Royal Rajasthan Public School

तेजस्विनावधितमस्तु

ABU ROAD

Study Material

Biology

Class:-12th **Session:-2024-25**

UNIT WISE WEIGHTAGE

Unit NO	UNIT	MARKS
VI	Reproduction	16
VII	Genetics and Evolution	20
VIII	Biology and Human welfare	12
IX	Biotechnology and its application	12
X	Ecology and environment	10
	Total	70
	Practical	30
	Grand Total	100

Question Paper Design (Theory) 2024-25 Class XII

COMPETENCIES	TOTAL
Demonstrate Knowledge and Understanding	50%
Application of Knowledge/Concepts	30%
Formulate, Analyze, Evaluate and Create	20%

CLASS XII – BIOLOGY

CBSE CURRICULUM

Unit-VI Reproduction

Chapter-1: Sexual Reproduction in Flowering Plants Flower structure; development of male and female gametophytes; pollination - types, agencies and examples; out breeding devices; pollen-pistil interaction; double fertilization; post fertilization events - development of endosperm and embryo, development of seed and formation of fruit; special modes- apomixis, parthenocarpy, polyembryony; Significance of seed dispersal and fruit formation.

Chapter-2: Human Reproduction Male and female reproductive systems; microscopic anatomy of testis and ovary; gametogenesis -spermatogenesis and oogenesis; menstrual cycle; fertilisation, embryo development upto blastocyst formation, implantation; pregnancy and placenta formation (elementary idea); parturition (elementary idea); lactation (elementary idea).

Chapter-3: Reproductive Health Need for reproductive health and prevention of Sexually Transmitted Diseases (STDs); birth control - need and methods, contraception and medical termination of pregnancy (MTP); amniocentesis; infertility and assisted reproductive technologies - IVF, ZIFT, GIFT (elementary idea for general awareness).

Unit-VII Genetics and Evolution

Chapter-4: Principles of Inheritance and Variation Heredity and variation: Mendelian inheritance; deviations from Mendelism – incomplete dominance, co-dominance, multiple alleles and inheritance of blood groups, pleiotropy; elementary idea of polygenic inheritance; chromosome theory of inheritance; chromosomes and genes; Sex determination - in humans, birds and honey bee; linkage and crossing over; sex linked inheritance - haemophilia, colour blindness; Mendelian disorders in humans - thalassemia; chromosomal disorders in humans; Down's syndrome, Turner's and Klinefelter's syndromes.

Chapter-5: Molecular Basis of Inheritance Search for genetic material and DNA as genetic material; Structure of DNA and RNA; DNA packaging; DNA replication; Central Dogma; transcription, genetic code, translation; gene expression and regulation - lac operon; Genome, Human and rice genome projects; DNA fingerprinting.

Chapter-6: Evolution Origin of life; biological evolution and evidences for biological evolution (paleontology, comparative anatomy, embryology and molecular evidences); Darwin's contribution, modern synthetic theory of evolution; mechanism of evolution - variation (mutation and recombination) and natural selection with examples, types of natural selection; Gene flow and genetic drift; Hardy- Weinberg's principle; adaptive radiation; human evolution.

Unit-VIII: Biology and Human Welfare

Chapter-7: Human Health and Diseases Pathogens; parasites causing human diseases (malaria, dengue, chikungunya, filariasis, ascariasis, typhoid, pneumonia, common cold, amoebiasis, ring worm) and their control; Basic concepts of immunology - vaccines; cancer, HIV and AIDS; Adolescence - drug and alcohol abuse.

Chapter-8: Microbes in Human Welfare Microbes in food processing, industrial production, sewage treatment, energy generation and microbes as bio-control agents and bio-fertilizers. Antibiotics; production and judicious use.

Unit-IX Biotechnology and its Applications

Chapter-9: Biotechnology - Principles and Processes Genetic Engineering (Recombinant DNA Technology).

Chapter-10: Biotechnology and its Applications Application of biotechnology in health and agriculture: Human insulin and vaccine production, stem cell technology, gene therapy; genetically modified organisms - Bt crops; transgenic animals; biosafety issues, biopiracy and patents. Unit-X Ecology and Environment

Chapter-11: Organisms and Populations Population interactions - mutualism, competition, predation, parasitism; population attributes - growth, birth rate and death rate, age distribution. (Topics excluded: Organism and its Environment, Major Abiotic Factors, Responses to Abiotic Factors, Adaptations)

Chapter-12: Ecosystem Ecosystems: Patterns, components; productivity and decomposition; energy flow; pyramids of number, biomass, energy (Topics excluded: Ecological Succession and Nutrient Cycles).

Chapter-13: Biodiversity and its Conservation Biodiversity-Concept, patterns, importance; loss of biodiversity; biodiversity conservation; hotspots, endangered organisms, extinction, Red Data Book, Sacred Groves, biosphere reserves, national parks, wildlife, sanctuaries and Ramsar sites.

Chapter 2:HUMAN REPRODUCTION

- Human beings reproduce sexually and are viviparous.
- In humans, the reproductive phase starts after puberty.

HUMAN MALE REPRODUCTIVE SYSTEM

It is located in the pelvic region. It consists of:

○ A pair of testes ○ Accessory glands and ducts ○ External genitalia

Scrotum:	A sac of skin and muscle that houses the testes. It helps regulate the temperature of the testes, which is important for sperm production. [2 - 2.5 ◦C less than body temperature].
Testes:	The primary male reproductive organs, located in the scrotum. They produce sperm through a process called spermatogenesis and also secrete testosterone, the male sex hormone.
Testicular lobules:	Each testis is divided into 250 compartments called testicular lobules. They are containing one to four highly coiled seminiferous tubules.
Seminiferous tubules:	These are tubules where spermatogenesis, the process of sperm production, takes place. They are lined by two types of cells: **Male germ cells** − They undergo meiosis to form sperms. **Sertoli cells**− They provide nourishment to the germ cells.
Interstitial space	Region outside the seminiferous tubules is called the interstitial space, which contains Leydig cells(interstitial cells). The Leydig cells produce androgens.

ACCESSORY DUCTS

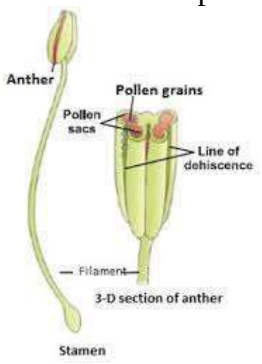
Rete testis	The rete testis is a network of tubules located in the testis which serves as a collecting system for sperm produced in the seminiferous tubules.
Vasa efferentia	Vasa efferentia are a series of small tubules that connect the rete testis to the epididymis in the male reproductive system.
Epididymis	A coiled tube located on the surface of each testis where sperm mature and are stored.

CHAPTER 1- SEXUAL REPRODUCTION IN FLOWERING PLANTS

FLOWERS THE FASCINATING ORGANS OF ANGIOSPERMS

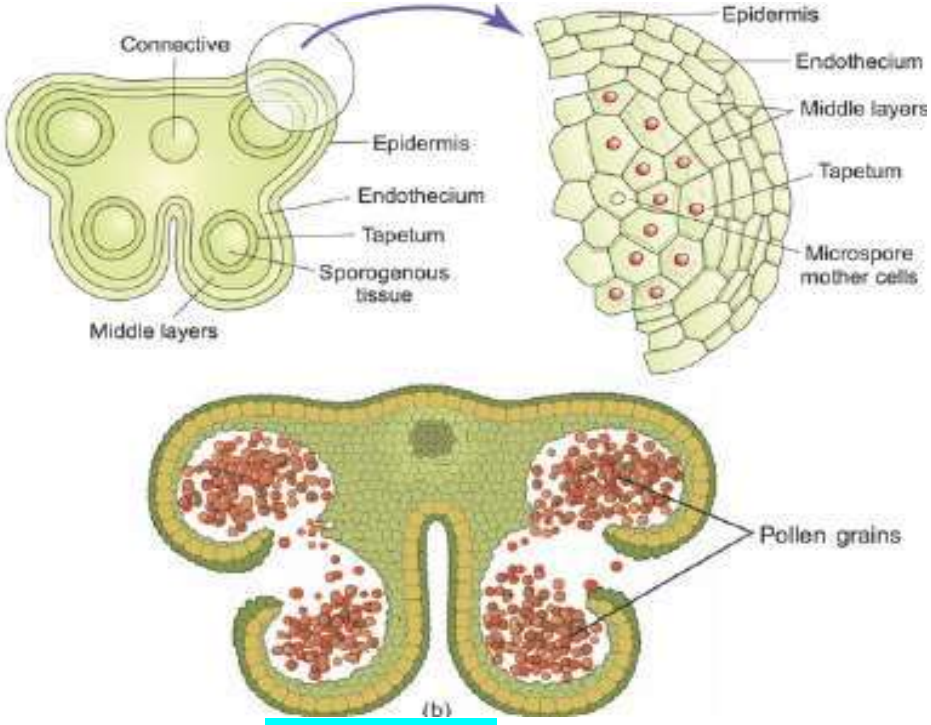
- ✓ A flower is a modified shoot meant for sexual reproduction
- ✓ Flower bears, the reproductive organs where gametes are produced
- ✓ **Androecium,** the male reproductive organ, consists of stamens.
- ✓ **Gynoecium**, the female reproductive organ consists of carpels (pistils)

Stamen - male reproductive part of flower



- has filament and anther.
-Each anther is **bilobed, dithecous & tetrasporangiate.**
- Inside the microsporangium, pollen grains develop.

. **STRUCTURE OF MICROSPORANGIUM (Pollen sac) 2m/3m**



a) **MICROSPORANGIUM**: has **4 wall layers** (Epidermis, endothecium, middle layers, tapetum)

-The outer 3 wall layers help in **protection and dehiscence** of anther to release the pollen.

-The inner most **layer tapetum**, **nourishes the developing pollen grain**. Its cells possess **dense cytoplasm** and **more than one nucleus**

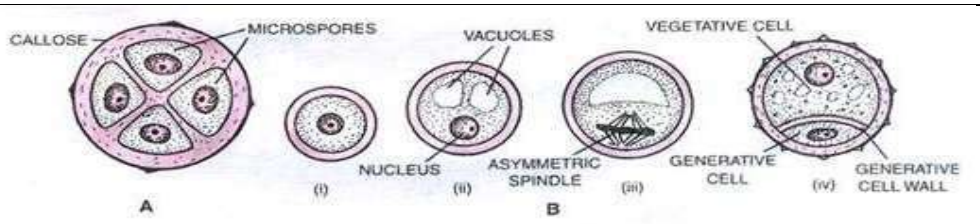
b) Sporogenous tissue (Site Of Pollen Mother Cells / Microspore Mother Cells)

- These PMC/MMC produces **TETRADS OF MICROSPORES BY MEIOSIS.**

The Process of **formation of microspores from pollen mother cell / Microspore mother cells** by Meiosis is called **MICROSPOROGENESIS (1m)**

Development of pollen grain from microspore

Vas deferens:	A long, muscular tube that transports mature sperm from the epididymis to the ejaculatory duct.

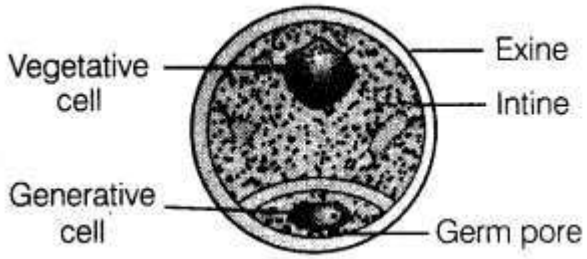


Microsporogenesis. A, a microspore tetrad. B, a microspore maturing into a pollen grain.

