases in Humans:

- The disease causing microorganisms like bacteria, virus, fungus, protozoa, helminthes are called pathogen.
- The pathogen can enter the body by various means and multiply and interfere with

normal vital activities resulting in morphological and functional damage.

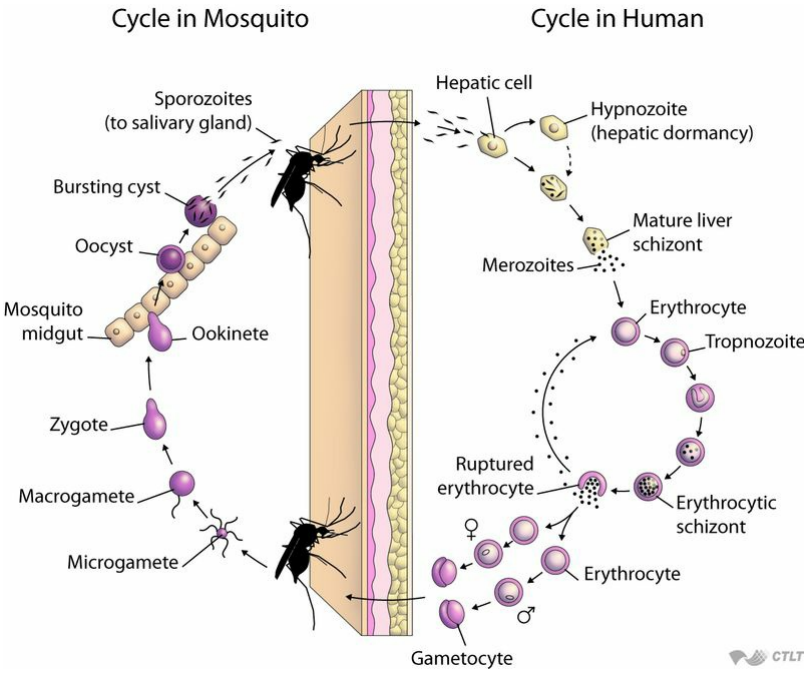
Name of disease /test	**Causal organisms**	**Symptoms**	**Effects**
Typhoid / Widal test	Salmonella typhi	Sustained high fever, weakness, stomach pain,	
Pneumonia	Streptococcus pneumoniae and Haemophilus influenzae	Fever, chills, cough and headache.	Alveoli get filled with fluid leading to severe problems in respiration.
Common cold	Rhino viruses	Nasal congestion and discharge, sore throat, cough and headache.	Infect the nose and respiratory passage.
Malaria	Plasmodium (P. vivax, P. malaria and P. falciparum)	The chill and high fever recurring 3 to 4 days.	Parasite multiply within lever cells and then attack the RBCs.
Amoebiasis or Amoebic dysentery	Entamoeba histolytica	Constipation, abdominal pain, cramps, stool with mucous and blood clot.	Infect the large intestine.
Ascariasis	Ascaris (Helminthes)	Internal bleeding, muscular pain, fever, anemia etc.	Healthy person get infected through water, vegetable etc.
Elephantiasis or filariasis	Wuchereria (W. bancrofti and W.	Inflammation in the lower limb and genital organs.	Lymphatic vessels of lower limbs get blocked.

	malayi)		
Ring worms	Microsporum, Trichophyton and Epidermophyton	Appearance of dry, scaly lesions on various part of body.	Infects the skin, nail and scalp.

Life cycle of plasmodium : Plasmodium enters the human body as small sporozoites through the bite of infected female anopheles mosquito and multiplies within the lever cells. Later attacks the RBCs resulting the rapture with release of toxic substance, haemozoin, which is responsible for high fever and chill recurring every three to four days.

Malarial parasite requires two hosts, human and anopheles mosquito to complete their life cycle. Female anopheles is vector of this disease to human beings.

Flowchart to show lifecycle of Plasmodium



Immunity – the ability of host cells to fight the disease causing microorganism due to immune system is called immunity. There are two types of immunity-

Innate immunity - non-specific types of defence presents at the time of birth and provide different kinds of barriers to the entry of foreign agents into the body. it consists of four types of barrier-

a. Physical barrier- skin, mucus coating of epithelium lining the respiratory, gastrointestinal and urogenital tract.

b. Physiological barrier- acid in stomach and saliva in mouth.

c. Cellular barrier- leucocytes, neutrophils, monocytes.

d. Cytokine barriers- virus infected cells secretes protein called interferon.

No	Innate Immunity	Acquired (Adaptive) Immunity
1	Present from birth itself	Develops during life time
2	The immunity remains throughout life.	Can be short lived or lifelong.
3	Contact or exposure with pathogen or its antigen is not essential.	Contact with pathogen or its antigen is essential.
4	Innate immunity is inheritable.	Acquired immunity cannot be passed to the next generation except for a brief period to neonates.
5	It protects the individuals from contraction of diseases of other organisms.	It protects the individuals from pathogens present on other members of the same species.

Acquired Immunity- pathogen specific defence characterised by memory. When our body encounters a pathogen first time produces a response called primary response of low intensity. Subsequent encounter by same pathogen produce highly intensified response called secondary response or anamnestic response due to memory of first encounter.

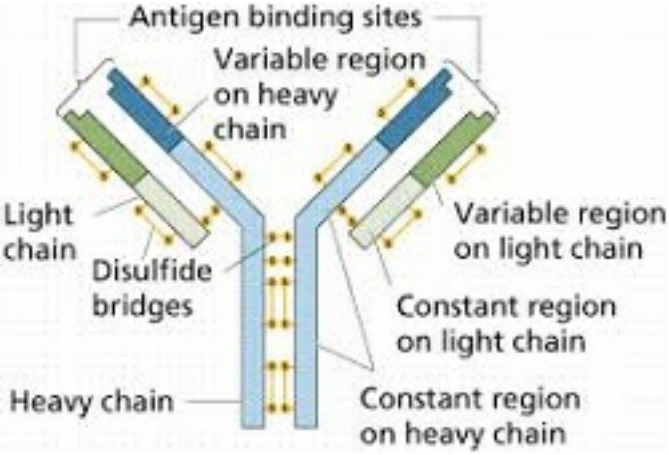
Primary and secondary responses are carried out with the help of B-lymphocytes and T-lymphocytes. B-lymphocytes produce army of protein called antibodies each having two light and two heavy chains.

It involves two types of lymphocytes –

- B lymphocytes: Show humoral immune response (HI)
- T lymphocytes: Show cell mediated immunity (CMI)

Structure of an Antibody:

- The antibodies are protein molecules called immunoglobulins and are of various types like IgA, IgM, IgE, IgG.
- Each antibody molecule consists of four polypeptide chains, two are long called heavy chains and other two are short called light chains. Both are arranged in the shape of 'Y', hence an antibody is represented as H2L2.



On the basis of production of antibodies, immunity can be further categorised as –

- Active immunity: Body produces its own antibodies against antigens
- Passive immunity: Readymade antibody is transferred from one individual to another
- Colostrum (contains antibodies IgA) is an example of passive immunity provided by the mother to her child.

Different types of antibodies produce in blood include IgA, IgM, IgEete. They are called humoral immune response due to presence in blood.

Human immune system can distinguish between self and foreign molecules or foreign bodies. Sometimes, due to genetic or unknown reasons, the body attack self-cells. This results in damage to the body and called auto-immune disease. Rheumatoid arthritis is due to this effect

Allergies – the exaggerated response of immune system to certain antigens present in the environment is called allergy. The substance to which such immune response is produced is called allergens. The antibodies produced due to these are IgE types. Allergy is due to secretion of chemicals like histamine and serotonin from the mast cells.

Immune system in the body- the human immune system includes lymphoid organs, tissue,

cells and soluble molecules like antibodies.

Lymphoid organs are the organs where origin and maturation and proliferation of lymphocytes occur. Primary lymphoid organs include bone marrow and thymus.

After maturation lymphocytes migrate to secondary lymphoid organ like spleen, lymph nodes, tonsils, peyer's patches of small intestine and appendix. They provide the sites for interaction lymphocyte with antigens.

There is lymphoid tissue also located within the lining of respiratory, digestive and urogenital tract called mucosal associated lymphoid tissue (MALT). It constitute 50% of lymphoid tissues in human body.

AIDS (Acquired Immuno Deficiency Syndrome) was first reported in 1981. It is caused by HIV (human Immuno deficiency virus), a retrovirus. Transmission of HIV virus occurs by-

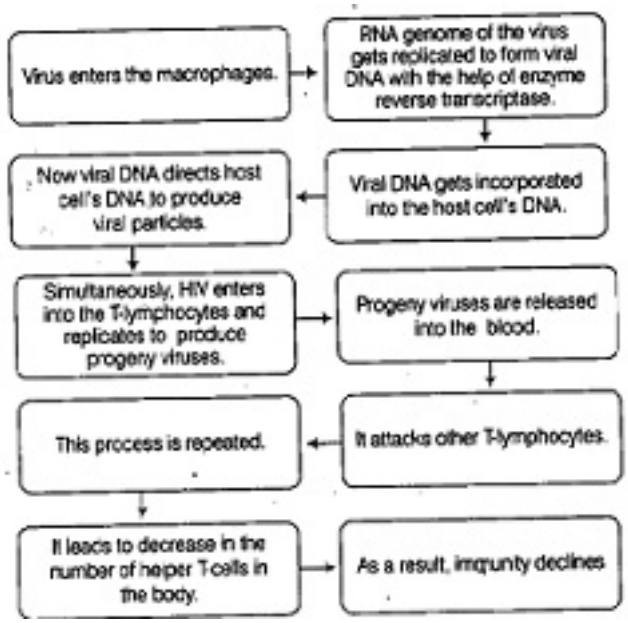
a. Sexual contact with infected person

b. Transfusion of contaminated blood and blood products

c. Sharing infected needles as in intravenous drug abusers

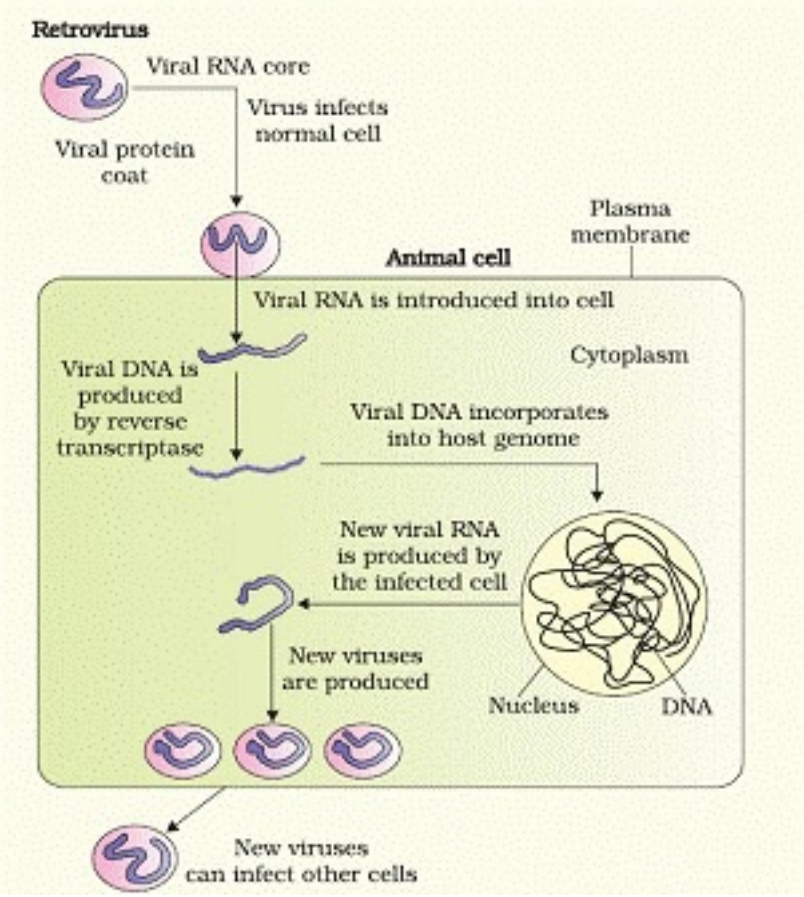
d. Infected mother to her child through placenta.

Replication of retrovirus in Macropahges



AIDS/HIV does not spread by physical contact. It spread only through body fluids. There is always time lag between infection and appearance of symptoms that may vary from 5-10 years.

Diagnostic test for AIDS is ELISA (enzyme-linked Immuno-sorbent assay). The treatment of this disease with anti-retroviral drug is partially effective and just prolonged the life but not prevents the death.



Cancer is one of the most dreaded diseases of human beings and is a major cause of death all over the world. Normal cells show a property called contact inhibition by virtue of which contact with other cells inhibit their uncontrolled growth. Cancer cells lost this property.

Cell Characteristics	**Normal Cells**	**Cancer Cells**
	Normal cells have uniform	Cancer cells have a large variety of sizes and shapes

Morphology	shapes and sizes	The nucleuses have irregular structure and have relatively small cytoplasm.
Reproduction and Cell Death	Cells stop dividing when too much of its kind are present. These cells grow and divide in a controlled manner and follow a predictable life cycle. Normal cells undergo the process of apoptosis – self destruction if they detect abnormalities and damage in their organelles.	Cancer cells don't stop growing resulting to appearance of a tumor (a cluster of mutant cells)
Communication	Normal cells communicate with each other for proper functioning.	Cancer cells do not communicate with each other
Adhesion and Invasion	These cells have external membranes that allow them to bond with other cells.	Cancer cells lose the molecules that keep cells bonded together. These cells have the ability to invade or spread to other parts of the body by travelling through the blood stream or the lymphatic system – metastasis.
Specialization	Normal cells start out as immature cells and mature with certain specialized functions.	Cancer cells do not mature, and undergo apoptosis. Instead these cells become immature overtime. Cancer cells are primitive and they don't have specialized functions.

Signal Recognition	Normal cells recognize signals. They know when there are enough new cells and stops dividing.	Cancer cells don't recognize signals. Hence these cells erratically reproduce mutated cells.

Cancerous cells continue to divide giving rise to masses of cells called tumors. There are two kind so tumors-

(a) Benign tumors

(b) Malignant tumors

Benign Tumor	Malignant Tumor
1. It remains confined to the affected organ.	1. It also spreads to other organs of the body.
2. Rate of growth is usually slow.	2. Rate of growth is usually rapid.
3. There is no latent stage.	3. There is latent stage.
4. It causes limited damage to the body.	4. The cancer cells migrate to other sites of the body.
5. There is no metastasis.	5. There is metastasis.
6. It is non-cancerous.	6. It is cancerous.

Causes of cancer – cancerous neoplastic cell may be induced by physical, chemical and biological agents called carcinogens. Cancer causing viruses called oncogenic virus have

gene called viral oncogenes. Several genes called cellular oncogenes (c-onc) or proto oncogenes have been identified in normal cells which, when activated under certain conditions, could lead to oncogenic transformation of the cells.