As the anther matures and dehydrates, the microspores dissociate from each other. And develop into pollen grain (**The male gametophyte).** When the pollen grain is mature, it contains two cells, the bigger cell is **vegetative cell** and smaller one is **generative cell**.

STRUCTURE OF POLLEN GRAIN (MALE GAMETOPHYTE) (3M)

Pollen grains are generally **spherical** and about 25-50 μm in diameter.



a)Pollen grains are made of 2 layered Wall, **Hard Outer Exine** :- Made up of **sporopollenin**,one of the **most resistant organic matter known**. It can withstand high temperature and strong acids/ alkali. No enzyme can degrade it. Hence **pollen grains are well preserved as fossils**

Inner Intine : Made of cellulose and pectin

Germ pores: apertures on exine where **sporopollenin is absent**. pollen tube comes out through the pore.

A plasma membrane surrounds cytoplasm of pollen grain.

A mature pollen consists of **2 cells with nucleus** (Vegetative and Generative).

Vegetative cell: Bigger, Abundant food reserve, responsible for the development of pollen grain, produces pollen tube.

Generative cell: It is small and floats in the cytoplasm of vegetative cell. Spindle shaped with dense cytoplasm and a nucleus, it divides mitotically to produce two male gametes.

Pollen grains may have **2 cells** (a **vegetative cell & generative cell) or 3 cells (**a **vegetative cell & 2 male gametes**) at the **time of shedding.**

Pollen allergy: Pollen of *Parthenium* (carrot grass), causes chronic respiratory disorders like asthma, bronchitis (1m)

Pollen as nutrient supplement: pollen is rich in nutrients. Pollen tablets and syrup are used as food supplements as they claim to increase performance of athletes and race horses.(1m)

In some cereals such as **rice and wheat ,pollen grains lose viability within 30 minutes** of their release and in some members of Rosaceae and Leguminoseae and Solanaceae,they maintain viability for months.

Storage of pollen: Pollen grains stored by **CRYOPRESERVATION** in liquid nitrogen at -196^0 C. **(1m)**

ACCESSORY GLANDS

MEGASPORANGIUM (OVULE) Structure: Fig 2.7(b)

Gynoecium, the female reproductive organ consists of carpels (pistils).

The gynoecium may consist of a single pistil (monocarpellary) or may have more than one pistil (multicarpellary). When there are more than one, the pistils may be fused together (syncarpous) (Fig 2.7b) or may be free (apocarpous) (Figure 2.7c).

Each pistil consists of **stigma, style and ovary.**

- ✓ **Stigma:** It is a landing platform for pollen grains.
- ✓ **Style**: It is an elongated slender part beneath the stigma.
- ✓ **Ovary**: It is the basal bulged part of the pistil. Inside the ovary is the ovarian cavity (locule) in which the placenta is located. Arising from the placenta are the ovules (megasporangia). The number of ovules in an ovary may be one (wheat, paddy, mango etc.) to many (papaya, water melon, orchids etc.).

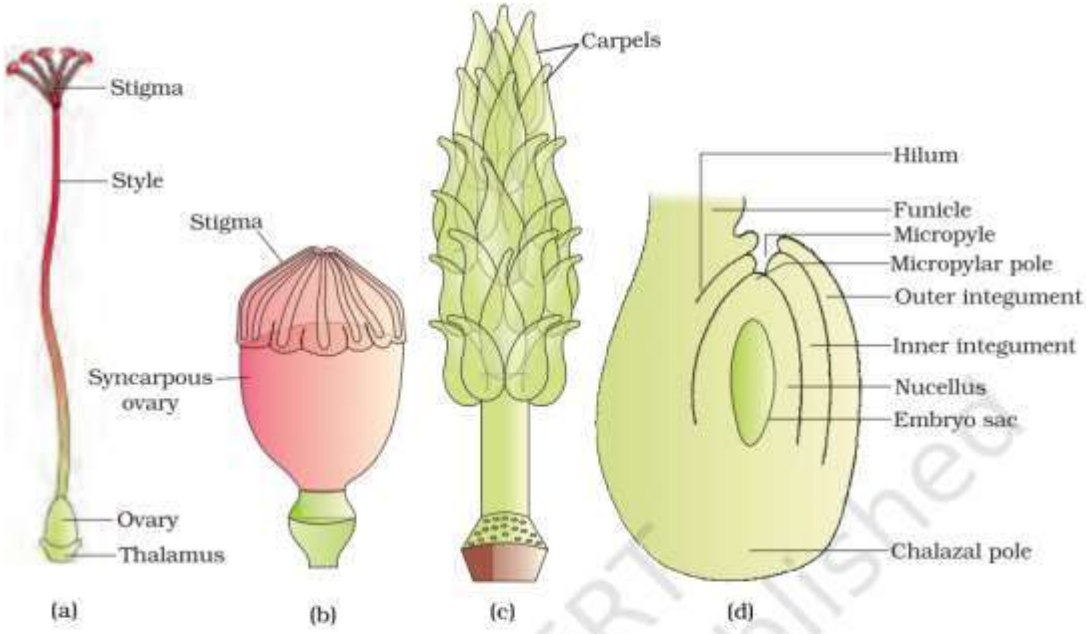


Figure 2.7 (a) A dissected flower of *Hibiscus* showing pistil (other floral parts have been removed); (b) Multicarpellary, syncarpous pistil of *Papaver*; (c) A multicarpellary, apocarpous gynoecium of *Michelia*; (d) A diagrammatic view of a typical anatropous ovule

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 from where pollen tube enters
- **Chalaza -** basal part of ovule
- **Nucellus (2n)-**mass of cells enclosed in integuments. Has abundant food reserve. It produces embryo sac

MEGASPOROGENESIS

- Process of formation of megaspores from megaspore mother cells is called **MEGASPOROGENESIS.**
- A nucellus cell near the micropylar end of ovule differentiates into megaspore mother cell.
- Megaspore mother cells divide meiotically to form 4 megaspores (haploid). Out of these, 3 degenerate and only 1 megaspore is functional and forms **female gametophyte (embryo sac).**

So, formation of embryo sac from a single megaspore is termed **MONOSPORIC DEVELOPMENT**.

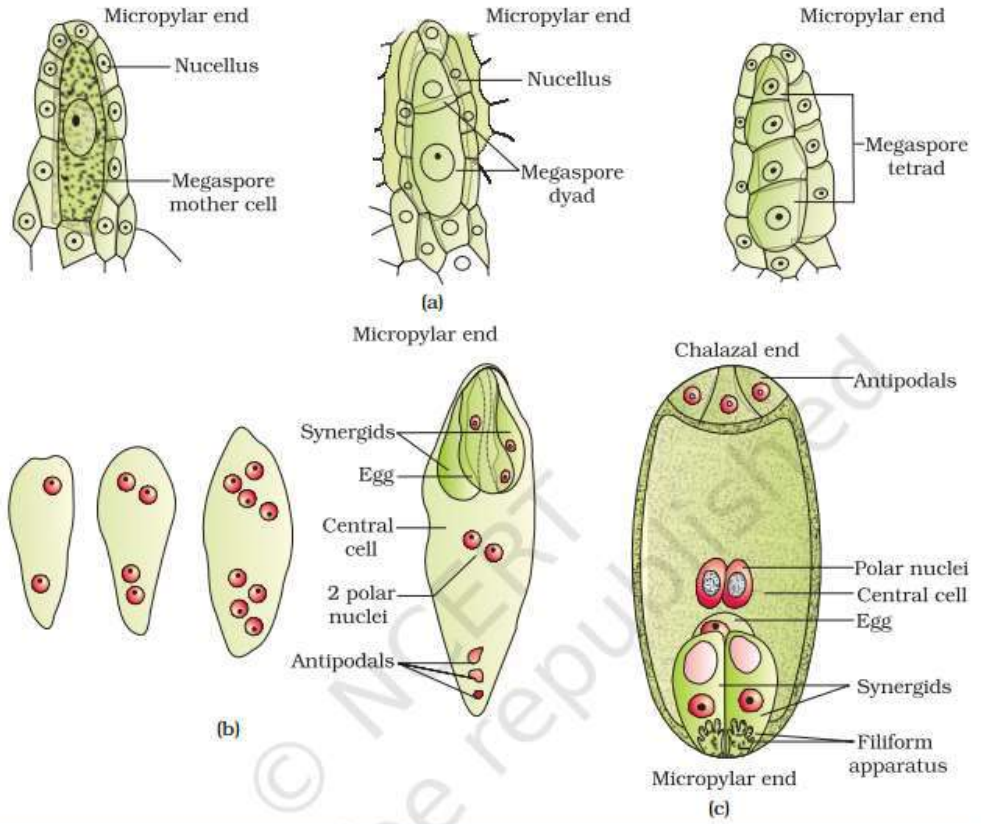


Figure 2.8 (a) Parts of the ovule showing a large megaspore mother cell, a dyad and a tetrad of megaspores; (b) 2, 4, and 8-nucleate stages of embryo sac and a mature embryo sac; (c) A diagrammatic representation of the mature embryo sac.

- The embryo sac develops from the functional megaspore (n).
- Nucleus of functional megaspore undergoes **3 successive mitotic divisions** to form **8 nuclei**.
- Then cell walls are laid down to form 7 cells.
- 3 of the cells at the micropylar end form Egg apparatus . It has 2 synergids and 1 egg cell. Synergids have cellular thickenings at micropylar tip called **filiform apparatus** – which **guides the pollen tube into the synergids**.
- Other 3 cells form antipodals at chalaza end
- Large central cell has two Polar Nuclei.
- Hence **a typical mature embryosac is 7- celled and 8-nucleate**.

Pollination: is transfer of pollen grains (shed from the anther) to the stigma of a pistil.
depending upon the source of pollen, pollination is 3 types:

(**i)Autogamy**: Transfer of pollen grains from the anther to the stigma of the same flower. Autogamy requires synchrony in pollen release and stigma receptivity and also ,the anthers and the stigma should lie close to each other so that self pollination can occur.
Some plants such **as Commelina ,Oxalis and viola produces two types of flowers. Chasmogamous flowers and Cleistogamous flowers (5m)**

Seminal vesicles:	Glandular structures that secrete a fluid rich in fructose and other substances that nourish and support sperm. This fluid contributes to semen volume.
Prostate gland:	A gland that secretes a milky fluid that makes up a significant portion of semen. This fluid helps activate sperm and increase their motility.

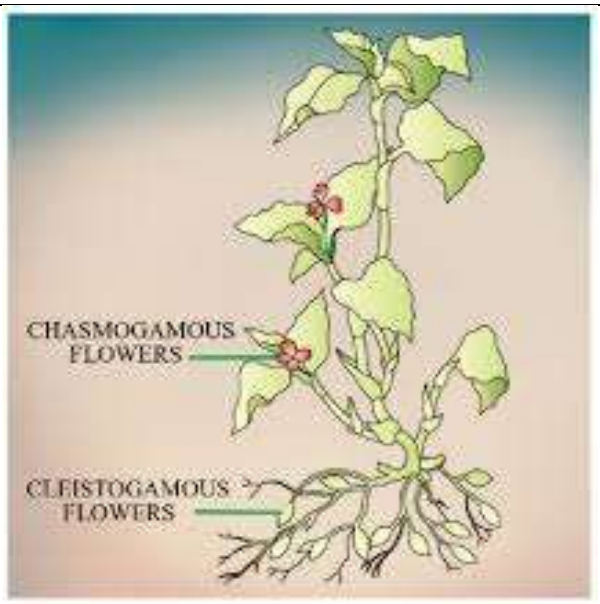


Figure: Chasmogamous and cleistogamous flowers

Chasmogamous flowers are similar to other species **with exposed anthers and stigma.**

Cleistogamous flowers :They **do not open** at all. Anthers & stigma lie close to each other. They are **Invariably Autogamous**. **Cleistogamous flowers** produce **assured seed - set even in the absence of pollinators.**

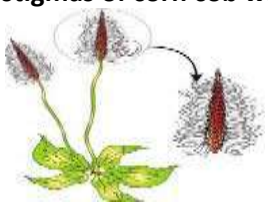
Agents of Pollination:

- Abiotic agents: Wind, Water
- Biotic agents: Insects, birds, bats, reptiles, mammals

a) Characteristic features of wind pollinated Flowers (Anemophily) (2m)

- Flower :- colourless, odourless and, nectarless.
- well exposed Anther/ large and feathery Stigma
- Pollen grains:– light, dry and non- sticky.
- Produced in large quantity to compensate the loss during transport by wind. (1m)

Note: **Tassels in corn- styles and stigmas of corn cob wave in the wind to trap pollen grains (1m)**



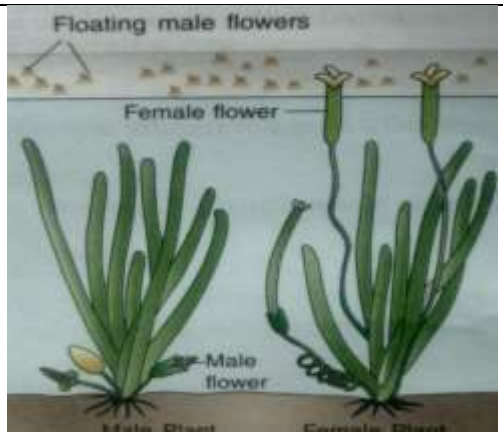
b) **Water Pollination (Hydrophily) (2m)**

Characteristics of water pollinated flowers:

- produce pollen grains in large no., Needle like.
- protected from wetting by mucilaginous covering (1m)
- Colourless,nectarless flowers.

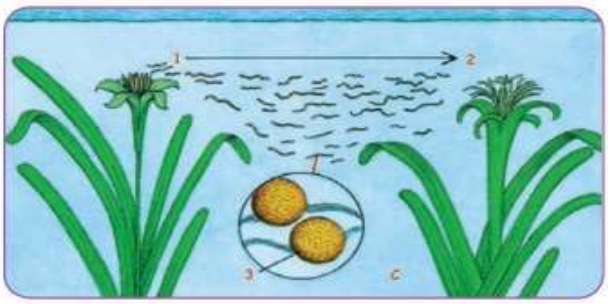
i)Vallisneria:

- The female flowers reach the surface of water by long stalk.
- Male flowers are released on to the surface of the water and they are passively carried by water currents to female flowers stigma.



ii)In sea grasses- zostera:

- Female flowers remain submerged in water.
- Pollen is long ribbon like and is released inside the water. Pollen is passively carried to the female flower.



iii)Water hyacinth and water lily: (1m)

Flowers emerge above the level of water and are pollinated by insects or wind

a) **Insect Pollination (**Entomophily**)**

- **Large, colourful, fragrant and rich in nectar**. Nectar & pollen grains are the floral rewards for pollination.
- **When the flowers are small, they form inflorescence to make them visible**.
- **The flowers pollinated by flies and beetles secrete foul odours to attract these animals**.
- **The pollen grains are generally sticky.**
- **Some plants provide safe places as floral reward to lay eggs.**

  Eg: Amorphophallus (tallest flower of 6 feet).

Many insects consume pollen or nectar without bringing about pollination. They are called **pollen/nectar robbers**

Bulbourethral glands:	Also known as Cowper's glands, these glands secrete a clear, slippery fluid that lubricates the urethra.

EXTERNAL GENITALIA

Urethra:	The tube that carries urine from the bladder to the outside of the body, and also serves as the passageway for semen during ejaculation.

- Rewards to pollinators: (2m)

- Nectar and (edible) pollen grains as foods
- Provide safe place for laying eggs (The tallest flower of Amorphophallus, and Yucca)

Yucca and moth: (Mutualism- +/+ Interaction) (2m)

- Both cannot complete their life cycles without each other.
- The moth deposits its eggs in the locules of the ovary and the larvae of the moth come out of the eggs as the seeds start developing.
- The flower in turn gets pollinated by the moth

Outbreeding Devices (Ways to avoid Self-pollination / inbreeding) (2m)

Continued self Pollination results in Inbreeding depression. So plants have developed devices to discourage self pollination and encourage cross pollination.

a) Pollen release & stigma receptivity are **not synchronized**.

b) Stigma and anther are placed **at different positions** so that the pollen cannot come in contact with the stigma of the same flower

c)**Self-incompatibility**: This is a genetic mechanism. When pollen falls on the stigma of the same flower or different flower of the same plant, it fails to germinate and produce pollen tube. So release of male gametes in the ovule and fertilization is prevented.

d)**Production of unisexual flowers**

- In monoecious plants, autogamy is prevented but not geitonogamy (castor and maize)
- In dioecious plants, both autogamy & geitonogamy are prevented. (Papaya and date palm)

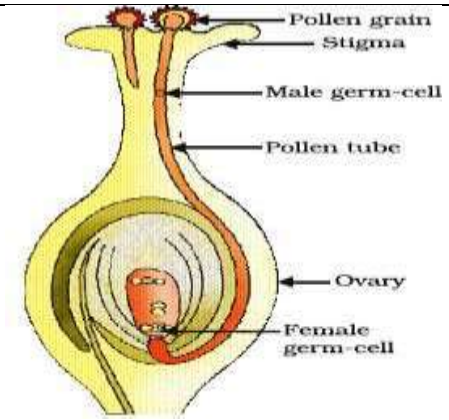
Pollen -Pistil Interaction(CBSE Sample QP)

nts that take place from deposition of pollen on stigma, till the pollen tube enters the ovule is Pollen-pistil interaction.

- ✓ Landing of compatible (right type of) pollen on the stigma.
- ✓ Chemical components of pollen interact with the stigma to decide the compatibility.
- ✓ Recognition followed by acceptance.
- ✓ The pollen grain germinates and produces pollen tube.
- ✓ If the pollen is shed in 2 celled stage, then the generative cell divides mitotically to produce two male gametes.
- ✓ Pollen tube grows through style and reaches ovary. It enters the ovule through the micropyle and releases 2 male gametes in one of the synergids
- ✓ Entry of pollen tube is guided by filiform apparatus of synergids.

Draw diagram – L S of flower showing growth of pollen tube

Penis:	The male organ of copulation, which contains the urethra. During sexual arousal, the penis becomes erect, allowing for penetration during sexual intercourse.

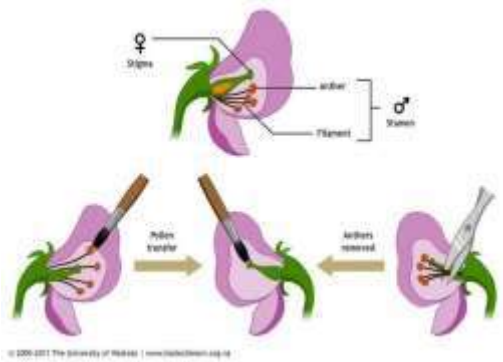


Artificial Hybridization (5m)

- Crossing different varieties of plant species to obtain hybrid individual- with desirable characters of both parental plants.

Steps:

- **Emasculation: removal of anther from a bisexual** flower before the anther dehisces.
- **Bagging:** flower covered with bag made up of butter paper to **prevent contamination of stigma by unwanted pollens.**
- **Dusting of desirable pollen**: when stigma attains receptivity, mature desirable pollen grains are dusted on the stigma; and the flower is rebagged for fruit development.



Note: If the female parent produces unisexual flowers, there is no need for emasculation.

Double Fertilisation

In flowering plants there are **two types of fusions** taking place in embryo sac.

(1) Syngamy: fusion of one of the male gametes with the egg nucleus resulting in the formation of **diploid zygote**. Zygote further develops into embryo.

(2) Triple fusion: - fusion of 2nd male gamete with polar nuclei to form **Triploid endosperm nucleus (PEN)**, which develops into **Endosperm.**

Post- fertilization Events

All events that occur in a flower, after double fertilization are called **Post- fertilization events**

Major events are:

i) Development of endosperm ii)Development of embryo

(iii)Maturation of ovule into seed (iv)Maturation of ovary into fruit

Endosperm development(2m)

- **Endosperm development precedes embryo development**: because endosperm is filled with reserve food material, which is used for the nutrition of developing embryo.
- PEN undergoes successive nuclear divisions to give rise to free nuclei. This stage of development is called **Free nuclear endosperm**.

- ❖ Later around the nuclei, cell wall formation occurs to form **Cellular endosperm.**
- ❖ **In tender coconut water** is **free-nuclear endosperm** and **white kernel is cellular endosperm.**

Embryo development (Embryogeny)**: (3M)**

The embryo develops at the micropylar end of the embryosac, where the zygote is situated. Most zygotes divide only after certain amount of endosperm is formed. This is an adaptation to provide assured nutrition to the developing embryo.

ZYGOTE→.PROEMBYO→GLOBULAR EMBRYO→HEART SHAPED EMBRYO→MATURE EMBRYO

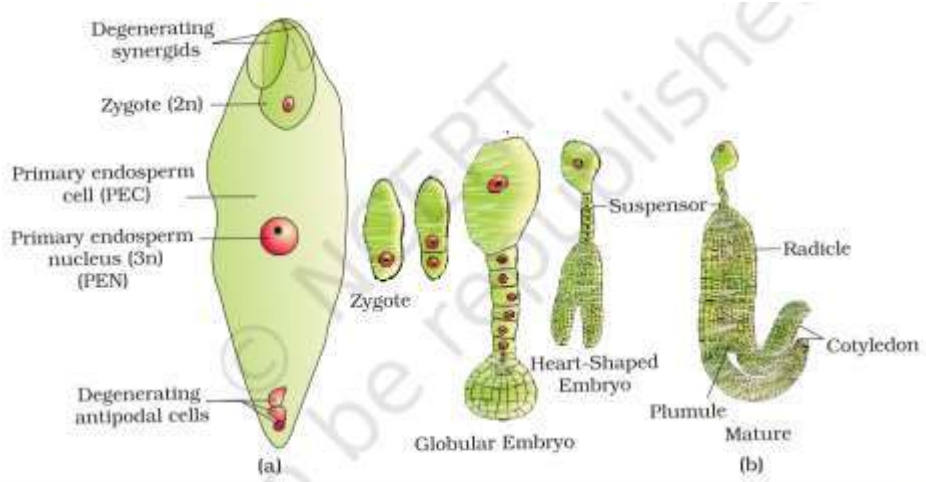


Figure 2.13 (a) Fertilised embryo sac showing zygote and Primary Endosperm Nucleus (PEN); (b) Stages in embryo development in a dicot (shown in reduced size as compared to (a))

Structure of dicot embryo:

- A mature dicot embryo consists of 2 cotyledons and embryonal axis.
- The portion of the embryonal axis above the level of cotyledons is epicotyl, which terminates with plumule (shoot apex).
- The portion of the embryonal axis below the level of cotyledons is hypocotyl, which terminates with radicle (root apex). Root is covered with a root cap.