Cancer detection and diagnosis-cancer detection is based on biopsy and histopathological study of the tissues, blood and bone marrow test for increased cell counts. Radiography, CT (computed tomography), MRI (magnetic resonance imaging) are very useful to cancers of internal organs.

Treatment of Cancer-

1. Surgical – cancerous tissues are surgically removed.
2. Radiotherapy – tumor cells are irradiated lethally by radiation.
3. Chemotherapy – drugs are used to kill cancerous cells, but shows side effects like hair loss, anemia, etc.
4. Immunotherapy – patients are given with alpha-interferon which activate their immune system and help in destroying the tumor

Drugs and Alcohol Abuse

Commonly abused drugs include opioids, cannabinoids and coca alkaloids obtained from flowering plants and a few from fungi.

Opioids are the drugs which bind to specific opioids receptors present in our central nervous system and gastrointestinal tract. Heroin commonly called smack is chemically diacetylmorphine which is a white, odourless, bitter crystalline compound. It is extracted from the latex of poppy plant (Papaversomniferum).Generally taken by snorting and injection, heroin is a depressant and slows down body functions.

Cannabinoids are a group of chemicals which interact with cannabinoid receptors present in the brain. Natural cannabinoids are obtained from the inflorescence of the plant cannabis sativa. They include marijuana, hashish, charas and gangja. They generally taken by inhalation and oral ingestion, these are known for their effects on cardiovascular system of the body.

Coca alkaloid or cocaine is obtained from coca plant Erythroxylum coca, native to South America. It interferes with the transport of the neuro-transmitter dopamine. Cocaine,

commonly called coke or crack is usually snorted. It has a potent stimulating action on central nervous system, producing a sense of euphoria and increased energy.

Adolescence and Drug abuse

- Adolescence is the period during which the child becomes matured.
- It is between 12 – 18 years of age.

Causes of drug abuse –

- Curiosity
- Adventure
- Excitement
- Experimentation
- Stress or pressure to excel in examination

Effects of drug/alcohol abuse –

- Reckless behaviour
- Malicious mischief
- Violence
- Drop in academic performance
- Depression, isolation, aggressiveness, etc.

Dependence is the tendency of the body to manifest a characteristic and unpleasant withdrawal syndrome if regular dose of drug/alcohol is abruptly discontinued that includes anxiety, shakiness, nausea and sweating.

Prevention avoid undue peer pressure, education & counselling, seeking helps from parents and peers, seeking professional and medical help etc.

CBSE Class 12 Biology

Revision Notes

CHAPTER- 09

STRATEGIES FOR ENHANCEMENT IN FOOD PRODUCTION

To fulfil the demand of food items due to increasing population, biological principles are applied in animal husbandry and plant breeding.

Animal husbandry- is the agricultural practice of breeding and raising livestock. Animal husbandry deals with the care and breeding of livestock like buffaloes, cows, pigs, horses, cattle, sheep, camel goat etc. It includes poultry farming and fisheries. Fisheries include rearing, catching, selling, etc., of fish, molluscs (shell-fish) and crustaceans (prawns, crabs, etc.) More than 70% of livestock population of the livestock live in India and China.

Management of Farm and Farm Animals

A professional approach of farm management have increased the food production many folds. Some of the management procedures applied in various livestock are as follows-

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.

Poultry Farm Management- poultry is the class of domesticated birds used for food or for

their eggs. It mainly includes chicken and ducks and with turkey and geese. Important components of poultry farm management includes-

o Selection of disease free and suitable breeds.

o Proper and safe farm condition.

o Proper feed and water

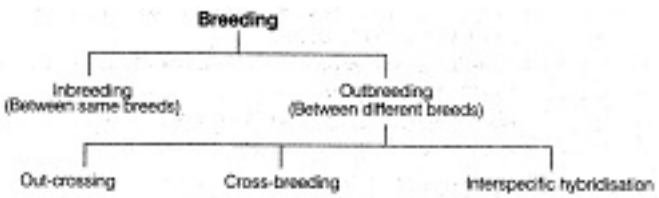
o Hygiene and health care

Animal Breeding – It aims at increasing yields of animals and improving the desirable qualities of the product. A breed is a group of animals related by descent and similar in most of characters like general appearance, features, size, configuration etc. There are two kinds of breeding

- Inbreeding – breeding between animals of same breeds.
- Outbreeding- crosses between different breeds.

Inbreeding	Outbreeding
Method of mating of more closely related individuals between animals of same breed for 4-6 generations.	Method of mating of unrelated animals between same breed that there should be no common ancestor for about 4-6 generations.
Mating is between same species.	Mating is between different species.
Advantage It increases homozygosity, so it is used for developing pure lines.	**Advantage** It produces hybrids with desirable characters of both the parents like better lactation period and high milk productions.

Inbreeding depression - continued inbreeding reduces fertility and even productivity. This is called Inbreeding Depression. Whenever this becomes a problem, selected animals of the breeding population should be mated with unrelated superior animals of the same breed. This usually helps restore fertility and yield.



Out-breeding is the breeding of unrelated animals, which may be between individuals of same breed but, having no common ancestors or between different breeds (cross breeding) or different species (interspecific hybridisation).

Out-crossing- this is the practice of mating of animals within the same breed but having no common ancestors on either side of their pedigree up to 4-6 generation. The offspring are called out-cross.

Cross breeding- superior male of one breed are mated with superior female of another females of another breed. Cross breeding allows the desirable qualities of two breeds to be combined.

Interspecific hybridisation- male and female animals of two different species are mated. The progeny may combine desirable features of both and parents. Ex- mule.

Controlled breeding experiments are carried out using artificial insemination. The semen is collected from the male that is chosen as a parent and injected into the reproductive tract of the selected female by the breeder.

Multiple Ovulation Embryo Transfer Technology (MOET) is used to increase the success rate of artificial insemination. In this method, a cow is administrated hormones (FSH) to induce follicular maturation and super ovulation, instead of one egg; they produce 6-8 eggs. The fertilised eggs 8-32 cells stages, are recovered non-surgically and transferred to surrogate mothers.The genetic mother is available for another round of super ovulation.

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. It also produces beeswax.

The most common species of honey bee is Apis indica. The following points are important for successful bee-keeping-

1. Knowledge of the nature and habits of bees
2. Selection of suitable location for keeping the beehives
3. Catching and hiving of swarms
4. Management of beehives during different seasons
5. Handling and collection of honey and of beeswax.

6. Keeping beehives in crop fields during flowering period increases pollination efficiency and improves the yield.

Fisheries : Fishery is an industry devoted to catching, processing or selling of fish, shellfish or other aquatic animals.

Fresh water fishes which are very common include catla, rohu and common carp. Common marine fishes are Hilsa, sardines, mackerel and pomfrets.

Different techniques have been applied to increase production like aquaculture and pisciculture. Blue Revolution is implemented to increase fish production.

Pisciculture	Aquaculture
It is a process of growing fish and selling it or using its products for domestic or commercial use. Fish can be grown both in salt water or fresh water.	It is a process of growing any aquatic animals and selling them for commercial purposes. It involves feeding, harvesting and many other processes. The most popular one's grown under controlled environments are shrimps,crab,fish,lobster and few others.

Plant Breeding is the purposeful manipulation of plant species in order to create desired plant species in order to create desired plant types that are better suited for cultivation, give better yields and are disease resistant.

Classical plant breeding involves crossing or hybridisation of pure lines, followed by artificial selection to produce plants with desirable traits of higher yield, nutrition and resistance to disease.

The main steps in plant breeding are-

a) Collection of variability is the collection and preservation of all the different wild varities, species and relatives of the cultivated species. The entire collection having all the diverse alleles for all genes in a given crop is called germplasm collection.

b) Evaluation and selection of parents is the identification of plants with desirable combination of characters. The selected plants are multiplied and used in the process of

hybridisation.

c) Cross hybridisation among the selected parents to obtained desired crop characters for example high protein quality of one parent may need to be combined with disease resistance from another parent. This is possible by cross hybridising the two parents to produce hybrids that genetically combine the desired characters in one plant

d) 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

e) Testing, releasing and commercialisation of new cultivars -The newly selected lines are evaluated for their yield and other agronomic traits of quality, disease resistance, etc.

Wheat and Rice : Production of wheat and rice increased tremendously between 1960-2000 due to introduction of semi-dwarf varieties of rice and wheat.

- In 1963, several varieties such as Sonalika and Kalyan Sona, which were high yielding and disease resistant were introduced all over the wheat growing field of India.
- Semi-dwarf rice varieties were derived from IR-8, and Taichung Native-1 were introduced in 1966. Later better-yielding semi-dwarf varieties Jaya and Ratna were developed in India.

Sugar cane

- Saccharum barberi and Saccharum officinarum were crossed to get the desirable qualities of high yield, thick stems, high sugar and ability to grow in the sugar cane areas of north India.

Millets

Hybrid maize, jowar and bajraare developed in India. These varieties are high yielding and resistant to water stress.

Plant Breeding for Disease Resistance

Several fungal, bacterial and viral pathogens affect the yield and quality of plant products. To minimise this loss disease resistant varieties were developed. Breeding is carried out by

conventional method or by mutation breeding.

Steps for breeding disease resistant plants:

- Selection of genome with disease resistant traits
- Mating of the selected parents
- Selection of superior hybrids
- Testing of the hybrid for superior variety
- Release of the new variety

Some crop varieties bred by hybridisation and selection for disease resistance to fungi, bacterial and viral disease are released-

Crop	Variety	Resistance to diseases
Wheat	*Himgiri*	*Leaf and stripe rust, hill bunt*
Brassica	*Pusa swarnim (Karan rai)*	*White rust*
Cauliflower	*Pusa Shubhra, Pusa Snowball K-1*	*Black rot and Curl blight black rot*
Cowpea	*Pusa Komal*	*Bacterial blight*
Chilli	*Pusa Sadabahar*	*Chilly mosaic virus, Tobacco mosaic virus and Leaf curl*

Mutation is the process by which genetic variations are created through changes in the base sequence within genes resulting in the creation of a new character or trait not found in the parental types. It is done by using mutants like chemicals or radiations. This process is called mutation breeding. e.g

- Mung bean resistance to yellow mosaic virus and powdery mildew were induced by mutation.
- Resistance to yellow mosaic virus in bhindi (Abelmoschus esculentus) was transferred from a wild species and resulted in a new variety of A. esculentus called Parbhani kranti.

Plant breeding for Developing Resistance to Insect Pests

Crop plant and crop products are destructed by insects and pests on large scale. To prevent this loss new varieties resistance to them are developed.

Steps for breeding disease resistant plants:

- Selection of genome with disease resistant traits
- Mating of the selected parents
- Selection of superior hybrids
- Testing of the hybrid for superior variety
- Release of the new variety

Crop	Variety	Insect Pests
Brassica (rapeseed mustard)	*Pusa Gaurav*	*Aphids*
Flat bean	*Pusa Sem 2, Pusa Sem 3*	*Jassids, aphids and fruit borer*
Okra (Bhindi)	*Pusa Sawani Pusa A-4*	*Shoot and Fruit borer*

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 varities of vegitables 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)– alternate source of protien for animal and human nutrition. Microbes are grown on industrial scale as a source of good protien.

- Microbes like spirullina can be grown easily on materials like waste water from potato processing plants having strach, molasses, animal manure and even sewage to produce large quantities and can serve as food rich in protien, minerals, fats, carbohydrates and vitamins.
- Methylophilus methylotrophus has high rate of biomass production and growth,it can be expected to produce 25 tonnes of protein by 250 g of microorganism.

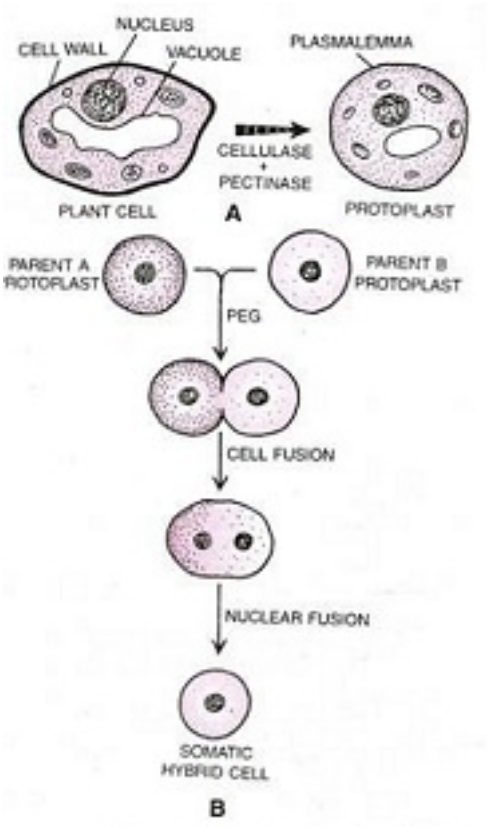
Tissue Culture

The capacity to generate whole plants form any cell/explant is called totipotency. Thousands of plants can be produced from expalnts in short interval of time using suitable nutrient medium, aseptic condition and use of phytohormones. This method of producing thousands of plant 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. Many important food plants like tomato, banana, apple.

Meristem Culture - the recovery of healthy plants from diseased plants can be done by mersitem culture .Although the plant is infected with a virus, the meristem (apical and axillary) is free of virus. Hence, one can remove the meristem and grow it in vitro to obtain virus-free plants

Somatic Hybridisation

Isolation of single cells from their plants and after digesting their cell wall fusing the cytoplasms of two differnet varieties is called somatic hybridisation and these hybrids are called somatic hybrids



Somatic hybridisation. A, Production of protoplasts using a combination of pectinase and cellulase. B, Protoplast fusion induced by PEG ultimately yields somatic hybrid cells.

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CHAPTER- 10
MICROBES IN HUMAN WELFARE

Microbes are diverse-protozoa, bacteria, fungi and microscopic plants viruses, viroid and also prions that are proteinacious infectious agents. They are found everywhere on earth ranging from soil, air water and some inhabitable places.

Bacteria and fungi can be grown on nutritive media to form colonies, which can be seen by necked eyes and very useful in study of microorganisms.

Microbes cause many diseases in human beings, plants and animals. Several microorganisms are useful to man in diverse ways.

Microbes in household products

a. Microorganisms like Lactobacillus and other commonly called lactic acid bacteria (LAB) grow in milk and convert it to curd. The LAB produces acids that coagulate and partially digest the milk proteins. It also improves its nutritional quality by increasing vitamin B12. In our stomach too, the LAB play very beneficial role in checking disease causing microbes.

b. The dough is used for making foods such as dosa and idli is fermented by bacteria. The puffed-up appearance of dough is due to the production of CO_2 gas. The dough used for making bread is fermented using baker's yeast (Saccharomyces cervisiae).

c. Cheese, is one of the oldest food items in which microbes were used. The large holes in 'Swiss cheese' are due to production of a large amount of CO_2 by a bacterium named Propionibacterium sharmanii. The 'Roquefort cheese' is ripened by growing a specific fungus on them for a particular flavour.