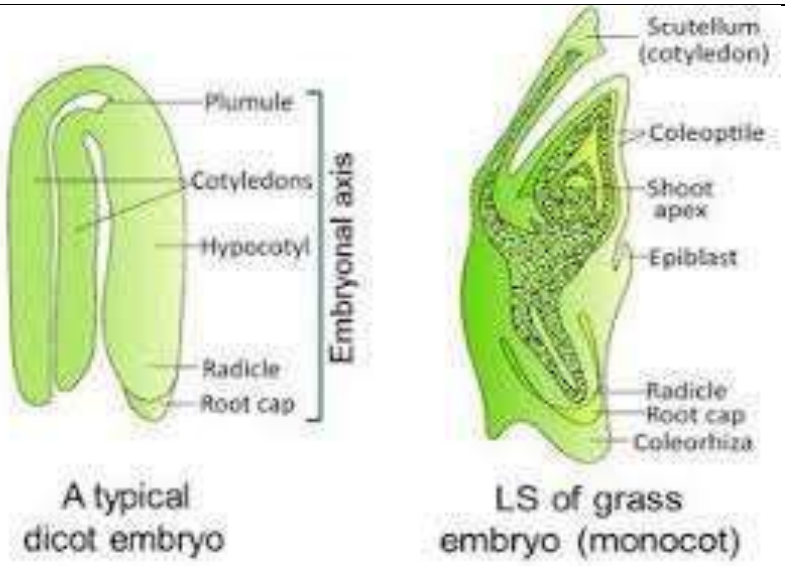
Structure of monocot embryo:

- **Scutellum**: a single reduced cotyledon.
- **Epicotyl:** the portion of the embryonal axis above the level of attachment of scutellum is epicotyl, which terminates with plumule. It is covered by a protective foliar structure known as coleoptile.
- **Hypocotyl:** the portion of the embryonal axis below the level of attachment of scutellum is hypocotyl, which terminates with radical It is covered by a protective sheath known as coleorhiza.

Seminal Fluid:	The combination of sperm and the various fluids secreted by the seminal vesicles, prostate gland, and bulbourethral glands. Seminal fluid makes up semen, which is ejaculated during coitus.

HUMAN FEMALE REPRODUCTIVE SYSTEM

It is located in the pelvic region. It includes:



Seed: Final product of sexual reproduction in angiosperms.

A typical seed consists of seed coat(s), cotyledon(s) and an embryonal axis.

Albuminous: seeds retain a part of endosperm, as it is not completely used up during embryo development. Ex: wheat, maize, barley, castor, sunflower.

Non- albuminous: seeds have no residual endosperm, as it is completely used up during embryo development. Ex: pea, ground nut

Perisperm: residual persistent nucellus in black pepper and beet root seeds. (**CBSE SQP**)

Seed dormancy: Inability of a seed to germinate under favourable conditions, due to inactivity of the embryo or some hormone inhibition

ADVANTAGES OF SEEDS

- ✓ Since pollination and fertilisation are independent of water, seed formation is more dependable.
- ✓ Seeds have better adaptive strategies for dispersal to new habitats and help the species to colonise in other areas.
- ✓ They have food reserves. So, young seedlings are nourished until they are capable of photosynthesis.
- ✓ The hard seed coat protects the young embryo.
- ✓ Being products of sexual reproduction, they generate new genetic combinations leading to variations.
- ✓ Dehydration and dormancy of mature seeds are crucial for storage of seeds. It can be used as food throughout the year and also to raise crop in the next season.

Fruit: Developed from fertilized ovary.

Pericarp:fruit wall developed from ovary wall.

True fruits	False fruits	Parthenocarpic fruits
Developed only from fertilized ovary	Besides ovary, floral parts like thalamus also contribute to fruit formation.	Fruits developed from ovary without fertilization. They are seedless.
Mango	Apple, strawberry, cashew	Banana

○ A pair of ovaries ○ A pair of oviduct ○ Uterus ○ Cervix ○ Vagina
○ External genitalia ○ Mammary glands

varies	They are the primary female sex organs. They produce the ovum and other ovarian hormones. The ovarian stroma is made up of: ○ Peripheral cortex ○ Inner medulla
viducts	They are 10 to 12 cm long, and extend from the ovary to the uterus. There are 3 parts of oviduct – infundibulum, ampulla and isthmus.

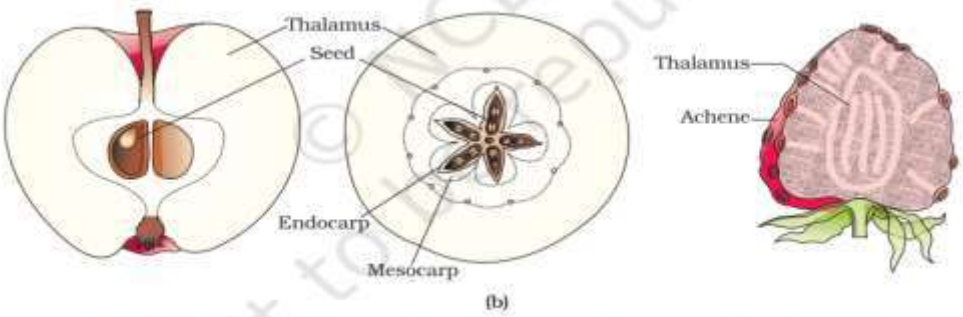


Figure 2.15 (a) Structure of some seeds. (b) False fruits of apple and strawberry

Apomixis:

Production of seeds without fertilization. Thus it is a form of asexual reproduction that mimics sexual reproduction. Ex: grasses and Asteraceae

Apomictic seeds are formed – when the diploid egg cell is formed without reduction division and develops into the embryo without fertilization.

Importance of Apomictic seeds:

- ✓ Plants grown by sowing hybrid seeds do not show hybrid characters, as the characters segregate during meiosis.
- ✓ Production of hybrid seeds is costly and hence the cost of hybrid seeds become too expensive for the farmers.
- ✓ Apomixis does not involve meiosis and fertilization. This prevents the loss of specific characters in hybrid. So growing plants by apomictic seeds is economical for farmers.

Polyembryony:

Presence of more than one embryo in a seed. Some of the nucellus cells surrounding the embryo sac start dividing, and protrude into the embryo sac and develop into embryos.

Eg: citrus and mango

COMPETENCY BASED QUESTIONS

Question no. 1to 10 consist of two statements. Assertion (A) and Reason(R). Answer these questions selecting the appropriate options given below:

(a)Both A and R are true, and R is the correct explanation of A.

(b) Both A and Rare true, but R is not the correct explanation of A

(c)A is true but R is false. **(d) A is false and R true**

1. **Assertion:** Farmers use apomictic hybrid seeds to grow new crop year after year.
   Reason: When hybrid seeds are used to grow crops, genes/traits segregate in the progeny.

2. **Assertion**: Pollen mother cell in pollen sac undergoes meiosis to produce 4 microspores.
   Reason: Out of 4, three microspores degenerate and only one remains functional.

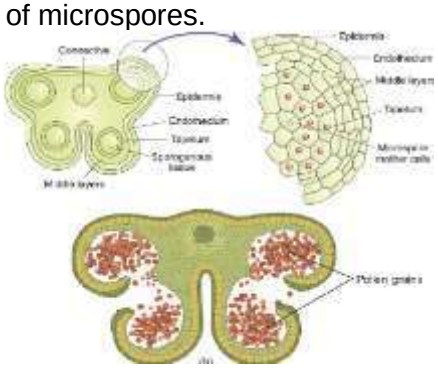
3. **Assertion**: In plants, apomixis is a form of asexual reproduction that mimics sexual reproduction.
   Reason: Apomixis involves the production of seeds without the fusion of gametes**.**

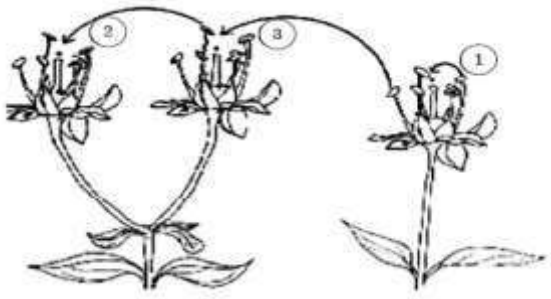
4. **Assertion**: If the tapetum is malfunctioning in an anther, the male gametophytes often become sterile.
   Reason: Tapetum nourishes the developing pollen grains.

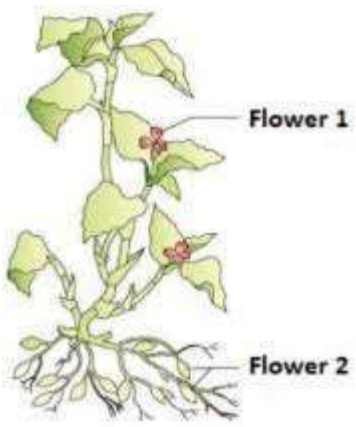
5. **Assertion**: Self pollen cannot affect fertilization in Self incompatible pistil.
   Reason: Self incompatibility prevents the germination of pollen grains or retard the growth of pollen tube.

6. **Assertion**: Seeds of beet and black pepper have perisperm, which is not found in pea seeds.
   Reason: Perisperm and endosperm have the same function.

7. **Assertion (A):** Endosperm development precedes embryo development.

	Reason (R): Endosperm development occurs only in dicotyledonous plants.
8.	**Assertion (A):** A species of wasp and a fig species cannot complete their life cycle without each other. **Reason (R):** While visiting wasps come to lay eggs in the fig inflorescence, the flower of wasp gets pollinated in return.
9.	**Assertion:** Primary endosperm nucleus is diploid. **Reason:** It is the product of double fertilisation.
10	**Assertion:** Farmers use apomictic hybrid seeds to grow new crop year after year. **Reason:** When hybrid seeds are used to grow crops, genes/traits segregate in the progeny
	Answers: **1)a 2)c 3)a 4)a 5)a** **6)b 7)c 8)a 9)d 10)a**
	CASE STUDY BASED QUESTIONS
1	A typical anther is bilobed, dithecous and tetrasporangiate. Pollen Grain develop inside the microsporangia. Four wall layers, epidermis, endothecium, middle layer and tapetum surround the microsporangium. Cells of the sporogenous tissue lying in the centre of the microsporangium undergo meiosis to form tetrads of microspores.  (a) A dithecous anther of an angiospermic plant species has 100 microspore mother cells in each of its microsporangia.How many pollen grains can this anther produce? (b) State the reason, why pollen grains lose their viability when the tapetum in the microsporangium is malfunctioning? ©Can you think of the reason how tapetal cells would become binucleate? OR ©Arrange the following terms in the correct developmental sequence: Pollen grain, sporogenous tissue, microscope tetrad, pollen mother cell, male gametes **Answers:** (a)1600 (b)Tapetum provides nutrition for the developing pollen grains. ©karyokinesis is not followed by cytokinesis. OR © Sporogenous tissue, pollen mother cell, microscope tetrad, pollen grain, male gametes
2	Embryo develops at the micropylar end of the embryo sac where the zygote is situated. Most zygotes divide only after certain amount of endosperm is formed. The early stages of embryo development are similar in both monocotyledons and dicotyledons. The zygote gives rise to the proembryo and subsequently to the globular, heart-shaped and mature embryo. A typical dicotyledonous embryo consists of an embryonal axis and two cotyledons. Embryo of monocotyledons possess only one cotyledon.