Microbes in industrial production

A number of products like beverages and antibiotics involve uses of microbes. Production on large scale requires growing microbes in very large vessels called fermenters.

a. Fermented Beverages- Saccharomyces cerevisiae used for bread-making and commonly called brewer's yeast, is used for fermenting malted cereals and fruit juices, to produce beverages like wine, bear, whisky and rum.. Wine and bear are produced without distillation whereas whisky, brandy and rum are produced by distillation of the fermented broth.

b. Antibiotics- they are chemical substances produced by some microbes and can kill or retard the growth of other microbes. Penicillin was first antibiotic to be discovered. Antibiotics have great improved our capacity to treat deadly diseases such as plague, whooping cough, diphtheria and leprosy.

c. Chemical, Organic acids , Enzymes and other Bioactive Molecules are commercially produced by microbes.

Chemicals :

- Aspergillus niger (fungus) – Citric acid
- Acetobacter aceti (bacterium) – Acetic acid
- Clostridium butylicum (bacterium) – Butyric acid
- Lactobacillus (bacterium) – Lactic acid
- Saccharomyces cerevisiae – Ethanol

Enzymes:

- Lipase – used in laundry detergents

- Pectinase and protease – used in bottled juices
- Streptokinase (Streptococcus bacterium) – used as clot buster (to remove clots)

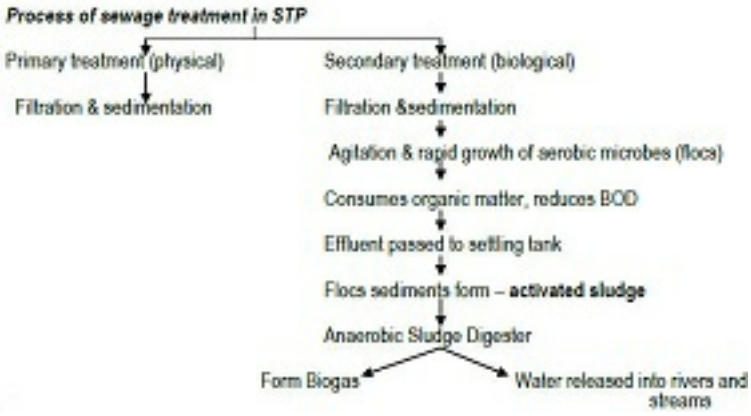
Bioactive molecules:

- Cyclosporin A (Trichoderma polysporum fungi) – used as immunosuppressive agent (for organ transplant patients).
- Statins (Monascus purpureus yeast) – used as blood cholesterol lowering agents.

Microbes in sewage Treatment

Municipal waste water (sewage) contains large amount of organic matter and microbes which are pathogenic and cannot be discharged into natural water bodies like rivers and streams.

Sewage is treated in sewage treatment plant to make it less polluting by using heterotrophic microbes naturally present in sewage. Sewage treatment is done in two stages-



In primary treatment, floating debris is removed by sequential filtration. Grit (soil and small pebbles) are removed by sedimentation.

Secondary treatment or biological treatment involves passing of primary effluents in large aeration tank to help the growth of aerobic microbes into flocs (masses of bacteria associated with fungal filaments to form mesh like structures). These microbes increase the consumption of organic wastes and decrease the BOD (biological oxygen demand)of the effluents.

BOD is the amount of oxygen that would be consumed if all the organic matter in one litre of water were oxidised by bacteria. It measures the amount of organic matter present in the

water. Greater the BOD of water more it is polluted.

- Once the BOD of sewage or waste water is reduced, the effluent is then passed into a settling tank where the bacterial 'flocs' are allowed to sediment. This sediment is called activated sludge.

Sludge is passed into large tanks called anaerobic sludge digesters in which anaerobic bacteria digest the bacteria and fungi in the sludge and produce mixture of gas called biogas, which is a mixture of methane, hydrogen sulphide and carbon dioxide.

The effluents from the secondary treatment plant are released into water bodies.

Microbes in Production of Biogas

Biogas is a mixture of gases produced by the microbial activity that can be used as fuel. Certain bacteria that grows anaerobically on cellulosic material produce large amount of methane along with CO2and H2. These bacteria are collectively called methanogens (Methanobacterium).

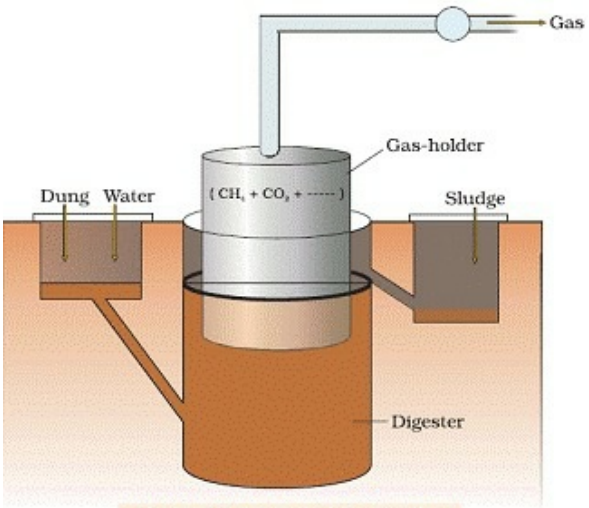


Figure 10.8 A typical biogas plant

Biogas Plant – the excreta of cattle (gobar) is rich in methanogens bacteria and is used for generation of biogas also called as gobar gas.

- The technology of biogas production was developed in India mainly due to the efforts of Indian Agricultural Research Institute (IARI) and Khadi and Village Industries Commission (KVIC).

Biogas plant consists of a concrete tank in which bio-wastes are collected and slurry of dung

is fed.

A floating cover is placed over digester that moves upward when gas is produced. The gas produced is removed and supplied through an outlet pipe for consumption.

The spent slurry is removed through another outlet and used as fertilisers. Biogas plant is more often build in rural areas as large amount of cattle dug is available easily.

Microbes as Biocontrol agent

Biocontrol means use of biochemical method for controlling plant disease and pests. The chemical used as pesticides and insecticides are harmful to human beings and animals.

Biological control of pests and disease is a method of controlling pest on natural prediction rather than chemicals. The organic farmer creates a system where the pests are not eradicated but kept at manageable level by complex system of check and balance within the living and vibrant ecosystem. For example, the Ladybird and Dragonflies are used to get rid of aphids and mosquitoes respectively. On brassicas and fruit tree, to control butterfly caterpillars bacteria Bacillus thuringiensis is used.

Biological control developed for use in the treatment of plant disease is the fungus Trichoderma. Trichoderma are free-living fungi that are very common in the root systems that control several plant pathogens.

- Baculoviruses are pathogens that attack insects and other arthropods. The majority of baculoviruses used as biological control agents are in the genus Nucleopolyhedrovirus. These viruses are excellent candidates for species-specific, narrow spectrum insecticidal applications.

Microbes as Bio fertilisers

Bio fertilisers are organisms that enrich the nutrient quality of the soil. The main sources includes bacteria, fungi and cyanobacteria.

The root nodule formed by Rhizobium bacteria on root of leguminous plants increase the nitrogen level of soil, necessary for various metabolic processes. Azotobacter and Azospirillum are free living bacteria that live in soil and fix atmospheric nitrogen into organic forms.

Symbiotic association of fungi with angiosperm plants (mycorrhiza) also increase the fertility of soil. Glomus form mycorrhiza that absorbs phosphorus from the soil and passes it to the plant. These microbes also provide benefits like resistance to root-borne pathogens, tolerance to salinity and drought.

Cyanobacteria (Nostoc, Anabaena), an autotrophic microbes found in aquatic and terrestrial environment fix atmospheric nitrogen. In paddy field this acts as important bio-fertiliser. Blue green algae also add organic matter to the soil and increase its fertility.

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Revision Notes
CHAPTER- 11
BIOTECHNOLOGY: PRINCIPLES AND PROCESSES

The techniques of using live organisms or enzymes from organisms to produce products and processes useful to humans. Many processes like in vitro fertilization leading to 'test-tube' baby, synthesizing gene and using it, developing a DNA vaccine or correcting a defective gene are also parts of Biotechnology.

The European Federation of Biotechnology (EFB) has given a definition of biotechnology that comprises both traditional and modern molecular biotechnology .The defination is as follow- "The integration of natural science and organisms, cells, parts thereof, and molecular analogous for products and services".

Principles of Biotechnology

Modern biotechnology is based on two main principles-

• **Genetic Engineering** - Genetic Engineering is defined as the direct manipulation of genome (DNA and RNA) of an organism. It involves the transfer of new genes to improve the function or trait into host organisms and thus changes the phenotype of the host organism.

• Maintenance of sterile condition in chemical engineering process to enable growth of only desired microbes for manufacture of biotechnological products like antibiotics, vaccine, enzymes etc.

• Traditional hybridization used in plants and animal breeding leads to inclusion and multiplication of undesirable genes along with the desired traits. The technique of genetic engineering which include creation of recombinant DNA, use of gene cloning and gene transfer allow us to isolate and introduce only one or a set of desirable genes without introducing undesirable genes into the target organism.

• In a chromosome there is a specific DNA sequence called the origin of replication, which is responsible for initiating replication. Therefore, for the multiplication of any alien piece of

DNA in an organism it needs to be a part of a chromosome which has a specific sequence known as '**origin of replication'**. Thus, an alien DNA is linked with the origin of replication, so that, this alien piece of DNA can replicate and multiply itself in the host organism. This is known as **Cloning** or making multiple identical copies of any template DNA.

• The construction of the first recombinant DNA emerged from the possibility of linking a gene encoding antibiotic resistance with a native Plasmid of *Salmonella typhimurium*.

- Stanley Cohen and Herbert Boyer in 1972 isolated the antibiotic resistance gene by cutting out a piece of DNA from a **plasmid** (autonomously replicating circular extra-chromosomal DNA) of *Salmonella typhimurium*. The cutting of DNA at specific locations became possible with the discovery of the so-called 'molecular scissors'– **restriction enzymes**.

• The cut piece of DNA was then linked with the plasmid DNA. These plasmid DNA act as **vectors** to transfer the piece of DNA attached to it.A plasmid can be used as vector to deliver an alien piece of DNA into the host organism.

• The linking of antibiotic resistance gene with the plasmid vector become possible with the enzyme ligase, which acts on cut DNA molecules and joins their ends. This makes a new combination of autonomously replicating DNA created in vitro and known as **recombinant DNA**.

• When this DNA is transferred into E.coli, it could replicate using the new host DNA polymerase enzyme and make multiple copies. The ability to multiply copies of antibiotic resistance gene in E.coli was called cloning of antibiotic resistance gene in E.coli.

"Recombinant DNA technology" or also called "Genetic Engineering" deals about, the production of new combinations of genetic material (artificially) in the laboratory. These "recombinant DNA" (rDNA) molecules are then introduced into host cells, where they can be propagated and multiplied.

Steps of Fecombinant DNA Technology -

I. Identification of DNA with desirable genes.

II. Introduction of the identified DNA into the host.

III. Maintenance of introduced DNA in the host and transfer of the DNA to its progeny.

Tools of Recombinant DNA Technology includes

• Restriction Enzymes

• Polymerase enzymes

• Ligases

• Vectors

• Host organisms

Restriction Enzymes (Molecular Scissors):
Restriction enzymes belong to a larger class of enzymes called **Nucleases**. There 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.

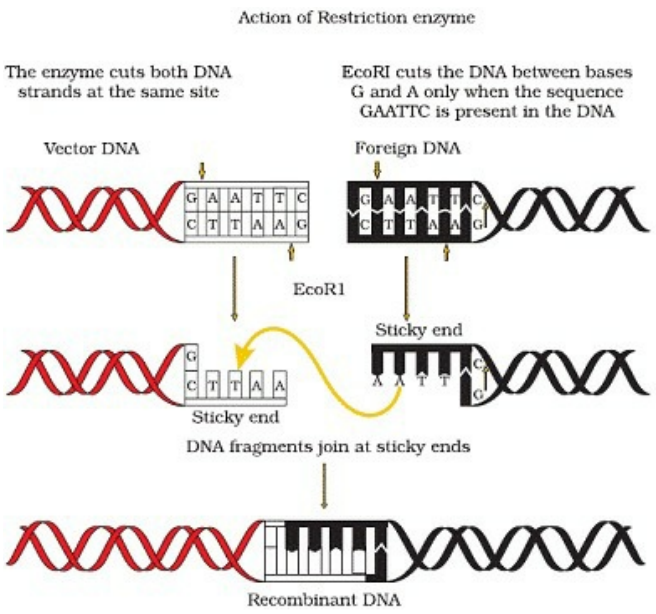
Example, the first restriction endonuclease – Hind II, always cut DNA molecules at a particular point by recognizing a specific sequence of six base pairs. This specific base sequence is known as the Recognition Sequence for Hind II.

• Each restriction endonuclease recognises a specific palindromic nucleotide sequence in the DNA. Palindromes are group of letters that form the same words when read both forward and backward for example “MALYALAM”.

5' —— GAATTC —— 3'

3' —— CTTAAG —— 5'

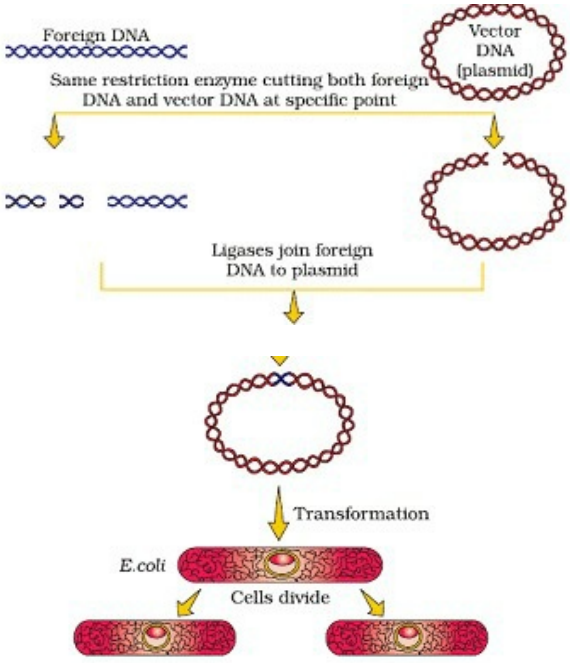
The palindrome in DNA is a sequence of base pairs that reads same on two stands when orientation of reading is kept the same.



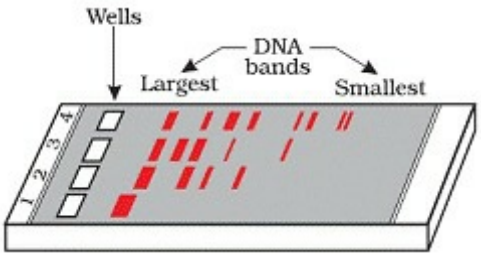
• Restriction enzymes cut the strand of DNA a little away from the centre of the palindrome site between the same two bases on the opposite strands having sticky strand. The stickiness of the strands facilities the action of the enzyme DNA ligase.

• Restriction endonucleases are used in genetic engineering to form recombinant molecules of DNA which are composed of DNA from different sources or genome.

• When cut the same restriction enzyme the resultant DNA fragments have the same kind of Sticky-ends and can be joined together using DNA ligases.



Diagrammatic representation of Recombinant DNA technology



Separation and isolation of DNA fragments

The fragment of DNA obtained by cutting DNA using restriction enzyme is separated by technique called **gel electrophoresis**. Negatively charged DNA fragments can be separated by forcing them to move towards the anode under an electric field through medium. DNA fragments separate according to their size through sieving effect provided by agarose gel.

• The separated DNA fragment can be visualized after staining the DNA with ethodium bromide followed by exposure to UV light. Separated bands of DNA are separated from agarose gel and extracted from gel, called **elution**. The DNA fragment purified this way is used for recombination.

Cloning Vector

Plasmids and Bacteriophages is commonly used vector for cloning. They have ability to replicate within bacterial cells independent of the control of chromosomal DNA. Bacteriophages because of their high number per cell, have very high copy numbers of their genome within the bacterial cells.

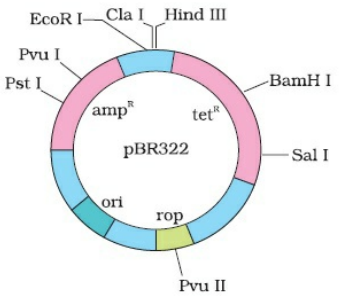
Following features are required to facilitate cloning into a vector-

a. **Origin of replication (ori)** – the sequence from where replication starts and any piece of DNA when linked to this sequence can be made to replicate within the host cells.This sequence is responsible for controlling the copy number of the linked DNA.

b. **Selectable marker**-help in the identifying and eliminating non transformants and selectively permitting the growth of the transformants.**Transformation** is a procedure through which a piece of DNA is introduced in a host bacterium. Generally,the genes encoding resistance to antibiotics such as ampicillin, chloramphenicol, tetracycline or

kanamycin, etc., are considered useful selectable markers for E. coli.

c. **Cloning sites**- to link the foreign DNA, the vector need to have single recognition sites for the commonly used restriction enzymes as presence of more than one recognition sites within the vector will generate several fragments, which will complicate the gene cloning. The ligation of foreign DNA is carried out at a restriction site present in one of the two **antibiotic resistance genes**.



E. coli cloning vector pBR322 showing restriction sites (Hind III, EcoR I, BamH I, Sal I, Pvu II, Pst I, Cla I), ori and antibiotic resistance genes (ampR and tetR). rop codes for the proteins involved in the replication of the plasmid.

Insertional inactivation:
The most efficient method of screening for the presence of recombinant plasmids is based on the principle that the cloned DNA fragment disrupts the coding sequence of a gene. This is termed as Insertional Inactiviation.

For example, the powerful method of screening for the presence of recombinant plasmids is referred to as Blue-White selection. This method is based upon the insertional inactivation of the lac Z gene present on the vector. The lac Z gene encodes the enzyme beta-galactosidase, which can cleave a chromogenic substrate into a blue coloured product. If this lac Z gene is inactivated by insertion of a target DNA fragment into it, the development of the blue colour will be prevented and it gives white coloured colonies. By this way, we can differentiate recombinant (white colour) and non-recombinant (blue colour) colonies.

d. **Vectors for cloning genes in plants and animals**- A*grobacterium tumefactions* (pathogen of dicot plant) is able to deliver a piece of DNA known as 'T-DNA" to transform normal plant cells into a tumor and direct these tumor cells to produce the chemicals required by the pathogen. Retroviruses in animals have the ability to transform normal cells into cancerous

cells. The tumor inducing (Ti) plasmid of Agrobacterium tumefaciens has been modified into cloning vector having no more pathogenic to plant. Similarly retrovirus have been modified into cloning vector for animals.

Competent host (For Transformation with Recombinant DNA)

1) Simple chemical treatment with divalent calcium ions increases the efficiency of host cells (through cell wall pores) to take up the rDNA plasmids.
2) rDNA can also be transformed into host cell by incubating both on ice, followed by placing them briefly at 42oC (Heat Shock), and then putting them back on ice. This enables the bacteria to take up the recombinant DNA.
3) In **Microinjection** method, rDNA is directly injected into the nucleus of cells by using a glass micropipette.
4) **Biolistics / Gene gun method,** it has been developed to introduce rDNA into mainly plant cells by using a Gene / Particle gun. In this method, microscopic particles of gold / tungsten are coated with the DNA of interest and bombarded onto cells.
5) The last method uses *"Disarmed Pathogen"* Vectors (*Agrobacterium tumefaciens*), which when allowed to infect the cell, transfer the recombinant DNA into the host.

Processes of Recombinant DNA Technology

Recombinant DNA technology involves several steps in specific sequence-

a. Isolation of DNA

b. Fragmentation of DNA by restriction endonucleases

c. Isolation of a desired DNA fragment

d. Ligation of the DNA fragment into vector

e. Transforming the recombinant DNA into the host

f. Culturing the host cells in a medium at large scale

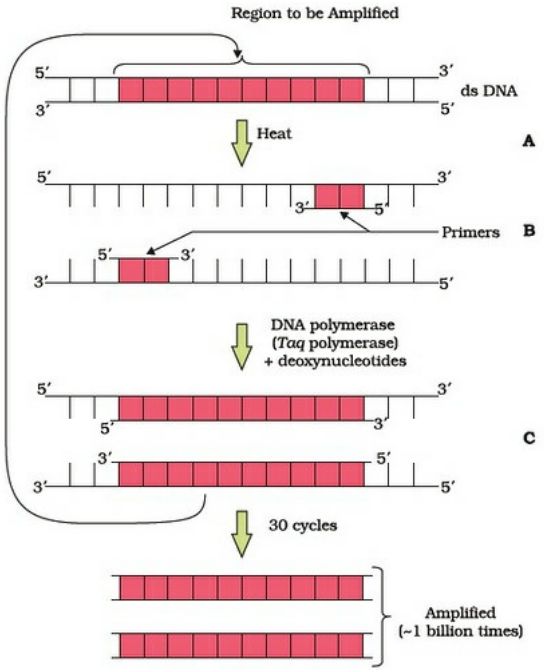
g. Extraction of the desired product.

•**Isolation of Genetic material**:Genetic material is isolated from other macromolecules by

using enzymes such as lysozyme (bacteria), cellulase (plant cells), chitinase (fungus). DNA that separate out can be removed by spooling. The RNA can be removed by treatment with ribonuclease whereas proteins can be removed by treatment with protease.

• **Cutting of DNA at specific location** is performed by using restriction enzyme and Agarose gel electrophoresis to check the progression of a restriction enzyme digestion. After cutting sources of DNA as well as vector DNA with a specific restriction enzyme to cut out '**gene of interest'** from the source DNA.

• **Amplification of Gene of Interest using PCR(Polymerase Chain Reaction)** to get multiple copies of the DNA or gene of interest in vitro by using set of primers and enzyme DNA polymerase.



Polymerase chain reaction (PCR) : Each cycle has three steps: (A) Denaturation; (B) Primer annealing; and (C) Extension of primers

This repeated amplification is done by the use of a thermostable DNA polymerase (isolated from a bacterium, *Thermus aquaticus*), which remain active during the high temperature induced denaturation of double stranded DNA.

• **Insertion of Recombinant DNA into the Host Cell/Organism** includes making the recipient cells competent to receive, take up DNA present in its surrounding etc. The recombinant DNA bearing gene for resistance to an antibiotic is transferred into E.coli cells,

the host cell become transformed into ampicillin-resistance cells.

• **Obtaining the foreign gene product** – the foreign DNA multiplies in plant or animal cell to produce desirable protein. Expression of foreign genes in host cells involve, optimized condition to obtain **recombinant protein.** The recombinant cell is multiplied in a continuous culture system in which used medium is drained out from one side while fresh medium is added from the other to maintain the cells in their physiological active phase. A bioreactor provides the optimal conditions for achieving the desired product by providing optimum growth conditions (temperature, pH, substrate, salts, vitamins, oxygen).

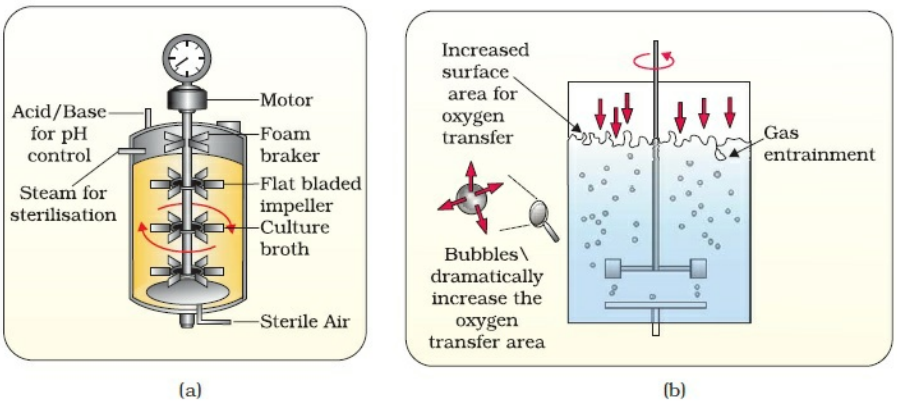


Figure 11.7 (a) Simple stirred-tank bioreactor; (b) Sparged stirred-tank bioreactor through which sterile air bubbles are sparged

• **Downstream Processing** involves processes that make the product obtain ready for marketing. This process includes separation and purification called as downstream processing. Suitable preservatives are added to it and send for clinical trial in case of drugs before releasing to market for public use.

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CHAPTER- 12
BIOTECHNOLOGY AND ITS APPLICATIONS

Biotechnology deals with industrial scale production of biopharmaceuticals and biological using genetically modified microbes, fungi, plants and animals. It application includes therapeutics, diagnostics, genetically modified crops for agriculture, processed food, bioremediation, waste treatment and energy production. The main three critical research areas of biotechnology includes –

I. Providing the best catalyst in the form of improved organism usually a microbes or pure enzyme.

II. Creating optimal conditions through engineering for a catalyst to act.

III. Downstream processing technologies to purify the protein or organic compounds.

Biotechnological Applications in Agriculture- food production can be increased by

a) Agro-chemical based agriculture

b) Organic agriculture

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. Further increase in production is not possible by using these methods. To overcome this genetically modified crop is used.
- Plants, bacteria, fungi and animals whose genes have been altered by manipulation are called **Genetically Modified Organisms (GMO).** GM plants have many applications-
- 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.

Application of Biotechnology in production of pest resistant plants-

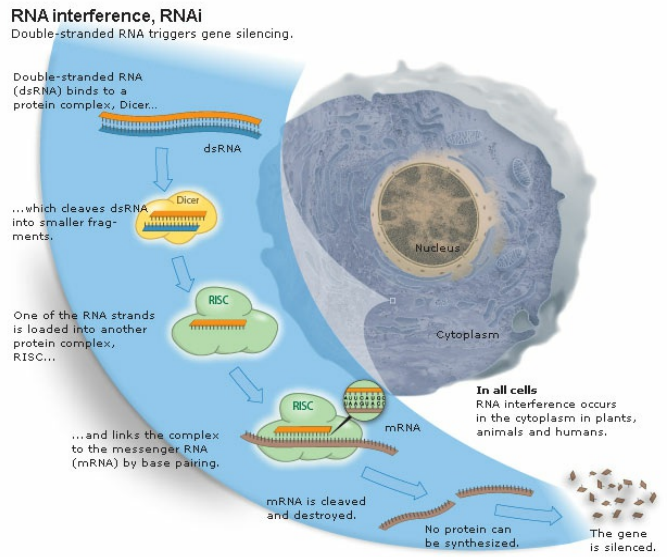
Pest resistant plants decrease the amount of pesticides used. Bt toxin is produced by a bacterium called *Bacillus thuringiensis*.Bt toxin gene has been cloned from the bacteria and been expressed in plants to provide resistance to insects without the need for insecticides; in effect created a bio-pesticide. Examples are Bt cotton, Bt corn, rice, tomato, potato and soyabean etc

Bt cotton- Bacterium *Bacillus thuringiensis* produce proteins that kill certain insects like lepidopterens, colepterans (beetels) and dipterans (flies, mosquitoes).

- *B. 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 due to alkaline pH of gut, it converted into an active form of toxin and bind to surface of midgut epithelial cells and create pores that cause cell swelling and lysis and eventually death of insect.
- The gene from B. thuringiensishas 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 crylAb and cryIIAb control the cotton bollworms, cryIAb controls corn borer.

Pest Resistant Plants

- Nematodes like *Meloidegyne incognitia* infects the roots of tobacco plants and causes reduction in yield. The infestation of these nematodes can be prevented by the process of **RNA interference (RNAi)**. RNAi is present in all eukaryotic organisms as cellular defence by silencing of specific mRNA due to complementary dsRNA molecules that bind to and prevents translation of the mRNA.



- The source of complementary dsRNA may be from an infection by viruses having RNA genomes or mobile genetic elements that replicate through RNA intermediate.
- Nematode specific genes were introduced into host plant using Agrobacterium vectors. The parasite could not survive in a transgenic host expressing specific interfering RNA.

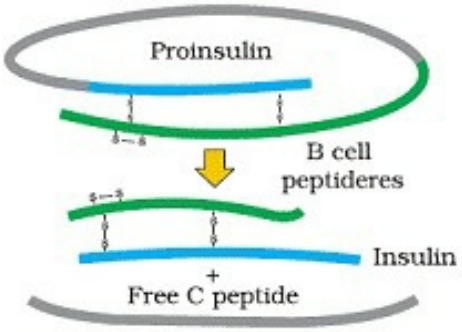
Biotechnological Applications in Medicine

The rDNA technological processes have made immense impact in the area of healthcare by enabling mass production of safe and more effective therapeutic drugs. At present, about 30 recombinant therapeutics have been approved for human use the world over. In India, 12 of these are presently being marketed.

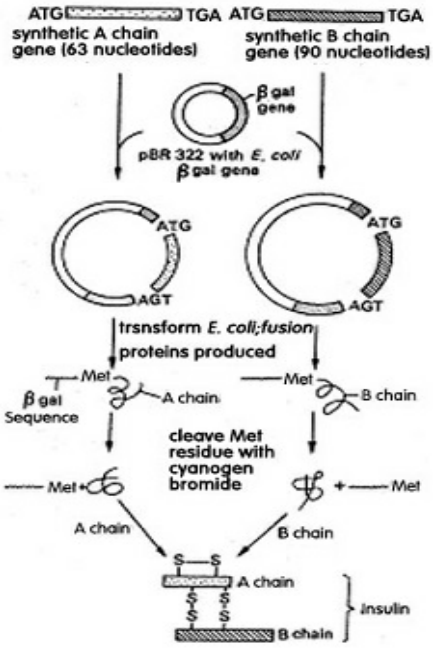
Genetically Engineered Insulin

Adult –onset diabetes can be controlled by taking insulin at regular intervals. The main source of this insulin was isolation of insulin from animals. Now a day's insulin can be obtained from bacterium 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.