	(a)What type of cell division takes place during embryo development? (b)Endosperm development precedes embryo development. Give reason. ©Distinguish between epicotyl and hypocotyl. Or © Distinguish between coleoptile and coleorhiza. **Answers:** (a)Mitosis (b)To ensure nutrition for the developing embryo. © Epicotyl: Portion of embryonal axis above the level of cotyledon. Hypocotyl: Portion of embryonal axis below the level of cotyledon OR Coleoptile: Sheath covering over the plumule in monocots Coleorhiza: Sheath covering over the radicle in monocots.
3	Post fertilization, ovules develop into seeds and ovary develop into fruits in angiosperms. These two processes occur simultaneously. The fruit may be true or false or some may be parthenocarpic.. Seedless fruits can be induced to develop, by the application of phytohormones such as auxins and gibberellins. **(**a)Give an example for the following: (i)A fleshy fruit ii) A dry fruit (b)How are strawberry, apple and cashew similar to each other with respect to their fruits? ©Name the process of development of an ovary into fruit without fertilization. Give an example. Mention the characteristic features of such fruits. OR ©What does the ovary wall develop into, in a fruit? Name its different regions / parts that can be distinguished in a true fleshy fruit**.** **Answers:** (a)i) Tomato /mango ii) Cashew/coconut (b)They are false fruits, not developed from fertilized ovary. ©Parthenacarpy. Banana. Parthenocarpic fruits are seed less. OR ©Fruit wall/the percarp. Outer epicarp/middle mesocarp/inner endocarp.
4	Study the diagram given below showing the modes of pollination. Answer the questions that follow:  (i) The given diagram shows three methods of pollen transfer in plants. What are the technical terms used for pollen transfer Methods in “1”,’2’ and ‘3’? (ii)Name the type of pollen transfers that may lead to inbreeding depression. Give reason. OR

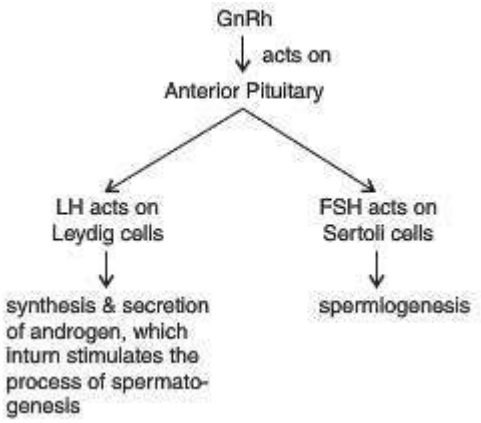
	(ii) How do the following plants achieve pollination successfully? (1) Water lily (2) Vallisneria (iii) In which type of pollen transfer, you may find maximum genetic variation among the young ones. Give reason. **Answers** (i)"1": Autogamy,'2': Geitonogamy and '3': Xenogamy. (ii)Autogamy and geitonogamy. OR (ii) (1**) Water lily:** The flowers emerge above the level of water and are pollinated by insect. (2) **Vallisneria:** The female flower reach the surface of water by the long stalk. The male flowers or pollen grains are released on to the surface of water and they are carried passively by water currents. (iii)Xenogamy. Two different parental plants involved.
5	 The above picture shows a Commelina plant bearing two types of bisexual flowers, an adaptation for assured seed set and genetic variation in the progeny. (a) Name two other plants species, which also produce these two types of flowers on the same plant. (b) Name the flower type 2 and the type of pollination that occur in it. © Which type of flowers 1 or 2 will have maximum chances of (i) assured seed set and(ii) genetic variation in the progeny, respectively? OR © Name the type of flower 1 and the type(s) of pollination that occur in it. **Answers** (a)Viola /oxalis (b)Autogamy ©(i) assured seed: flower 2 ii) Flower 2 OR ©Chasmogamous flowers. Geitonogamy/ xenogamy.
6	Apomixis Seeds in general are the product of fertilization. But, some species of Asteraceae and grasses have evolved a special mechanism to produce seeds without fertilization called apomixis. Thus apomixis. Is a form of asexual reproduction that mimics sexual reproduction. There are several ways of developing of apomictic seeds. In some species, the diploid egg cell is formed without meiosis develops into embryo without fertilization .In many citrus and mango varieties, some of
fundibulum	It is funnel shaped. It has finger like projections called fimbriae.

	the nucellus cells surrounding the embryo sac start dividing ,protrude into the embryo sac and develop into embryos. (a)If the parental maize plant has 20 chromosomes in the nucellus cells, what will be the no. of chromosomes in its apomictic seeds? (b)What is the similarity between apomixis and sexual reproduction? ©Explain the importance of apomixis in horticulture and agriculture. OR ©Can new plants produced by apomixis be called clones. Give reason. **Answers** (a)20 chromosomes (b) Seed production involved. ©No segregation of desirable characters/Farmers need not spend huge money for purchase of hybrid seeds. OR ©Yes, new plants produced will be carbon copy of parental plants/no variation/only one parent involved in seed production.

terus	It is also called womb, and is pear shaped. It is connected to the pelvic walls by ligaments. The uterine wall consists of: ○ External perimetrium ○ Middle myometrium ○ Internal endometrium, which lines the uterine cavity ● The endometrium undergoes changes during the menstrual cycle.
ervix and agina	The cervix connects the uterus to the vagina. ● The cervix and the vagina constitute the birth canal.
xternal enitalia	Consists of: ○ Mons pubis ○ Labia majora ○ Labia minora ○ Hymen ○ Clitoris
ammary lands	Present in all female mammals ● It is paired and is glandular. ● Each breast contains 15 to 20 mammary lobes with alveoli which secrete milk. ● The alveoli open into the mammary tubules, which unite to form a mammary duct. ● Many mammary ducts constitute the mammary ampulla, which is connected to the lactiferous duct.

Gametogenesis: The testis and ovary produce the male and female gametes respectively by gametogenesis (spermatogenesis in males and oogenesis in females.

HORMONAL CONTROL OF SPERMATOGENESIS

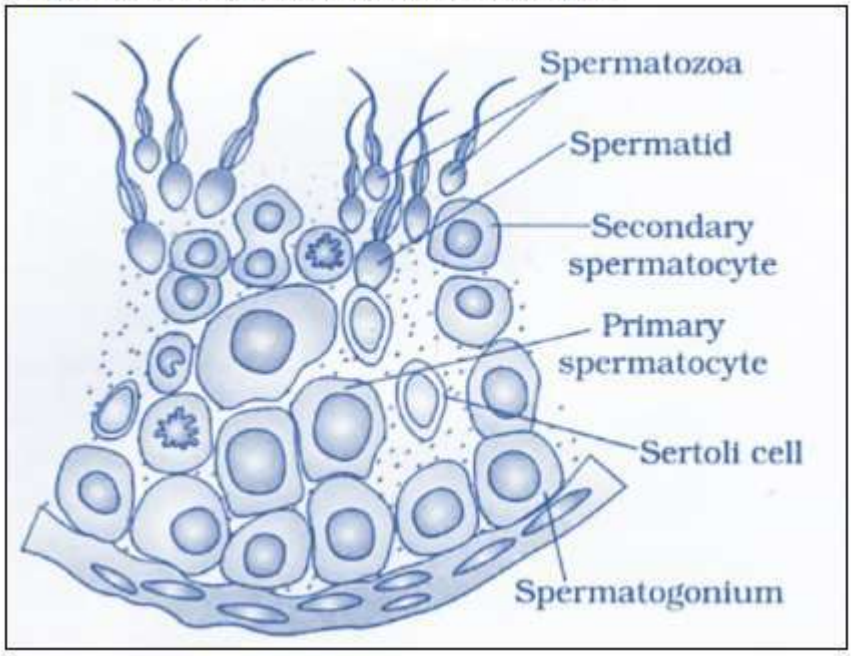


Spermatogenesis - occurs in the testes.

Spermatogonium(2n):	A diploid germ cell that undergoes mitosis to produce more spermatogonia.
Primary Spermatocyte (2n):	A spermatogonium that has undergone DNA replication and is now preparing to undergo meiosis.

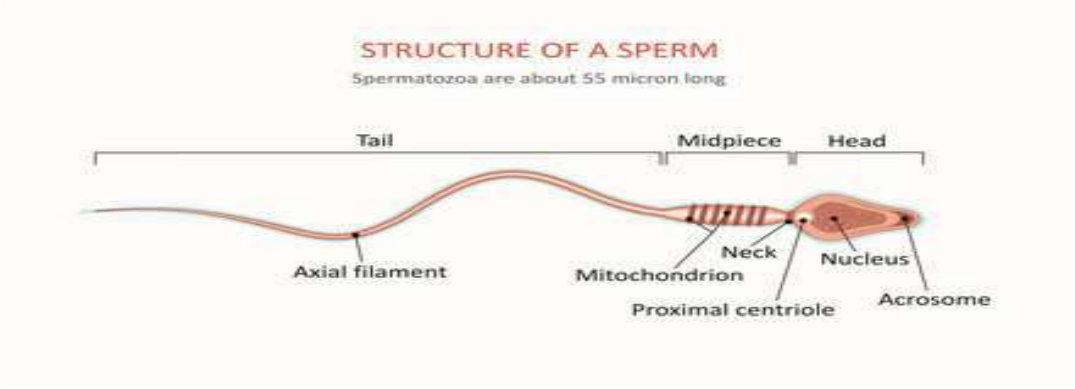
Secondary Spermatocytes (n):	The primary spermatocyte undergoes the first meiotic division to produce two haploid secondary spermatocytes.
Spermatids (n):	Each secondary spermatocyte undergoes the second meiotic division to produce two haploid spermatids. Totally 4 spermatids.
Spermiogenesis:	The sperm head gets embedded in the Sertoli cells. the spermatids undergo extensive morphological changes, including the formation of a head (containing the nucleus), a midpiece (containing mitochondria for energy production), and a tail (flagellum for movement).
Spermiation:	The release of sperms from the seminiferous tubules.

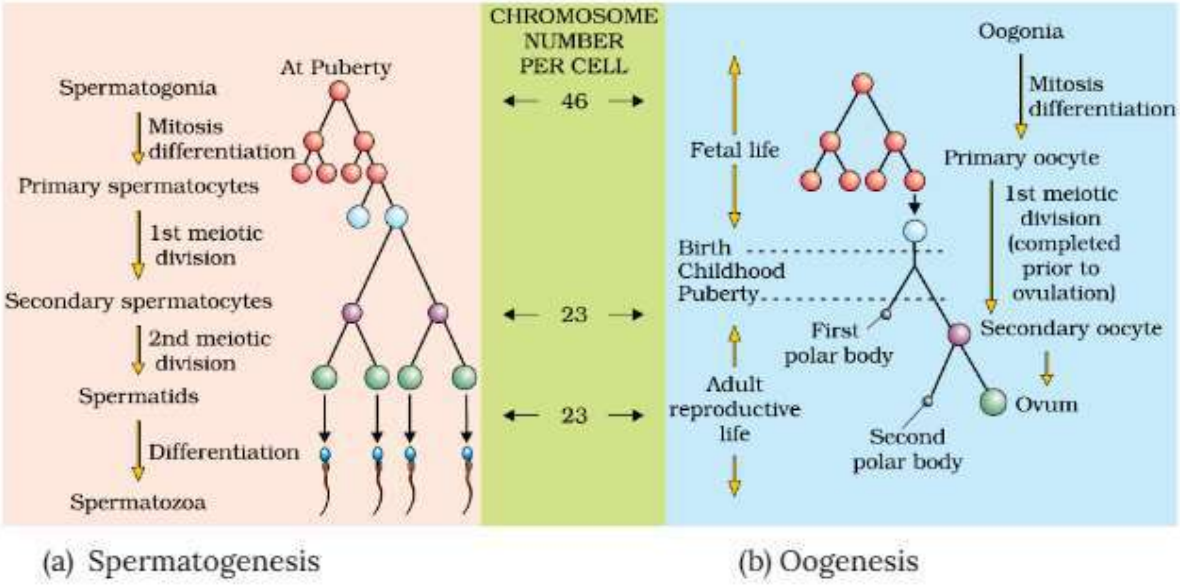
Diagram: Sectional view of seminiferous tubule



Structure of a Sperm

Head	-consists of a haploid nucleus and a cap-like acrosome, which contains enzymes that aid in fertilisation.
Middle piece	-contains mitochondria, which produce energy for the motility of the sperm.
Tail	- is a long, whip-like structure that propels the sperm forward through its environment.
Plasma membrane	-surrounds the entire sperm cell and regulates the movement of substances in and out of the cell.