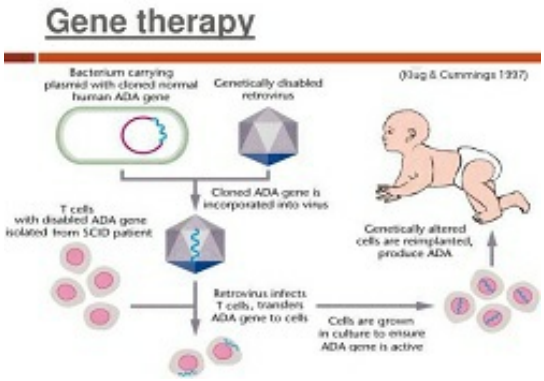
- In humans, insulin is synthesised as a prohormone, which contains an extra stretch called C peptide, which is absent in mature insulin. The main challenge for production of insulin using rDNA technique was getting insulin assembled into a mature form.
- An American company, Eli Lilly in 1983 prepared two DNA sequence corresponding to A and B chain of human insulin and introduced them in plasmids of E.coli to produce insulin chain. Chain A and Chain B were produced separately, extracted and combined by creating disulphide bonds to form human insulin.



Gene Therapy

It is a collection of methods that allows correction of a gene defect that has been diagnosed in a child or embryo. This method is applied in a person with a hereditary disease. In this method, genes are inserted into a person's cells and tissues to treat a disease.

- The correction of gene defect 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. This defect can be treated by enzyme replacement therapy in which functional ADA is given to the patient by injection or bone marrow transplant.
- In gene therapy method lymphocytes from the blood of the patient are grown in culture medium outside the body. A functional ADA cDNA is then introduced into these lymphocystes and returned to the patient. In this method periodic infusion of such genetically engineered lymphocytes is needed. If gene isolated from bone marrow cells producing ADA is introduced into cells at early embryonic stages, it could be a permanent cure.



Molecular Diagnosis

Conventional method of diagnosis such as serum or urine analysis is not able to early detection of disease causing pathogens or virus. Following methods can be used to diagnosed earlier-

I. Recombinant DNA technology

II. Polymerase Chain Reaction (PCR)

III. Enzyme Linked Immuno-sorbent Assay (ELISA).

- Symptoms of disease appear only when the concentration of pathogen get increased significantly. Low concentration of bacteria and virus can be detected by

amplification of nucleic acid by PCR. It detects the mutation in the gene in cancer patient. PCR is routinely used to detect the HIV in suspected AIDS patients. Genetic disorder can be also detected by using PCR technique.

- A single stranded DNA or RNA having radioactive molecule is allowed to hybridise to its complementary DNA in a clone of cells followed by detection using autoradiography. The clone having the mutated gene will not appear on the photographic film.
- ELISA is based on the principle of antigen-antibody interaction. Infection by pathogen can be detected by the presence of antigens like proteins, glycoproteins etc. or by detecting the antibodies synthesised against the pathogen.

Transgenic Animals

Animals that have had their DNA manipulated to possess and express a foreign gene are known as transgenic animals. Transgenic mice, rats, rabbits, pigs, sheep, cows and fish have been produced. Common reasons for development of transgenic animals-

a) **Normal physiology and development**- they are designed to allow the study of gene regulation, their effect on normal function of body. By introducing genes from other species that alter the formation of this factor and studying eh biological affects that results.

b) **Study of disease**- a number of transgenic animals are designed to increase our understanding of how genes contribute to the development of disease. Transgenic model has been developed for disease like cancer, cystic fibrosis, Alzheimer's disease etc.

c) **Biological products**- .Transgenic animals that produce useful biological products can be created by the introduction of the portion of DNA (gene) which codes for a particular product such as human protein (alpha – 1-antitrypsin) used to treat emphysema. The first transgenic cow, Rosie, produced human protein-enriched milk (alpha-lactalbumin - 2.4 gm / litre).

d) **Vaccine safety**- transgenic mice are developed for used in testing the safety of vaccine before they are used on human. Polio vaccine was tested on transgenic mice and then on monkey.

e) **Chemical safety testing**- transgenic animals are made that carry genes which make them more sensitive to toxic substances than non-transgenic animals. It gives us the results in less

time.

- **Ethical Issues:**
  The Indian Government has set up organizations such as **GEAC (Genetic Engineering Approval Committee**), which will make decisions regarding the validity of GM research and the safety of introducing GM-organisms for public services.

  Biopatent:
  A patent is the right granted by a government to an inventor to prevent others from making commercial use of his invention. Now, patents are granted for biological entities and for products derived from biological resources.

  Biopiracy:
  It is the term used to refer to the use of bio-resources by multinational companies and other organizations without proper authorization from the countries and people concerned without compensatory payment.

  In 1997, an American company got patent rights on Basmati rice through the US Patent and Trademark Office. This allowed the company to sell a 'new variety of Basmati, in the US and abroad. This 'new' variety of Basmati had actually been derived from Indian farmer's varieties. Indian Basmati was crossed with semi-dwarf varieties and claimed as an invention or a novelty.

  Several attempts have also been made to patent uses, products and processes based on Indian traditional herbal medicines, e.g., turmeric and neem.

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CHAPTER- 14
ECOSYSTEM

Ecosystem is the functional unit of nature where living organisms interact among themselves and also with the surroundings physical environment.

Ecosystem- Structure and Functions

Ecosystem : There are two basic categories of ecosystem , namely the terrestrial and the aquatic.

Terrestrial ecosystem – forest, grassland , desert etc.

Aquatic ecosystem – ponds, lake, river estuary etc.

The biotic and abiotic factors of ecosystem work in integrated manner for flow of energy within the components of ecosystem. Interaction of biotic and abiotic components results in a physical structure that is characteristic for each type of ecosystem. The vertical distribution of different species occupying different levels is called stratification.For example, trees occupy top vertical strata or layer of a forest, shrubs the second and herbs and grasses occupy the bottom layers.

The components of ecosystem that are seen as functional unit are

(i) Productivity
(ii) Decomposition
(iii) Energy flow
(iv) Nutrient cycling.

· Productivity- Primary production is defined as the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis. It is expressed in terms of weight (g –2) or energy (kcal m–2).The rate of biomass production is called productivity. It is expressed in terms of g –2 yr –1 or (kcal m–2) yr –1. It can be divided into gross primary productivity (GPP) and net primary productivity (NPP). GPP of an ecosystem is

the rate of production of organic matter during photosynthesis and NPP is the remaining biomass after respiration (R).

GPP –R = NPP

NPP is the available biomass for consumption to heterotrophs. Secondary productivity is defined as the rate of formation of new organic matter by consumers.

Decomposition- breakdown of complex organic matter into inorganic substances like carbon dioxide, water and nutrients is called decomposition. Dead plants remains like leaves, bark, flowers and dead remains of animals constitute detritus. Decomposition involves following steps- fragmentation, leaching, catabolism, humification and mineralization.

1. Fragmentation of Detritus: Detritivores feed on detritus ---breakdown --- increases the surface area of detritus particles for microbial action.
2. Leaching: Soluble inorganic nutrients dissolve in water –– percolate through the soil --- removed due to leaching action.
3. Catabolism: Decomposers (bacteria, fungi) release enzymes --- decompose detritus --- simpler inorganic compounds.
4. Humification: Simplified detritus--- converted to humus

- Humus is a Dark, Amorphous substance.
- Highly resistant to Microbial Action
- Undergoes Decomposition very Slowly.
- Reservoir of nutrients (due to colloidal nature)

5. Mineralisation: Humus is degraded – releases inorganic substances
(CO_2, H_2O etc) and nutrients (Ca^{2+}, Mg^{2+},K^{+} etc)

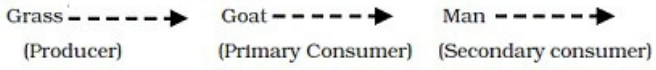
Factors affecting rate of Decomposition:

1. Chemical composition - decomposition rate will be slow when detritus is rich in lignin and chitin and rate 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.

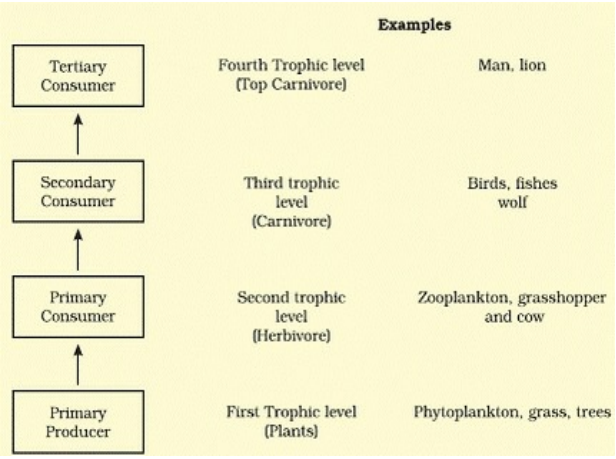
Energy Flow- All living organisms are dependent for their food on producers, directly or indirectly. There is a unidirectional flow of energy from the sun to producers and then to consumers. Photosynthetically active radiation (PAR) is responsible for synthesis of food by plants. Animals obtain their food from plants, so they are called consumers. The process of eating and being eaten is called food chain in which energy flow from producers to consumers. In Grazing food chain (GFC)-



The detritus food chain begins (DFC) begins with dead organic matter. It is made up of decomposers which are heterotrophic organisms (fungi and bacteria). These are also known as saprotrophs (sapro: to decompose). Decomposers secrete digestive enzymes that breakdown dead and waste materials into simple, inorganic materials, which are subsequently absorbed by them.Natural interconnection of food chain forms the food web.

Grazing food chain	Detritus food chain
Transfer of energy starts from producers.	Transfer of energy starts from detritus/decomposing organic matter.
Less energy flows through this.	More energy flows through this.
In aquatic ecosystem, it is the major conduit for energy transfer.	In terrestrial ecosystem, it is the major conduit for energy transfer.

Based on source of food, organism occupies a specific place in food chain that is known as trophic level.

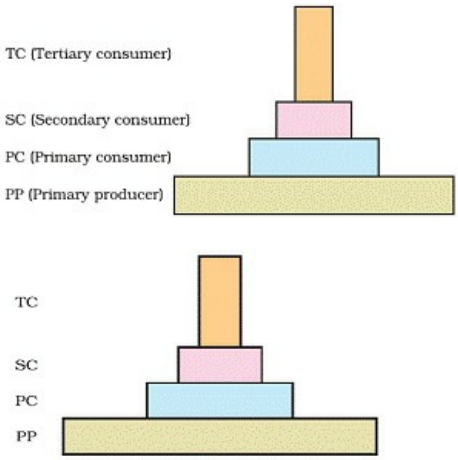


Each tropic level has a certain mass of living material at particular time called as standing crop. It is measured as biomass of living organism or number in unit area.

The number of trophic levels in the grazing food chain is limited as the transfer of energy follows 10 percent law that is only 10 percent of the energy is transferred to each trophic level from the lower trophic level. In GFC, following trophic levels are possible- producer, herbivore, primary carnivore, secondary carnivore.

Ecological Pyramids

Ecological pyramid is the graphical representation of an ecological parameter (number, biomass, energy) sequence wise in various trophic levels of a food chain with producers at the base and herbivores in the middle and carnivores at the top tiers. It can be upright, inverted, or spindle shaped.



Three common ecological pyramids are

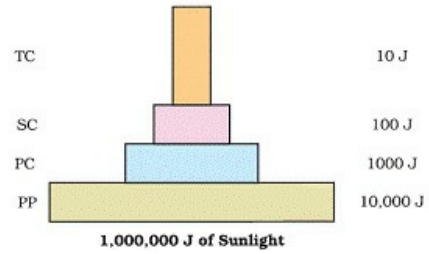
a) Pyramids of number- employs the number of individuals per unit area at various trophic levels with producer at base and various consumers at successively higher levels. It is generally upright.

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) Pyramids of biomass- represent the biomass in various trophic levels. A pyramid of mass 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 give s 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 when energy flows from a particular trophic level to the next trophic level, some energy is always lost as heat at each step e.g in feeding, digestion, assimilation and respiration.

Ecological Succession

The gradual and fairly predictable change in species composition of a given area is called ecological succession. During succession some species colonise an area and their population becomes more numerous whereas population of other species decline and even disappear.

· Orderly and sequential change that leads to a community that is near equilibrium is called climax community.

· The entire sequence of communities that successively changes in a given area is called sere and individual transitional communities are termed seral stage or seral communities.

Ecoloical Succession : Primary sucsesion, Secondary Succession

· Primary succession starts where no organism are there. For example bare rocks, cooled volcano etc. Secondary succession occurs in the area where the living organisms have lost due to certain regions like forest fire. Earthquake etc.

Succession of Plants

On the basis of nature of habitat, succession of plants can be grouped as-

o Hydrach succession takes place in wetter area and the successional series progress from hydric to the mesic conditions.

o Xerarch succession takes place in dry areas and series progress from xeric to mesic conditions.

	Hydrarch Succession	Xerarch Succession
(i)	Ecological succession that starts in water bodies and proceeds to mesic condition called hydrarch succession	Ecological succession that starts with barren rocks xeric condition and proceeds to mesic conditions, called xerarch succession.
(ii)	Phytoplankton stage → Submerged plant stage → Submerged free floating plant stage → Reed swamp stage → Marsh Meadow stage → Scrub stage → Forest (Climax community)	Bare rock → Lichen mass stage → Annual herb stage → Perennial herb stage → Scrub stage → Forest (Climax community)

· The species that invade a bare area are called pioneer species. In primary succession on rocks lichens are pioneer species that secrete acids to dissolve the rock for weathering to form soil.

· In primary succession in water, the pioneer species are the small phytoplanktons that are replaced by free floating angiosperms.

· Primary succession is slow process as soil is not available for pioneer species but secondary succession is comparatively faster due to availability of soil or other nutrients. A climax community is reached much faster in case of secondary succession.

Primary succession	Secondary succession
Initiates in area where organisms never existed, i.e. bare areas.	Initiate in areas where communities are recently destroyed.
The absence of the soil, humus and reproductive structures of organisms.	The presence of the soil, humus and reproductive structures from organisms of previous communities.
Takes a long time, i.e. several hundred to thousands of years to reach climax stage.	Takes comparatively lesstime (50-200 years) to reach climax or stable stage.

Nutrient Cycling

The movement of nutrients elements through the various components of an ecosystem is called nutrient cycling. It is also called as biogeochemical cycles. There are two types of nutrient cycles-

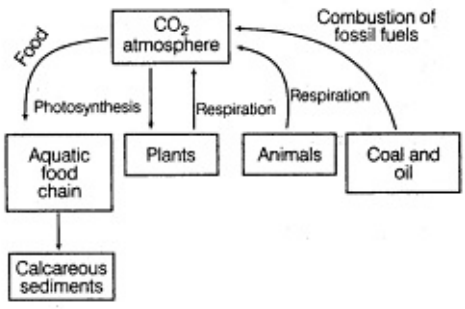
· Gaseous – exist in atmosphere.