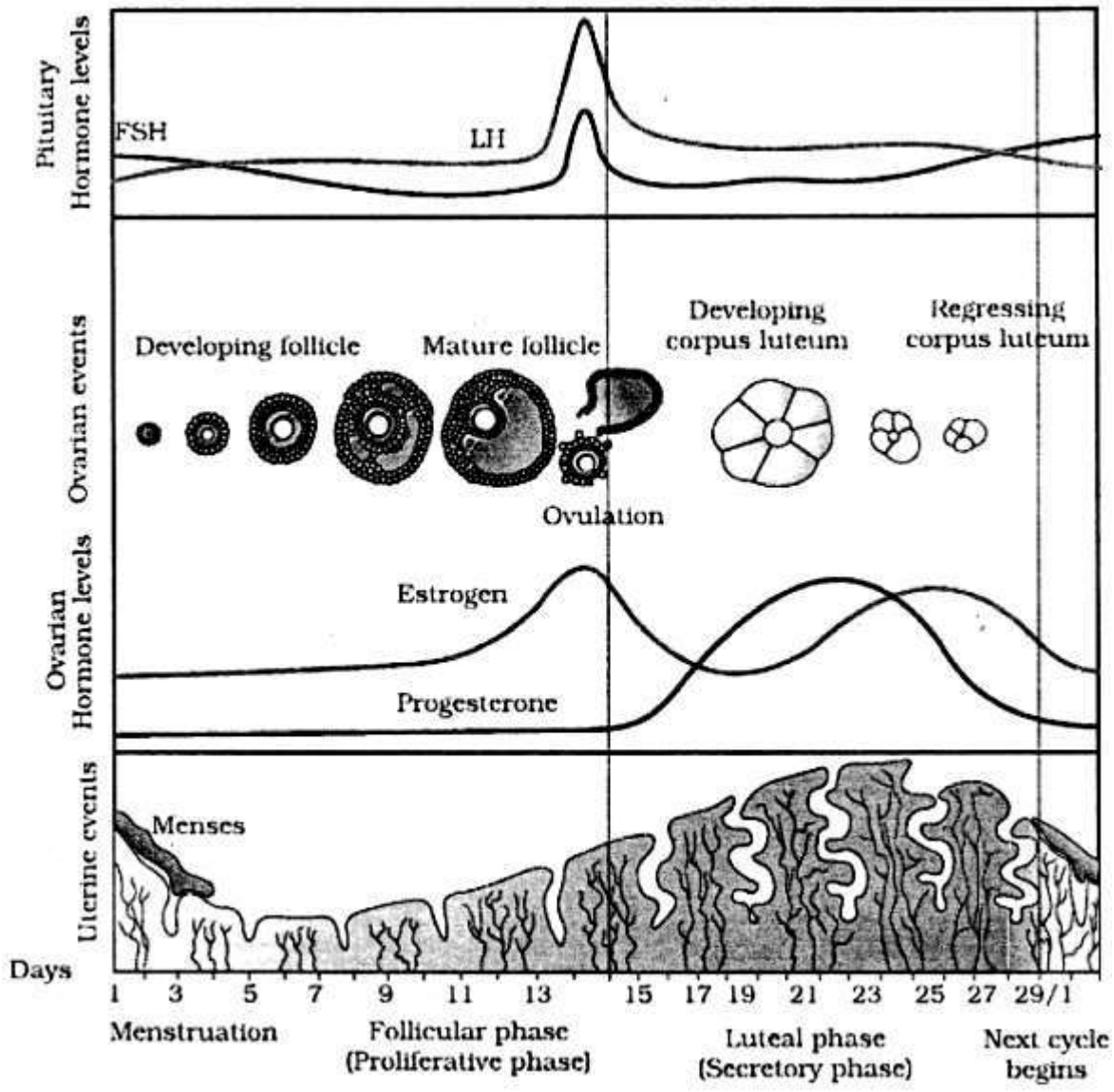
(a) Spermatogenesis (b) Oogenesis

Oogenesis: occurs in the ovaries.

Oogonium	The process begins before birth, when primordial germ cells in the developing fetus multiply and differentiate into oogonia. These oogonia then enter a period of mitotic division to increase their numbers
Primary Oocyte (2n)	Each oogonium undergoes DNA replication to become a primary oocyte, which is diploid (2n). This process starts during fetal development but is arrested in prophase I of meiosis until puberty.
Secondary follicles .	Before reaching puberty, a large number of primary oocytes degenerate and the remaining ones get surrounded by layers of granulosa cells and new theca and are called secondary follicles.
Tertiary follicles	The secondary follicles are then converted into tertiary folliclesthat have characteristic fluid-filled cavity called antrum.
Formation of secondary oocyte	The primary oocyte present within the tertiary follicle completes meiosis I, which results in the formation of haploid secondary oocyte and a tiny polar body.
Graafian follicle	This tertiary follicle further changes into the Graafian follicle. The secondary oocyte is surrounded by the zone pellucida.

Ovulation	The Graafian follicle ruptures to release the (secondary oocyte) ovum by ovulation.
Meiosis II	If the secondary oocyte is fertilized by a sperm cell, it completes the second meiotic division, resulting in the formation of a mature ovum (n) and second polar body. The mature ovum is now ready for fertilization and contains a haploid set of chromosomes.

MENSTRUAL CYCLE



Menstrual cycle is the reproductive cycle in all primates and begins at puberty (menarche).
In human females, menstruation occurs once in 28 to 29 days. The cycle of events starting from one menstruation till the next one is called the menstrual cycle

Menstrual Phase (Days 1-5)	The menstrual phase marks the beginning of the cycle and is characterized by the shedding of the endometrial lining of the uterus, resulting in menstrual bleeding. This phase is triggered by a decrease in estrogen and progesterone levels.

Follicular Phase (Days 1-13)	The follicular phase begins on the first day of menstruation and lasts until ovulation. During this phase, follicle-stimulating hormone (FSH) stimulates the development of ovarian follicles, each containing an immature egg (oocyte). Usually, one follicle continues to develop, Estrogen levels gradually increase, causing the endometrium to thicken in preparation for a potential pregnancy.
Ovulation (Around Day 14)	Ovulation usually occurs around the middle of the menstrual cycle, triggered by a surge in luteinizing hormone (LH). The Graafian follicle ruptures to release the (secondary oocyte) ovum by ovulation.
Luteal Phase (Days 15-28)	The luteal phase begins after ovulation and lasts until the start of the next menstrual period. During this phase, the ruptured follicle transforms into a structure called the corpus luteum, which secretes progesterone and some estrogen. These hormones help maintain the thickened endometrial lining and prepare the uterus for implantation of a fertilized egg. If fertilization does not occur, the corpus luteum degenerates, leading to a decrease in hormone levels and the start of menstruation.

FERTILISATION

During coitus, the semen is released into the vagina, passes through the cervix of the uterus and reaches the **ampullary-isthmic** junction of the fallopian tube.

- The ovum is also released into the junction for fertilisation to occur.
- The process of fusion of the sperm and the ovum is known as fertilisation.
- During fertilisation, the sperm induces changes in the zona pellucida and blocks the entry of other sperms. This ensures that only one sperm fertilises an ovum.
- **The enzymatic secretions of the acrosomes** help the sperm enter the cytoplasm of the ovum.
- This causes the completion of meiotic division of the secondary oocyte, resulting in the formation of a haploid ovum (ootid) and a secondary polar body.
- Then, the haploid sperm nucleus fuses with the haploid nucleus of the ovum to form a diploid zygote.

IMPLANTATION

- Mitosis starts as the zygote moves through the isthmus of the oviduct (cleavage) and forms 2, 4, 8, 16 daughter cells called blastomeres.
- The 8−16 cell embryo is called a morula,which continues to divide to form the blastocyst. The morula moves further into the uterus.
- The cells in the blastocyst are arranged into an outer trophoblast and an inner cell mass.
- The trophoblast gets attached to the uterine endometrium, and the process is called implantation. This leads to pregnancy.
- The inner cell mass gets differentiated to form the embryo.

GESTATION/ PREGNANCY

- After implantation, the trophoblast forms finger-like projections called **chorionic villi,** surrounded by the uterine tissue and maternal blood.
- The chorionic villi and the uterine tissue get integrated to form the placenta, which helps in supplying the developing embryo with oxygen and nutrients, and is also involved in the removal of wastes.
- The **placenta** is connected to the embryo by the umbilical cord. The placenta acts as an endocrine gland, and produces the human chorionic gonadotropins, human placental lactogen, oestrogen, progesterone and relaxin (later stages of pregnancy).
- These hormones support foetal growth and help in the maintenance of pregnancy.

Hormones like oestrogen, progestogen, cortisol, prolactin, etc., are increased several folds in the maternal blood.

DEVELOPMENT OF EMBRYO

- Immediately after implantation, the inner cell mass(embryo) gets differentiated into the, ectoderm mesoderm and endoderm, which give rise to the different tissues. This ability of the inner cell mass is due to the presence of multi-potent cells called stem cells.
- Most of the major organs are formed at the end of 12 weeks of pregnancy; during the 5th, the month limbs and body hair are formed; by the 24th week, the eyelids separate and eyelashes are formed. At the end of nine months, the foetus is fully formed.

PARTURITION AND LACTATION

- Human pregnancy has the duration of 9 months. This duration is called the gestation period
- At the end of this period, vigorous uterine contractions lead to the delivery of the foetus. This process is called **parturition.**
- Parturition is a neuro-endocrine mechanism, and is started by the signals from the developed foetus and the placenta, which produce the **foetal ejection reflex.**
- This causes the release of **oxytocin** from the pituitary, which causes stronger uterine contractions.
- This leads to the expulsion of the baby along with the placenta.
- During pregnancy, the mammary glands undergo differentiation, and milk is produced during the end of pregnancy.
- The milk produced during the first few days of lactation is known as **colostrum**. It contains several antibodies that aid the newborn to develop resistance.

QUESTIONS

1. Testis like ovary develop within the pelvic cavity, but in the later part of the development testis descend out of the abdominal cavity. What could be the reason for it?
2. Placenta is an intimate connection between maternal and foetal tissues. It is a dual organ. Justify?
3. Seminiferous tubules are the factories for the generation of spermatozoa, but they can't work on their own. What stimulus do they get? Is the stimulus generated within the tubule or somewhere else?
4. There is no direct connection between ovary and fallopian tube, so there is possibility that the ovum may be released within the abdominal cavity, but it does not happen. How does a fallopian tube prevent this situation?
5. The generating tissue must be accompanied by nursing tissue also. Elaborate this statement with respect to human testis?
6. For completing the act of fertilization, the sperm must fuse with the ovum, but the latter is surrounded by lot of extra follicular cells. How does the sperm manage to fuse with the ovum?
7. Fertilization requires one male and one female gamete, but there are approximately 200 million sperms in a single ejaculation. How then the female reproductive system and the ovum ensure monospermy?
8. Spermatogenesis and spermiogenesis are two different processes but both are essential for male reproductive system. How do they differ from each other?

ANSWERS

1. Spermatogenesis – Required temperature is app.350 C, which can be maintained if they descend out.
2. Placenta- attachment, transport route and endocrine gland.
3. Hormonal stimulus – obtained from pituitary gland.
4. Fallopian funnel has fimbriated margins that develop a funnelling effect to entrap the released ovum.
5. Testis – generating tissue- Generative layer of seminiferous tubule. Nursing tissue – Sertoli cells.
6. Sperm acrosome release sperm lysins which digest the additional layers around the ovum.
7. Touching of the sperm at the right position on the ovum initiates a reaction that blocks the penetration of any further sperm thus polyspermy prevented.
8. Spermatogenesis is spermatogonia to spermatid, but spermiogenesis is from spermatid to spermatozoa.

ASSERTION AND REASONING QUESTIONS

(A)Both A and R are true, and R is the correct explanation of A.

(B)Both A and R are true, but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

1. Assertion: Seminiferous tubule is lined by male germ cells and Sertoli cells.
   Reason: Seminiferous tubule is structural and functional unit of testes. [A]
2. Assertion: The inner lining of the uterus is endometrium.
   Reason: The endometrium undergoes cyclical changes during menstrual cycle. [A]
3. Assertion: The spermatids are transformed into sperms during spermiogenesis.
   Reason: Mitosis and meiosis are involved during spermiogenesis. [C]
4. Assertion: The human sperm is a microscopic structure composed of head, neck, middle piece and tail.
   Reason: The functions of male accessory ducts and glands are maintained by Androgens. [B]
5 Assertion: The embryo with 8 to 16 blastomeres is called morula.
   Reason: The cells of morula are arranged into an outer layer called trophoblast and an inner group of cells called inner cell mass. [C]
6. Assertion: Only one sperm fertilises an ovum.
   Reason: During fertilisation, the sperm induces changes in the zona pellucida and blocks the entry of other sperms. [A]
7. Assertion: Not all copulations lead to fertilisation and pregnancy.
   Reason: One reason can be that sperms and ovum are not transported simultaneously to the region where fertilisation occurs. [A]
8. Assertion: In the testis, spermatogenesis occurs in the seminiferous tubules and testosterone secretion takes place from Sertoli cells.
   Reason: Testosterone brings growth and maturation of secondary sex organs and also the development secondary sexual characteristics [D]
9. Assertion: In Graafian follicles, the primary oocyte and the follicle cells may be regarded as sibling cells.
   Reason: Both arise from the same parent cell, the oogonium, by mitotic divisions. [C]
10. Assertion: Parturition is induced by neural signal in maternal pituitary.
    Reason: At the end of gestation period, the maternal pituitary releases oxytocin which causes uterine contractions. [D]

1.CASE BASED QUESTIONS

Read the following passage and answer questions:

The reproductive cycle in the human female is called menstrual cycle. The first menstruation begins at puberty and is called menarche. In human females, menstruation is repeated at an average interval of about 28/29 days, and the cycle of events starting from one menstruation till the next one is called the menstrual cycle. One ovum is released (ovulation) during the middle of each menstrual cycle. The cycle starts with the menstrual phase, when menstrual flow occurs, and it lasts for 3-5 days.

I) The first menstruation is called as ……
a) Menopause b) Menarche c) maturity d) Andropause

II) Identify the incorrect statement …….
a) Lack of menstruation may be indicative of pregnancy
b) LH & FSH increases gradually during follicular phase
c) Corpus luteum acts as a temporary endocrine gland
d) Oestrogens maintain endometrium

III) Ovulation occurs during
a) Beginning of each menstrual cycle
b) End of each menstrual cycle
c) Middle of first menstrual cycle only
d) Middle of each menstrual cycle

IV) Read the following

i.) Menstruation cycle has 4 phases ii). Luteal phase is called secretory phase
iii.) Follicular phase is also called proliferative phase.
iv). Primary Follicles grow to fully mature graafian follicle in follicular phase.
The correct combinations…
a) Only i & ii b) Only i & iii c) Only i & iv d) All
V) Assertion (A): Endometrium undergoes cyclical changes during menstrual cycle.
Reason (R): Degeneration & regeneration of endometrium takes place during menstrual cycle.
a) A and R are true, and R is the correct explanation of A
b) A and R are true, and R is not the correct explanation of A
c) A is true, R is false
d) A is false, R is true
ANSWERS: (I) - b, (II) - d, (III) - d, (IV) - d, (V) - a

2. CASE BASED QUESTIONS

Read the following passage and answer questions: The process of formation of a mature female gamete is called oogenesis. Oogenesis is initiated during the embryonic development stage when a couple of million gamete mother cells (oogonia) are formed within each foetal ovary; no more oogonia are formed and added after birth. These cells start division and enter prophase-I of the meiotic division and get temporarily arrested at that stage, called primary oocytes. Each primary oocyte then gets surrounded by a layer of granulosa cells and is called the primary follicle. Many of these follicles degenerate during the phase from birth to puberty. Therefore, at puberty only 60,000-80,000 primary follicles are left in each ovary. The primary follicles get surrounded by more layers of granulosa cells and a new theca and are called secondary follicles.

1. Find out the correct statement ….
   a) Primary follicle is with oogonia
   b) Primary follicle is with primary oocyte
   c)Secondary follicle is with secondary oocyte.
   d)Tertiary follicle is with primary oocyte without antrum.

2. i. Primary follicles are surrounded by many layers of granulosa cells & theca
   ii Secondary follicles are surrounded by theca.
   iii. Antrum is formed at Tertiary follicle stage.
   The correct combinations….
   a) Only I b) Only ii c) Only iii d) i, ii & iii only

3. Assertion (A): Primary oocyte completes its first meiotic division in tertiary follicle.
   Reason (R): Antrum develops during secondary follicular stage.
   a) A and R are true, and R is the correct explanation of A
   b) A and R are true, and R is not the correct explanation of A
   c) A is true, R is false
   d) A is false, R is true
4. Read the following & arrange them in a sequence ….
   a) Ova b) Oogonia c) Primary oocyte d) Secondary oocyte e) Graffian follicle
   a) a-c-b-d-e b) c-d-e-a-b
   c)b-d-c-e-a d) b-c-d-e-a
   ANSWERS: (1) - b, (2) - d, (3) - c, (4) – d

MULTIPLE CHOICE QUESTIONS

1. Ovulation in the human female normally takes place during the menstrual cycle.

(a) at the mind secretory phase
(b) just before the end of the secretory phase
(c) at the beginning of the proliferative phase
(d) at the end of the proliferative phase.

2. If mammalian ovum fails to get fertilised, which one of the following is unlikely?
(a) Corpus luteum will disintegrate.
(b) Progesterone secretion rapidly
(c) Estrogen secretion increases.
(d) Primary follicle starts developing.
3. Which part of the sperm plays an important role in penetrating the egg membrane? (a) Allosome (b) Tail (c) Autosome (d) Acrosome
4. In human adult female's oxytocin –
(a) stimulates pituitary to secrete vasopressin
(b) causes strong uterine contractions during parturition
(c) is secreted by anterior pituitary
(d) stimulates growth of mammary gland
5. Spot the odd one out from the following structures with reference to the male reproductive system.
(a) Rate testis (b) Epididymis (c) Vasa efferentia (d) Isthmus
6. How many sperms are formed from 4 primary spermatocytes?
(a) 4 (b)1 (c) 16 (d) 32
7. In spermatogenesis, reduction division of chromosome occurs during conversion of -
(a) spermatogonia to primary spermatocytes.
(b) primary spermatocytes to secondary spermatocytes
(c) secondary spermatocytes to spermatids
(d) spermatids to sperms.
8. 1st polar body is formed at which stage of oogenesis?
(a) 1st meiosis (b) 2nd mitosis (c) 1st mitosis (d)Differentiation
9. In the event of pregnancy, the corpus luteum persists under the influence of –
(a) LH (b) FSH (c) chorionic gonadotropin (d) progesterone.
10. What is true about cleavage in the fertilised egg in humans?
(a) It starts while the egg is in Fallopian tube.
(b) It starts when the egg reaches uterus.
(c) It can start in uterus or in oviduct.
(d) It is identical to the normal mitosis.

ANSWERS: (1) - b, (2) - c, (3) - d, (4) – b, (5) – d, (6) – c, (7) – a, (8) – a, (9) – a, (10) – a

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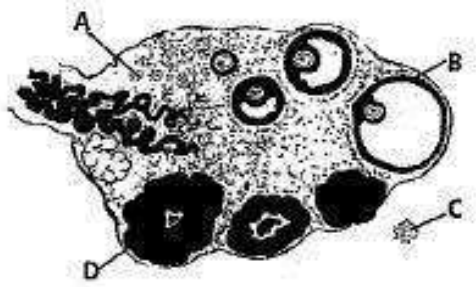
LONG ANSWER QUESTION

1. (i) Draw a diagram of a human sperm. Label any four parts and write their functions.
(ii)In a human female, probability of an ovum to get fertilized by more than one sperm is impossible. Give reason.
2. The figure below shows the sequence of changes within the ovary that occur during the menstrual cycle.
a) Name the process A. Name the hormone that plays an important role during this event.
b) Identify B and name the hormone that regulates the maturation of B.



c) Identify and write the function of D.
3. Explain the functions of the following structures in the human male

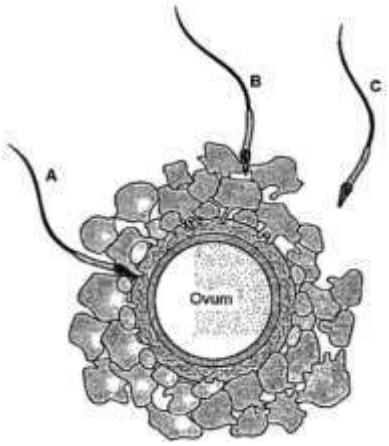
reproductive system.

(a) Scrotum (b) Leydig cells (c) Male accessory glands

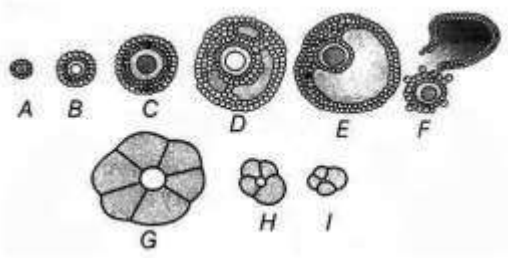
4. (a) Explain the menstrual phase in a human female. State the levels of ovarian and pituitary hormones during this phase.
   (b) Why is follicular phase in the menstrual cycle also referred as proliferative phase? Explain

.

   (c) Explain the events that occur in a graafian follicle at the time of ovulation and thereafter.
   (d) Draw a graafian follicle and label antrum and secondary oocyte.
5. The figure given below shows 3 sperms A, B and C.
   a) Which one of the three sperms will gain entry into the ovum?
   b) Describe the associated changes induced by it on the ovum.



6. i) Describe the development of placenta during pregnancy in human female.
   ii) Explain its role.
7. The following isthe illustration of the sequence of ovarian events(a - i) in a human female.



   (i) Identify the figure that illustrates ovulation and mention the stage of oogenesis it represents.
   (ii) Name the ovarian hormone and the pituitary hormone that have caused the above mentioned event.
   (iii) Explain the changes that occur in the uterus simultaneously in anticipation.
   (iv) Write the difference between ‘c’ and ‘h’
   (v) Draw a labelled sketch of the structure of a human ovum prior to fertilization.

CHAPTER- 4

REPRODUCTIVE HEALTH

GIST OF MAJOR AND MINOR CONCEPTS

According to the World Health Organization (WHO) - reproductive health means a total Well-being in all

Aspects of reproduction i.e. physical, emotional, behavioral and social.

REPRODUCTIVE HEALTH: PROBLEM AND STRATEGIES

* In India "family planning" plan was initiated in 1951.

* Reproductive and child health care (RCH) program- Creating awareness among the people about various reproduction related aspects and providing facilities and support for building up a

Reproductively healthy society.

* Important role is played by - Audio-visual, print-media governmental and non-governmental

agencies, Parents, teachers and friends.