· Sedimentary- exists in earth crust.

Environmental factors like soil, moisture, pH, temperature regulate the rate of release of nutrients into the atmosphere. The function of reservoir is to meet with the deficit which occurs due to imbalance in the rate fo influx and efflux.

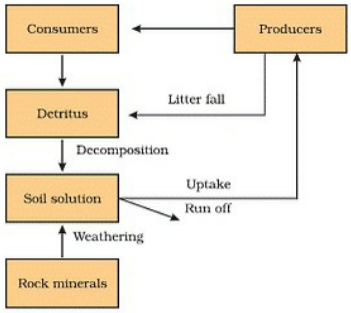
Carbon Cycle

Carbon cycling occurs through atmosphere, ocean and through living and dead organisms. Most of carbon is fixed by plants during the process of photosynthesis and returns to atmosphere in form of CO2 during respiration. Burning of wood, forest fire and combustion of organic matter, fossil fuel, and volcanic activity are other sources of releasing CO2 in the atmosphere.



Phosphorus Cycle

The natural reservoir of phosphorus is rock which contains phosphorus in the form of phosphates. On weathering, minute amount of phosphates dissolve in soil solution and absorbed by the roots of the plants. The waste products of dead organisms are decomposed by bacteria to release phosphorus. Gaseous exchange between organism and environment is negligible as compared to carbon.



Phosphorus Cycle

Ecosystem Services

The products of ecosystem processes are called ecosystem services. It includes-

· The healthy forest ecosystem purify air and water

· Mitigates floods and droughts

· Cycle nutrients

· Generate fertile soil

· Provide wildlife habitat

· Maintain biodiversity etc.

Researchers have put an average price tag of US $33 trillion a year on these fundamental ecosystems services which are taken granted because they are free although its value is twice the total global gross national product (GNP).

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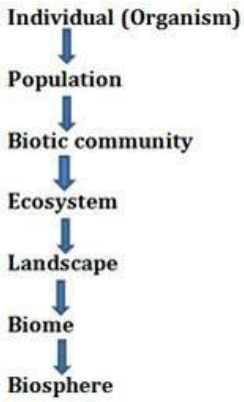
CHAPTER-13

ORGANISMS AND POPULATIONS

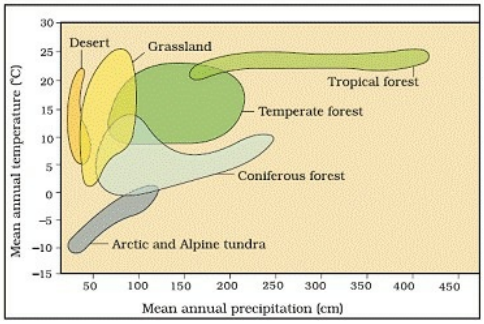
Ecology is the branch of biology that deals with the interactions among organisms and between the organism and its physical (abiotic) environment . Study of ecology is important to strike a balance between development and maintenance of natural environmental and biotic communities, use and conservation of resources, solve local , regional and global environmental problems.

- It is basically concerned with four levels of biological organisation – organisms, populations, communities and biomes.
- Ecological hierarchy or ecological level of organization connected with ecological grouping of organisms.



- Organism and its Environment
- The sum total of all biotic and abiotic factors, substances and conditions that surround and potentially influence organisms without becoming their constituent part is called environment.

  At organism level, physiological ecology tries to understand how different organisms are adapted to their environment in terms of survival and reproduction. The variation in the intensity and duration of temperature along with annual variations in precipitation results in formation of major biomes like desert, rain forest and tundra.



- Regional and local variations within each biome lead to the formation of different kinds of habitats like tropical rain forest, deciduous forest, desert, sea coast etc.
- The habitat includes biotic components like pathogens, parasites, predators and competitors of the organism with which they interact constantly.

Major Abiotic Factors

a) Temperature- is the most important ecological factor to determine the bio-mass of a place. Average temperature on land varies seasonally and decreases progressively from the equator towards the poles and from plains to mountain tops. Temperature affects the kinetics of enzymes and basal metabolism along with physiological functions of the organisms.

- The organisms that can tolerate wide range of temperature are called eurythermal ,for example cat , dogs , tigers etc.
- The organism which have the ability to tolerate only a narrow range of temperature are called stenothermal ,for example Penguin, fishes,crocodile.etc.

b) Water- life on earth is unsustainable without water. Productivity and distribution of plants is heavily dependent on water. For aquatic organisms the quality (chemical composition, pH) of water becomes important. The salt concentration (measured as salinity in parts per thousand), is less than 5 in inland waters, 30-35 in the sea and > 100 in some hypersaline lagoons

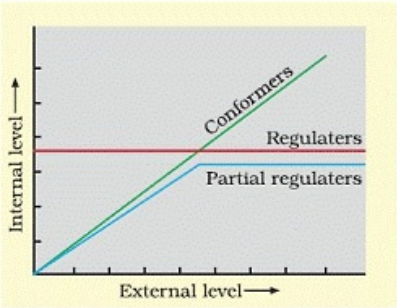
- The organisms that can tolerate wide range of salinities are called euryhaline ,for example salmon , hierring etc.
- The organism which have the ability to tolerate only a narrow range of salinities are called stenohaline, for example goldfish (freshwater) and haddock (marine

water)etc.

c) Light- plants produce food through photosynthesis in presence of sunlight. Some plants are adapted to low light conditions because they are overshadowed by tall canopied trees. Flowering in some plants occurs only in presence of critical day light called Photoperiodism. The availability of light and land is closely linked that of temperature as the sun is the source of both. UV component of sunlight is harmful to plants and animals.

d) Soil- Types of soil depends upon climate, weathering process, whether soil is transported or sedimentary and how soil development occurred. Soil composition, grain size and aggregation determine the percolation and water holding capacity of the soils along with pH, mineral, composition and topography determine the vegetation in any area.

Responses to Abiotic Factor : In the course of evolution, many species have evolved constant internal environment to permits all biochemical reactions and physiological functions to work with maximum efficiency to have over all fitness of species. Organisms try to maintain the constancy of its internal environment (homeostasis)inspite of varying external environment. There are various ways to establish hemostasis-



- Regulate- all birds and animals are capable of maintaining homeostasis by physiological means which ensures constant body temperature, constant osmotic concentration etc. Thermoregulation and osmoregulation is the source of success of mammals in all the environmental conditions. In summer, when outside temperature is more than our body temperature, we sweat oftenly, resulting evaporative cooling,

which brings down the body temperature. In winter we start to shiver, a kind of exercise which produces heat and raises the body temperature.

- Conform- most of animals and plants, their body temperature change with ambient temperature. In aquatic animals osmotic concentration of the body fluid change with that of the ambient water osmotic concentration. These animals are called conformer. Conformer are not able to bear the energetic expenses to maintain the constant body temperature.

  Heat loss or heat gain is a function of surface area. Since small animals have a larger surface area relative to their volume, they tend to lose body heat very fast when it is cold outside; then they have to expend much energy to generate body heat through metabolism. This is the main reason why very small animals are rarely found in polar regions.
- Migrate- the organism move away for time being from the stressful unfavorable habitat to more suitable habitat and return back when stressful period is over. Many birds undertake long-distance to migrate to more hospitable areas. Siberia birds migrate to Keolado National park, Bharatpur, India.
- Suspend- in microorganisms like bacteria, fungi and lower plants a thick walled spores is formed which help them to survive unfavorable conditions. These spores germinate on return of suitable conditions. In higher plants, seeds and some other vegetative reproductive structures serves the means to tide over periods of stress and help them in dispersal also. The metabolic activities are reduced to minimum during this dormant period.

  a)Hibernation - the condition or period of an animal or plant spending the winter in a dormant state e.g bear
  b)Aestivation - the condition or period of an animal or plant spending the summer to avoid heat and dessication in a dormant state e.g snails .
  c)Diapause - a stage of suspended development in zooplankton species in lakes and ponds.

Adaptation is the attribute of organism morphological, physiological and behavioral changes that enables the organism to survive and reproduce in its habitat.

- Kangaroo rat in North American deserts fulfill the water requirement by internal oxidation of fat in absence of water.It also has the ability to concentrate its urine so that minimal volume of water is used to remove excretory products.
- Thick cuticle in many plants also prevents loss of water. CAM plants open their stomata during night to reduce the loss of water during photosynthesis.

- 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.
- Altitude sickness is observed at higher altitude that includes symptoms like nausea, fatigue, heart palpitations due to less oxygen and atmospheric pressure. The person gradually get acclimatized and stop experiencing altitude sickness. This is type of physiological adaptation.
- A number of marine invertebrate and fish live in temperature always less than zero and some lives in greatdepth in ocean where pressure is very high by array of biochemical adaptations.
- Some organisms like desert lizard lack the physiological ability that mammals have but deal with high temperature of their habitat by behavioral means. They bask in the sun and absorb heat and when their body temperature drops below the comfort zone, but moves in shade when the ambient temperature starts increasing.

Populations : Individuals of any species live in groups in well-defined geographical area, share or compete for similar resources, potentially interbreed and constitute a population.

Population Attributes : A population has certain attributes that an individual organism does not such as an individual may have births and deaths, but a population has birth rates and death rates.

- The birth and death rates are referred as per capita births or deaths respectively, which is increase and decrease with respect to members of the population.
- Sex ratio is another attributes of population. An individual may be male or female but population has sex ratio.

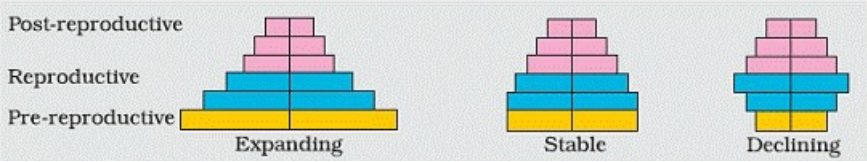
- A population at given time composed of different individual of different ages. If the

age distribution is plotted for the population, the resulting structure is called age pyramids. The shape of pyramids reflects the shape of growth status of population. Which may be

(i) Expending

(ii) Stable

(iii) Declining



§ Population size or population density (N) is measured in terms of number but it may sometime not appropriate.

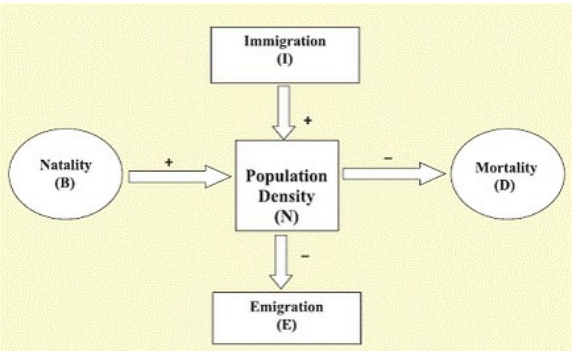
Population Growth : The size of population is not static. It keeps changing with time, depending upon food availability, predation pressure and reduces weather. The main factors that determine the population growth are-

o Natality (number of birth during a given period in the population)

o Mortality (number of death during a given period in the population)

o Immigration (individual of same species that have come into the habitat)

o Emigration (individual of population that have left the habitat)



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

Nt + 1 Nt + [(B + I) – (D + E)]

Population density will increase if the number of births plus the number of immigrants (B +

I) is more than the number of deaths plus the number of emigrants (D + E), otherwise it will decrease.

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 models-

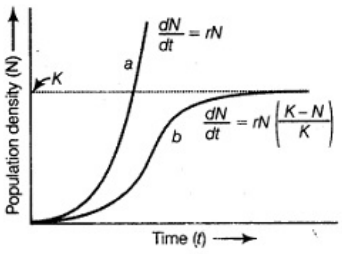
i. Exponential Growth- in this kinds of growth occurs when food and space is available in sufficient amount. When resources in the habitat are unlimited, each species has the ability to realise fully its innate potential to grow in number .The population grows in an exponential or geometric fashion. 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'.



Population growth curve

ii. Logistic Growth- there is a competition between the individuals of a population for food and space. The fittest organism survives and reproduces. In this types of growth initially shows a leg phase followed by phases of acceleration and de-acceleration.

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

Where N = Population density at time t

R = Intrinsic rate of natural increase

K = Carrying capacity

Since resources for growth for populations are finite and become limiting , the logistic growth model is considered a more realistic one.

Population interaction

All animals, plants and microbes in a biological community interact with each other. These interactions may be beneficial, detrimental or neutral to one of species or both. Following types of interaction is seen-

a. Predation

b. Competition

c. Parasitism

d. Commensalism

e. Mutualism

Species A	Species B	Name of Interaction
+	+	*Mutualism*
–	–	*Competition*
+	–	*Predation*
+	–	*Parasitism*
+	0	*Commensalism*
–	0	*Amensalism*

PREDATION : It is an Interspecific Interaction where one animal kills and consumes the other weaker animal.

Roles of Predators

- Transfer energy from plants to higher trophic levels (position of organism in food chain)
- Control Prey population – Prickly pear cactus- moth
- Biological control of Agricultural pest
- Maintain species diversity by reducing intensity of competition among competing prey species

- Over exploitation of prey by the predators results in extinction of prey and predator.
- Defense to lessen impact of predation
  a)Insects and frog – camouflage
  b)Monarch butterfly – poisonous

PLANTS MORPHOLOGICAL AND CHEMICAL DEFENCES

- Thorns- cactus and Acacia
- Produce and store chemical – Calotropis
- Nicotine, Caffeine, Quinin, Strychnine, opium – against grazers & browsers

COMPETITION

Interaction either among individuals of same species or between individuals of different species.

Occurs among closely related species but not always true

1. Unrelated species also compete- flamingo & fish compete for zooplankton
2. Feeding efficiency of a species reduce due to other species even if resources are plenty – Abingdon tortoise.

Evidence for competition

Competitive release – species distribution restricted to small areas due to competitively superior species.

GAUSE'S COMPETITION EXCLUSION PRINCIPLE

"Two closely related species competing for same resources cannot coexist as the competitively inferior one will be eliminated."

Resource partition- Two competing species avoid competition by diff. feeding and foraging patterns-Mc Arthur (warblers foraging activities)

PARASITISM

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

- Parasites and host self-evolve.
- Adaptations of parasites

  - Loss of unnecessary sense organs
  - Hooks and sucker
  - Loss of digestive system
  - High Reproductive capacity

- Parasites-

(i) Reduce the survival of host
(ii) Growth and reproductive rate are reduced
(iii) Render the host vulnerable to its predators by making them weak

Types of parasite

ECTOPARASITES-depend on external surface of host
Example - head lice on humans, ticks on dogs

ENDOPARASITES-take shelter within the body of the host organism
Example - Liverfluke, Plasmodium

MUTUALISM
It is interaction in which both the interacting species are benefited
Examples
1. Lichen – fungi and algae
2. Mycorrhizae - fungi and roots of higher plants
3. Pollination of plants by insects
4. Mediterranean orchid- sexual deceit for pollination- appears as female bee

AMENSALISM: Interaction between two different species, in which one species is harmed and the other species is neither harmed nor benefited. Example. Bacterial culture, after few days fungus growth will be there on it like Pencillium, and its secretions of chemical will kill bacteria, but no benefits to fungi.

CBSE Class 12 Biology

Revision Notes

CHAPTER- 15

BIODIVERSITY AND CONSERVATION

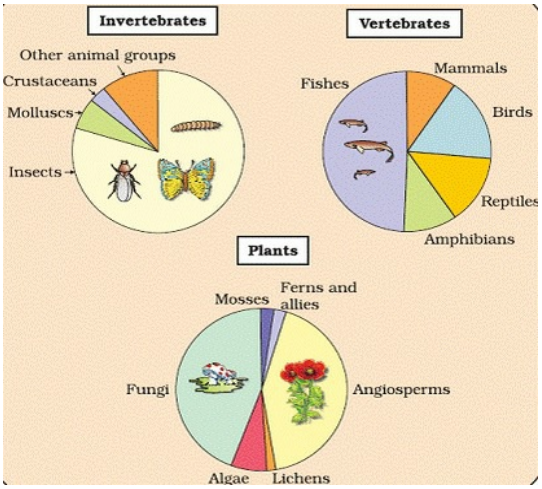
Biodiversity or biological diversity is the occurrence of different types of ecosystems, different species of organisms and their variant like biotypes, ecotypes and gene adapted to different climates and environments of different regions including their interactions and processes.This term was coined by Edward Wilson.The vast array of species of micro-organisms, algae, fungi, plants and animals occurring on the earth either in the terrestrial or aquatic habitats and the ecological complexes of which they are a part comprises biodiversity . Diversity ranges from macromolecules to biomes.

The important diversity at the levels of biological organization are-

I. Genetic Diversity- a single species might show high diversity at the genetic level over its distributional range. *Rauwolfia vomitoria* shows genetic variation in terms of concentration and potency of chemical reserpine India has more than 50,000 genetically different strains of rice and 1000 varieties of mango.

II. Species Diversity- diversity at species level for example, the Western Ghats have more amphibian species diversity than the Eastern Ghats.

III. Ecological Diversity- deserts, rain forests, mangroves, coral reefs, wetlands, estuaries and alpine meadows are types of ecological diversity.



Biodiversity and its conservation are vital environmental issues of international concern as more and more people around the world begin to realize the critical importance of biodiversity for survival and well-being on this planet.

· According to the IUCN, the total number of plant and animal species described so far is about 1.5 million but still many species are yet to discovered and described.

· More than 70% of all the species recorded are animals while rest are plants including algae, fungi, bryophytes, gymnosperms and angiosperms. Among animals, 70% of total are insects.

· The number of fungi species in the world is more than the combined total of the species of fishes, amphibians, reptiles and mammals.

BIODIVERSITY IN INDIA

• India is one of the twelve mega biodiversity countries of the world.
• India has only 2.4% of the land area of the world, it has 8.1% of the global species biodiversity.
• There are about 45,000 species of plants and about 90,000-1,00,000 species of animals.
• New species are yet to be discovered and named.
• Applying Robert May's global estimate, only 22% of the total species have been recorded, India has probably more than 1,00,000 species of plants and 3,00,000 species of animals to be discovered and described

Patterns of Biodiversity

a) Latitudinal gradients- the diversity of plants and animals is not uniform throughout the world and shows uneven distribution. This distribution pattern is along the latitudinal gradient in diversity. Species diversity decreases as we move away from the equator towards the poles. Tropics harbor more species than temperate or polar areas.Amazonian Rainforest has the greatest biodiversity on earth. It has more than 40000 species of plants, 1,25,000 species of insects, 300 species of fish, 427 of amphibian and 378 of reptiles, 1300 species of birds and 427 of mammals. Various hypothesis has been proposed regarding this such as-

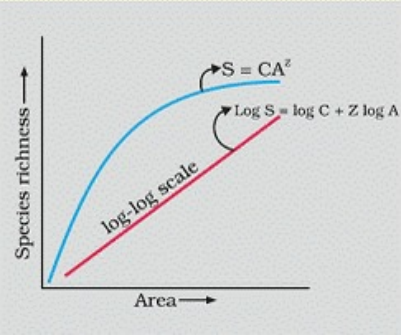
a) Speciation is a function of time unlike temperate regions subjected to frequent glaciation in past, tropical latitudes have remained relatively undisturbed for millions of years and thus had long evolutionary time for species diversification.

b) Tropical environments unlike temperate ones are less seasonal and more constant and predictable which promote niche specialization and lead to a greater species diversity.

c)There is more solar energy available in the tropics which contribute to higher productivity this in turn contribute indirectly to greater diversity.

b) Species-Area relationships

• Alexander Von Humboldt has observed that within a region, species richness gets increased when explored area is increased, but only up to a limit.
• The relationship between species richness and area for a number of taxa like angiospermic plants, fresh water fishes and birds is found to be a rectangular hyperbola.



On logarithmic scale, the relationship is a straight line described by the equation-

log S = log C + Z log A.

Where, S= species, A= Area, Z= slope of the line, C =Y- intercept.

- Ecologists have discovered that the value of Z lies in range of 0.1 to 0.2 regardless of taxonomic group of the region.
- In very large area like continents, Z value ranges between 0.6 & 1.2.

The importance of Species Diversity to the Ecosystem
The communities with more species are generally more stable than those with less species. A stable community should not be show too much variation in productivity from year to year.

Rich biodiversity is essential for ecosystem health and imperative for the very survival of human race on this planet.

Rivet popper hypothesis - given by Paul Ehrlich. In an airplane (ecosystem) all parts are

joined together using thousands of rivets (species). If every passenger travelling in it starts popping a rivet to take home (causing a species to become extinct), it may not affect flight safety (proper functioning of the ecosystem) initially, but as more and more rivets are removed, the plane becomes dangerously weak over a period of time. Furthermore, which rivet is removed may also be critical. Loss of rivets on the wings (key species that drive major ecosystem functions) is obviously a more serious threat to flight safety than loss of a few rivets on the seats or windows inside the plane

Loss of Biodiversity

The biological wealth of our planets have been declining rapidly due to three factors - Population, Urbanisation and Industrialisation.The IUCN Red List (2004) documents the extinction of 784 species (including 338 vertebrates, 359 invertebrates and 87 plants) in the last 500 years. Some examples of recent extinctions include the dodo (Mauritius), quagga (Africa), thylacine (Australia), Steller's Sea Cow (Russia) and three subspecies (Bali, Javan, Caspian) of tiger. In last 20 years, 27 species have been disappeared. In general, loss of biodiversity in a region may lead to

a. Decline in plant production

b. Lowered resistance to environmental perturbations, drought, and flood.

c. Increased variability in ecosystem processes such as productivity, water use, and pest and disease cycles.

Causes of biodiversity losses

Faster rates of species extinctions are largely due to human activities. The four major causes are called **'The Evil Quartet'.**

1) **Habitat loss and fragmentation**- is the most important cause of animals and plants extinction. The amazon rain forest (lungs of the planet) having millions of species is being cut and cleared for cultivating soya beans or for conversion to grasslands. When large habitats are broken up into small fragments due to various human activities, mammals are birds requiring large territories migrate and badly affected.

2) **Over-exploitation**- When biological system is over exploited by man for the natural

resources ,it results in degradation and extinction of the resources , *e.g Steller's sea cow, passenger pigeon etc.* Many marine fish population are over harvested, endangering the continued existence of some important species.

3) **Alien species invasions**- when alien species enters intentionally or unintentionally, some of them turn invasive and cause decline or extinction of indigenous species.The Nile perch introduced into Lake Victoria in east Africa led eventually to the extinction of an ecologically unique assemblage of more than 200 species of cichlid fish in the lake. Invasive weeds species like carrot grass (parthenium), Lantana and water hyacinth causing threats to indigenous species.

4) **Co-extinctions**- when a species becomes extinct, the plant and animal species associated with it also become extinct. When a host fish species becomes extinct, its unique assemblage of parasites also becomes extinct.

Biodiversity Conservation

We should conserve the biodiversity due to following groups of regions-

I. The **narrowly utilitarian**- human obtain countless direct economic benefits from nature like food, firewood, fibres, construction material, medicinal plants and industrial products. With increasing resources put into 'bio-prospecting' nations endowed with rich biodiversity can expect to reap enormous benefits.

II. The **Broadly Utilitarian**- biodiversity plays a major role in ecosystem services that nature provides. Productions of Oxygen during photosynthesis, pollination without natural pollinator, pleasure from nature are priceless.

III. **Ethical**- for conserving biodiversity relates to what we own to millions of plants, animals and microbes species with whom we share this planet. Every species has an intrinsic value although it may not be of current or any economic value to us. It is our moral duty to care for their well-being and pass on our biological legacy in good order to future generations.

How do we conserve Biodiversity?

When whole ecosystem is conserved, all its biodiversity is also protected. There are two ways of conservation of biodiversity-

In situ (on site) conservation- conservationists have identified for maximum protection certain 'biodiversity hotspots' regions with very high levels of species richness and high degree of endemism, species found in that region and not found anywhere else. There are 34 biodiversity hot spots in the world. These hotspots are also regions of accelerated habitat loss. India has 14 biosphere reserves, 90 national parks and 448 wildlife sanctuaries.

Ex situ (off site) conservation- in this method, threatened animals and plants are taken out from their natural habitat and placed in special setting when they be protected and given special care . Zoological parks, Botanical Gardens and wildlife safari parks are used for this purpose. Now gemetes of threatened species can be preserved in viable and fertile condition for long periods of time using cryopreservation technique. Eggs can be fertilized in vitro and plants can be propagated using tissue culture methods.

In situ conservation	*Ex situ* conservation
This method involves protection of endangered species in their natural habitat.	It involves placing of threatened animals and plants in special care unit for their protection.
It helps in recovering populations in the surroundings where they have developed their distinct features.	It helps in recovering populations or preventing their extinction under stimulated conditions that closely resemble their natural habitats.
e.g. national parks, biosphere reserves, wildlife sanctuaries, etc.	e.g. botanical garden, zoological parks.

The historic convention on Biological Diversity (The Earth Summit) held in Rio de Janeiro in 1992,called upon all nations to take appropriate measures for conservation of biodiversity and the World Summit on sustainable development held in 2002 in Johannesburg, South Africa, 190 countries pledged their commitment to achieve by 2010, a significant reduction in the current rate of biodiversity loss at global, regional and local levels.

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CHAPTER- 16
ENVIROMENTAL ISSUES

With increase in human population, demands for food, shelter, water, electricity, roads, and automobiles are increasing rapidly and exerting pressure on environment and altering the natural health of ecosystem. All across the world, people are facing a wealth of new and challenging environmental problems every day. Some of them are- pollution, greenhouse effect, ozone depletion, deforestation etc.

Pollution is undesirable change in physical, chemical or biological properties of air, land, water or soil. The agents which cause undesirable change are called **pollutants.**

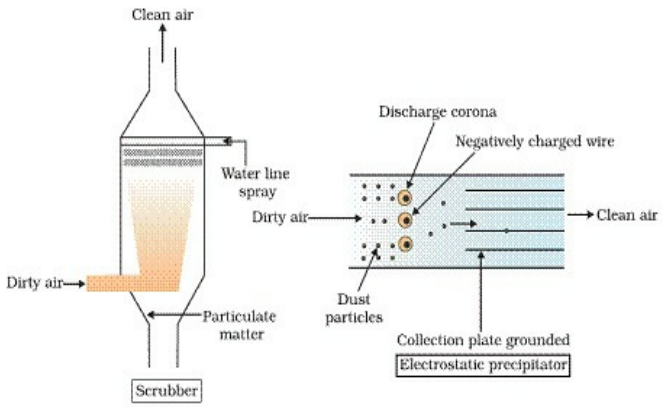
Air Pollution and its Control

Air is essential for respiration in all living organisms. Pollutants reduce growth and production of crops as well as premature death of plants. The harmful effect of pollution on all the living organisms depends upon-

- Concentration of pollutants.
- Duration of exposure.
- Organisms involved.

Thermal power plants, smelters and other industries release particulate and gaseous air pollutants along with harmless gases such as nitrogen, oxygen etc. These pollutants should be filtered out before releasing the harmless gases into the atmosphere. There are many methods of removing particulate matter; the most widely used is the **electrostatic precipitator**.

Electrostatic Precipitator- can remove over 99% of particulate matter present in the exhaust from thermal power plant.



It has electrode wires that are maintained at several thousand volts to produce a corona that releases electrons. These electrons attach to dust particles giving them a net negative charge. The collecting plates are grounded and attract the charged dust particles to that clean air can pass through electrostatic precipitator.

A scrubber can remove gases like sulpher dioxide. The exhaust is passed through spray of water or lime.

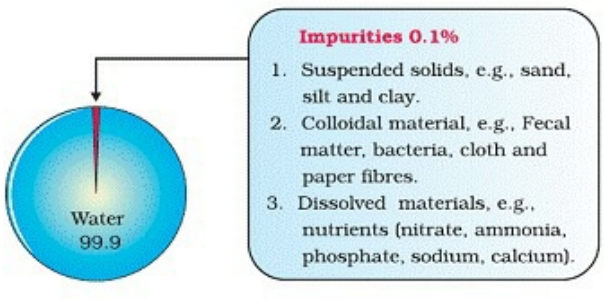
- According to CPCB (Central Pollution Control Board) particulate size less 2.5 micrometers or less in diameter (PM 2.5)cause greatest harm to human health.
- The fine particles can be inhaled deep into the lungs and can cause breathing and respiratory symptoms, irritation, inflammations and damage to lungs and premature death.
- Automobiles are main cause of atmospheric pollution in metro cities. Proper maintenance of automobiles along with use of lead-free petrol or diesel can reduce the pollutants they emit.
- Catalytic converters contain platinum-palladium and rhodium as the catalyst, are fitted into automobiles for reducing emission of poisonous gases. As the exhaust passes through the catalytic converter, unburnt hydrocarbons are converted into carbon dioxide and waterand carbon monoxide and nitric oxide are changed to carbon dioxide and nitrogen gas . The vehicles fitted with catalytic converter should use unleaded petrol because lead in the petrol inactivates the catalyst.
- In Delhi, entire fleet of public transport was converted to **compressed natural gas (CNG)** mode to reduce the fast increasing pollution level of metro. CNG is better than diesel because it is cheaper than petrol and diesel, burn completely with leaving any residue and cannot be adulterated like petrol and diesel. But the main problem with

switching over to CNG is the difficulty of laying down pipelines to deliver CNG through distribution points/pumps and ensuring uninterrupted supply.

- **Auto Fuel Policy** : The Government of India has laid out a road map to cut down the vehicular air pollution in many cities of India. The goal of this policy is to reduce Sulphur to 50 ppm in petrol and diesel and reduce levels of aromatic hydrocarbons to 35% of the fuel. The Bharat Stage II will be applicable to all automobiles in all cities April, 1, 2005. The cities (like Delhi, Mumbai, Chennai, Kolkata etc.) will have to meet Euro III emission norms from April 1, 2005 and Euro IV Emission norms from April 1, 2010
- In India, **the Air (Prevention and Control of Pollution) Act** came into force in 1981 and was amended in 1987 to include noise as an air pollutant.**Noise is undesired high level of sound**. High sound level greater than 150 dB or more generated by takeoff or a jet plane or rocket may damage ear drums thus permanently impairing hearing ability.
- Noise also causes sleeplessness, increased heart beating, altered breathing pattern, thus considerably stressing humans.
- Reduction of noise in industries can be affected by use of sound absorbent materials or by muffling noise.

Water Pollution and it Control

Water bodies are lifeline of human beings as well as other animals. Due to disposal of all kinds of waste and other anthropogenic actions the ponds, lakes ,stream, river, estuaries and oceans are becoming polluted in several parts of world. The Government of India has passed the **Water (Prevention and Control of Pollution) Act, 1974** to protect the water resources.



Domestic Sewage and Industrial Effluents-

The sewage that comes out from house and office makes the domestic sewage. A mere 0.1%

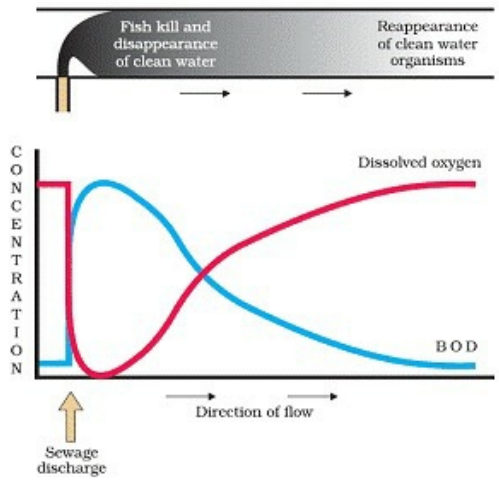
impurities make domestic sewage unfit for human use. Solid wastes are relatively easy to remove but dissolved salts as nitrates, phosphates and other nutrients and toxic metal ions and organic compounds present in domestic wastes are comparatively difficult to remove.

Domestic sewage mainly contains biodegradable organic matter, which can be easily decomposed by microbes like bacteria and fungi. They use organic wastes as nutrients.

Biological Oxygen Demand (BOD)

The microbes that decompose organic wastes in water bodies consume a lot of oxygen that result into sharp decline in dissolved oxygen downstream from the point of sewage discharge. This causes mortality of fish and other aquatic creatures.

BOD refer to the amount of oxygen that would be consumed if all the organic matter is one litre of water were oxidized by bacteria. The BOD test measures the rate of uptake of oxygen by micro-organisms in a sample of water. Indirectly BOD is a measure of the organic matter present in the water. The greater the BOD of waste water, more is its polluting potential.



Algal Bloom

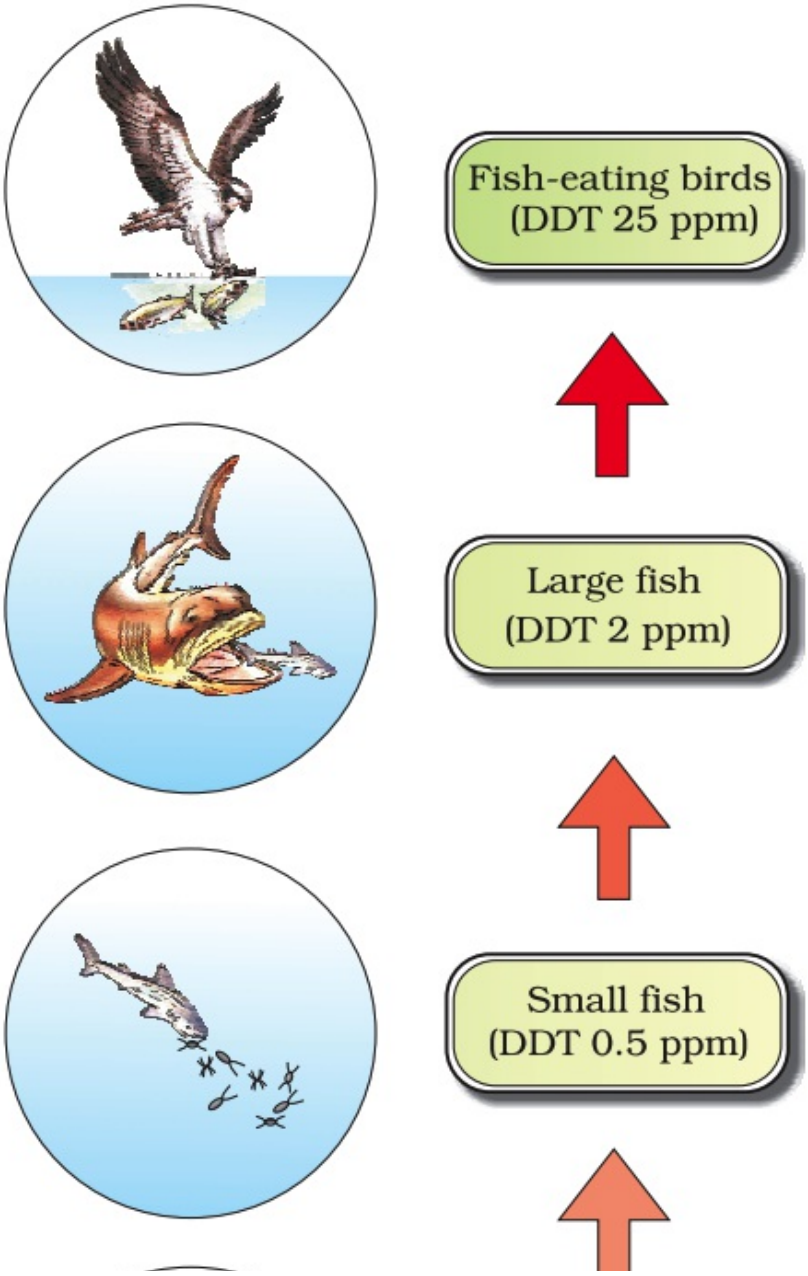
Presence of large amount of organic nutrients in water causes excessive growth of planktonic or free floating algae called algal bloom. Due to this colour of water bodies get changed. This may cause deterioration of the water quality and fish mortality.

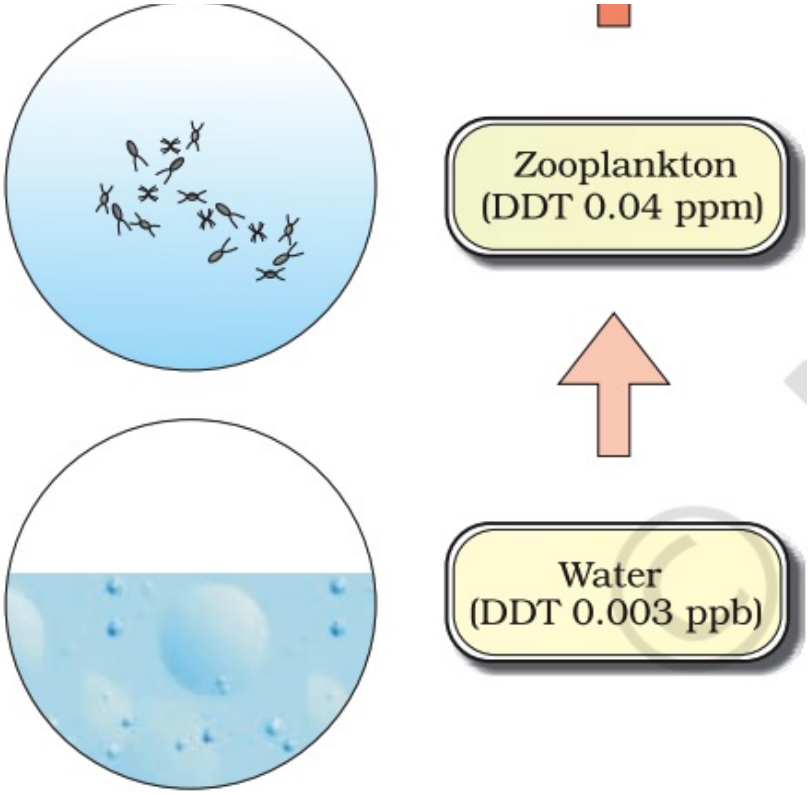
Water hyacinth (*Eichhornia crassipes*) is the world's most problematic aquatic weed. They are introduced into India for their beautiful flowers that have caused havoc by their excessive growth by causing blocks in our water bodies. This weed is commonly known

as **'Terror of Bengal'.**

Biomagnification or Biological Magnification

Toxic wastes present in industrial wastes and water from farmhouse containing pesticides and weedicides enters 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 eggshell and their premature breaking, eventually causing decline in bird populations.





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 shall lowing of lake. Over the centuries the silt and organic debris piles up at the bottom of lake and encourage the growth of marsh 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.** Main contaminants include nitrates, phosphates that act as plant nutrients.They increase the growth of algae, causing unsightly scum and unpleasant odors, and depleting the dissolved oxygen of water which is important for other aquatic life.

Integrated Waste Water Treatment

Wastewater including sewage can be treated in an integrated way, by combining artificial and natural processes. An example of such an initiative is the town of Arcata, situated along the northern coast of California .The native people in collabaration with Humboldt State

University created an integrated waste water treatment process within a natural system. The cleaning occurs in two stages –

(a) the conventional sedimentation, filtering and chlorine treatments are given.

(b) To combat with pollutants like dissolved heavy metals , the biologists developed a series of six connected marshes over 60 hectares of marshland where plants, algae, fungi and bacteria were seeded which neutralise, absorb and assimilate the pollutants.

As the water flows through the marshes, it gets purified naturally. The marshes also constitute a sanctuary, which is highly diverse in the form of fishes, animals and birds that now reside there.

A citizens group called **Friends of the Arcata Marsh (FOAM)** are responsible for the safety of this project.

Ecological sanitation is a sustainable system for managing human excreta, using dry composting toilets. This is a practical, hygienic, efficient and cost-effective solution to human waste disposal. The important part is that with this composting method, human excreta can be recycled into natural fertiliser. There are working **'EcoSan'** toilets in many areas of Kerala and Sri Lanka

Solid Wastes

Municipal solid wastes are wastes from home, offices, stores, schools, hospitals etc. that are collected and disposed by the municipality. It consists of paper, food wastes, plastics, glass, metals, rubber, leather, textile etc.Burning reduces the volume of the wastes but the waste generally not burnt to irts completion and open dumps often serve as the breeding ground for rodents and flies. **Sanitary landfills** were used as substitute for open burning dumps where wastes are dumped in a depression or trench after compaction and covered with dirt every day. There is a danger of seepage of chemicals from these landfills polluting the underground water resources.

Municipal wastes : Bio-degradable wastes, Recyclable wastes, Non-biodegradable waste

- The biodegradable materials can be put into deep pits in the ground and be left for natural breakdown.

- Kabadiwallahs and rag-pickers do a great job of separation of materials for recycling of different kinds of wastes.
- **Polyblend -** Polyblend is the best way to combat with ever-increasing problem of accumulating plastic waste .It is a fine powder of recycled modified plastic which is mixed with the bitumen .Polyblend and bitumen, when used to lay roads, enhanced the bitumen's water repellant properties, and helped to increase road life by a factor of three.
- Hospitals generate hazardous wastes that contain disinfectants and other chemicals and alos pathogenic micro-organisms. Such wastes need careful treatment and disposal. Incinators are used for disposal of hospital wastes.

Electronic wastes- Unrepairable computers and other electronic goods are known as electronic wastes (e-wastes). E-wastes are buried in landfills or incinerated. Over half of the e-wastes generated in the developed world are exported to developing countries, mainly to China, India and Pakistan, where metals like copper, iron, silicon, nickel and gold are recovered during recycling process. Recycling is the only solution for the treatment of e-wastes provided it is carried out in an environment-friendly manner

Agro-chemicals and other effects

Use of inorganic fertilizers and pesticides has been increased many fold due to green revolution for enhancing crop production. The pesticides and insecticides are toxic to non-target organisms that are important components of the soil ecosystem. They are biomagnified in the terrestrial ecosystem and also causes eutrophication in aquatic ecosystems .

Organic Farming

Integrated organic farming is a cyclic, zero-waste procedure in which waste products from one process are cycled in as nutrients for other processes to allow the maximum utilization of resource and increase the efficiency of production. It includes bee-keeping, dairy management, water harvesting, composting and agriculture in a chain of processes which support each other and allow an extremely economical and sustainable venture. No chemical fertilizer is used in this process.

Radioactive Wastes

Nuclear energy has two very serious problems-

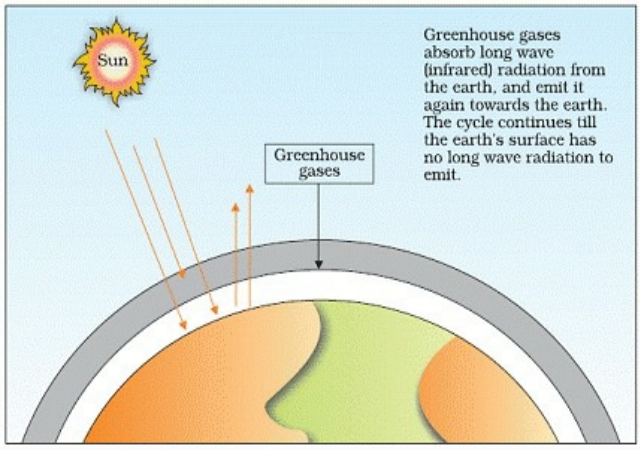
- Accidental leakage
- Safe disposal of radioactive wastes

The radiation released from nuclear wastes is extremely damaging to biological organisms as it causes mutations to occur at very high rate. It has been recommended that storage of nuclear wastes after sufficient pre-treatment should be done in suitably shielded containers and buried within the rock about 500m deep below the earth surface.

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 due to increase in concentration of carbon dioxide and methane gas. Clouds and gases reflect about one-fourth of the incoming solar radiation and absorb some of it but 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 but part of this does not reflected back due to greenhouse gases that leads to heating of earth atmosphere. Global warming is caused due to greenhouse effect.

Scientists believe that this rise in temperature is leading to harmful changes in the environment and resulting in odd climatic changes (e.g. El Nino effect) , thus leading to increased melting of polar ice caps.



Global warming can be controlled by

- Cutting down use of fossil fuel
- Improving efficiency of energy usage

- Reducing deforestation
- Planting tree
- Slowing down the growth of human population.

Ozone Depletion in the Stratosphere

Ozone found in the upper part of the atmosphere called stratosphere acts as a shield absorbing ultraviolet radiation form the sun. UV rays are highly injurious to living organisms.

The thickness of the ozone-layer in a column of air from the ground to the top of the atmosphere is measured in tems of **Dobson units (DU)**. 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.

Chlorofluro Carbons deplete the ozone layer. The part of atmosphere with lesser concentration of ozone is called ozone hole.

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.

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** where 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** for 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.