* Proper education about reproductive organs, adolescence and related changes, safe and

* Hygienic sexual practices, sexually transmitted diseases (STD), AIDS should be encouraged to

Provide right information to the young generation.

* Education about birth control options of fertile couples, care of pregnant mothers, post-natal

Care of the mother and child, importance of breast feeding, equal opportunities for the male

and the female child should be properly addressed.

Amniocentesis –

* Amniocentesis is a procedure used to take out a small sample of the amniotic fluid for testing of

Chromosomal abnormalities in developing embryo.

 Misuse- 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 CONTROLL

 MMR- Maternal mortality rate (MMR)

 IMR- Infant mortality rate

CONTRACEPTIVE METHODS

Natural methods	Work on the principle of avoiding chances of ovum and sperms meeting.
Periodic abstinence	Couples avoid or abstain from coitus from day 10 to 17 of the menstrual cycle when ovulation could be expected.
Withdrawal or coitus interruptus	Male partner withdraws his penis from the vagina just before ejaculation so as to avoid insemination.
Lactational amenorrhea	As long as the mother breast-feeds the child fully, chances of conception are almost nil (up to 6 months)
Barrier methods	Ovum and sperms are prevented from physically meeting with the help of barriers.
Condoms	Made of thin rubber/ latex sheath that are used to cover the penis in the male/ vagina or cervix in the female, just before coitus so that the semen would not enter into the female reproductive tract. Also protect. from STDs
Other examples of barrier methods	Diaphragms, cervical caps and vaults.
IUDs	These are inserted by doctors or expert nurses in the uterus through vagina. IUDs increase phagocytosis of sperms within the uterus and the Cu ions released suppress sperm motility and the fertilizing capacity of sperms. The hormone releasing IUDs, in addition, make the uterus unsuitable for Implantation and the cervix hostile to the sperms.
Non-medicated	Lippes loop
Copper releasing	**CuT, Cu7, Multiload 375**
Hormone releasing IUDs	Progestasert, LNG-20
Pills	Pills of either progestogens or progestogen–estrogen combinations Pills have to be taken daily for a period of 21 days starting preferably within the first five days of menstrual cycle. After a gap of 7 days (menses) it has to be repeated in the same pattern. Pills inhibit ovulation and implantation, alter the quality of cervical mucus to prevent/ retard entry of sperms. CDRI:- Central drug research institute (Lucknow) It develops Saheli–a new oral contraceptive pill for the females. Saheli – the new oral contraceptive for the females contains a non-steroidal preparation. It is a 'once a week' pill with very few side effects and high contraceptive Value.
Injection	Progestogens alone or in combination with estrogen can also be used by Females as injections or implants under the skin. Administration of Progestogens or progestogen-estrogen combinations or IUDs within 72 hours of coitus have been found to be very effective as emergency contraceptives as they could be used to avoid possible pregnancy due to rape or casual unprotected intercourse.
Surgical methods/ Sterilization	
Vasectomy	In male a small part of the vas deferens is removed or tied up through a small incision on the scrotum
Tubectomy	a small part of the fallopian tube is removed or tied up through a small incision in the abdomen or through vagina.

An ideal contraceptive should be-

 User friendly

 Easily available

 Effective

 Reversible

 No side effects

 No way interferes with sexual desire and sexual act.

MEDICAL TERMINATION OF PREGNANCY (MTP)

 Voluntary termination of pregnancy before full term is called MTP or induced abortion.

 In India, MTP is legalized in 1971 with some strict conditions to avoid its misuse like female Foeticide.

 MTP is used to get rides of unwanted pregnancy due to unprotected intercourse or failure of Contraceptives used during coitus or rapes.

 It is relatively safe during first trimester or up to 12 weeks of pregnancy.

SEXUALLY TRANSMITTED DISEASES (STDS)

 Diseases or infections which are transmitted through sexual intercourse are collectively called Sexually transmitted diseases (STD) or venereal diseases (VD) or reproductive tract infections (RTI).

 Examples- HIV- AIDS, Genital warts, Hepatitis, Gonorrhea, syphilis, genital herpes, chlamydiasis, Trichomoniasis etc.

 Some infections like 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.

One could be free of these infections by following the simple principles given below:

(i) Avoid sex with unknown partners/multiple partners.

(ii) Always use condoms during coitus.

(iii) In case of doubt, one should go to a qualified doctor for early detection and get complete treatment If diagnosed with disease.

INFERTILITY

The couples which are unable to reproduce children in spite of unprotected sexual cohabitation are

Called infertile.

Reason of infertility:

Physical, Congenital, Diseases, Drugs, Immunological, Psychological,

ART (assisted reproductive technologies)- Infertile couples can be assisted to have children through

certain special techniques commonly called (ART).

Examples of ARTs-

In vitro fertilization (IVF)/ Test Tube baby	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 Blastomere 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.
AI (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.

IMPORTANT QUESTIONS

MCQs Q.1. Tubectomy is a method of sterilization in which

(a) one fallopian tube is removed

(b) both fallopian tubes are removed

(c) small part of fallopian tube is removed

(d) small part of vas deferens is removed

Q.2. Following statements are given regarding MTP.

(i) MTPs are generally advised during first trimester

(ii) MTPs are used as a contraceptive method

(iii) MTPs are always surgical

(iv) MTPs require the assistance of qualified medical personnel

Choose the correct option. (a) (ii) and (iii)

(b) (i) and (iii)

(c) (i) and (iv)

(d) (i) and (ii)

Q.3. The method of directly injecting a sperm into ovum in Assisted Reproductive Technology is called (a) GIFT

(b) ZIFT

(c) ICSI

(d) ET

Q.4. Increased IMR and decreased MMR in a population will

(a) cause rapid increase in growth rate

(b) result in decline in growth rate

(c) not cause significant change in growth rate

(d) result in an explosive population

Q.5. In-vitro fertilization involves transfer of ____ into the fallopian tube.

(a) embryo up to eight cell stage

(b) embryo of thirty-two cell stage

(c) zygote

(d) either zygote or embryo up to eight cell stage

Q.6. Intensely lactating mothers do not generally conceive due to the

(a) suppression of gonadotropins

(b) hyper secretion of gonadotropins

(c) suppression of gametic transport

(d) suppression of fertilization

Q.7. Sterilisation techniques are generally fool proof methods of contraception with least side effects. Yet, this is the last option for the couples because

(i) it is almost irreversible

(ii) of the misconception that it will reduce sexual urge

(iii) it is a surgical procedure

(iv) of lack of sufficient facilities in many parts of the country

Choose the correct option.

a) (i) and (iii

(b) (ii) and (iii)

(c) (ii) and (iv)

(d) (i), (ii), (iii) and (iv)

Q.8. Which of the following STDs are caused by bacteria?

(a) AIDS and Genital Herpes

(b) Syphilis and gonorrhea

(c) Trichomoniasis and scabies

(d) All of these

Q.9. Which of the followings is example of hormone releasing IUDs?

(a) CuT and Multilobed 375

(b) LNG-20 and Progestasert

(c) Lippe's loop

(d) Both (b) and (c)

Q10.A national level approach to build up a reproductively healthy society was taken up in our country in

(a) 1950s

(b) 1960s

(c) 1980s

(d) 1990s

Q.11. Emergency contraceptives are effective if used within

(a) 72 hrs of coitus

(b) 72 hrs of ovulation

(c) 72 hrs of menstruation

(d) 72 hrs of implantation

Q.12. Choose the right one among the statements given below.

(a) IUDs are generally inserted by the user herself

(b) IUDs increase phagocytosis reaction in the uterus

(c) IUDs suppress gametogenesis

(d) IUDs once inserted need not be replaced

Q.13. IUDs release copper ions to

(a) prevent ovulation

(b) suppress mortality

(c) increase phagocytosis of sperm

(d) make the uterus unsuitable for implantation.

Q.14. From the sexually transmitted diseases mentioned below, identify the one which does not specifically affect the sex organs

(a) Syphilis

(b) AIDS

(c) Gonorrhoea

(d) Genital warts

Q.15. Condoms are one of the most popular contraceptives because of the following reasons

. (a) These are effective barriers for insemination

(b) They do not interfere with coital act

(c) These help in reducing the risk of STDs

(d) All of the above

Q.16. Which of the following is/are barrier method of contraception?

(a) Rhythm method/Periodic abstinence

(b) Lactational amenorrhea

(c) Withdrawal method

(d) None of these

Q.17. Which of the following is not a cause of population explosion in India?

(a) Better health care

(b) Increased IMR

(c) Decline MMR

(d) Increased population of reproductive age

Q.18. Choose the correct statement regarding the ZIFT procedure.

(a) Ova collected from a female donor are transferred to the fallopian tube to facilitate zygote formation

. (b) Zygote is collected from a female donor and transferred to the fallopian tube

(c) Zygote is collected from a female donor and transferred to the uterus

(d) Ova collected from a female donor and transferred to the uterus

Q.19. The correct surgical procedure as a contraceptive method is

(a) ovariectomy

(b) hysterectomy

(c) vasectomy

(d) castration

Q.20. Diaphragms are contraceptive devices used by females. Choose the correct option from the statements given below

(i) They are introduced into the uterus

(ii) They are placed to cover the cervical region

(iii) They act as physical barriers for sperm entry

(iv) They act as spermicidal agents Choose the correct option: (a) (i) and (ii) (b) (i) and (iii) (c) (ii) and (iii) (d) (iii) and (iv)

Q.21. Lactational amenorrhoea means

(a) Absence of menstruation during pregnancy

(b) Absence of menstruation during lactation

(c) Excessive bleeding during menstruation

(d) No production and secretion of milk

Q.22. Medical Termination of Pregnancy is safe up to

(a) 8 weeks of pregnancy

(b) 12 weeks of pregnancy

(c) 18 weeks of pregnancy

(d) 24 weeks of pregnancy

ASSERTION-REASON QUESTIONS Directions: In the following questions, a statement of assertion is followed by a statement of reason.

Mark the correct choice as: (a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(c) If Assertion is true but Reason is false.

(d) If both Assertion and Reason are false.

1. Assertion: Amniocentesis is often misused

Reason: Amniocentesis is meant for determining the genetic disorders in the foetus, but it is being used to determine the sex of the foetus, leading to the death of the normal female foetus.

2. Assertion: Cu-T and Cu-7 do not suppress sperm-motility.

Reason: Hormones released by them do not affect sperm motility.

3. Assertion: Pills are very effective contraceptive methods with lesser side effects.

Reason: Pills inhibit ovulation and implantation as well as retard entry of sperms.

4. Assertion: In zygote intra fallopian transfer the zygote is transferred to the fallopian tubes of the female

. Reason: ZIFT is an in vivo fertilisation method

. 5. Assertion: Artificial insemination is the method of introduction of semen inside the female.

Reason: This technique is used in those cases where males have low sperm count.

6. Assertion: IUT is the transfer of embryo with more than 8 blastomeres into the fallopian tubes. Reason: This is a very popular method of forming embryos in-vivo.

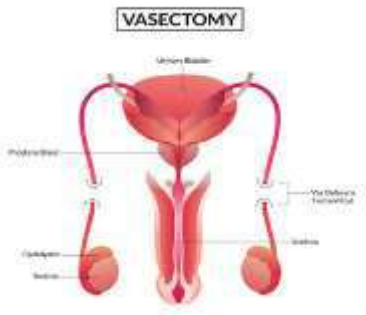
7. Assertion: Saheli, the new oral contraceptive for the females, contains a steroidal preparation. Reason: It is “once in a day” pill with very few side effects.

ANSWER KEY MCQs 1. C 2.C 3.C 4.C 5D 6.A..7. D.8. B 9.B 10A. 11.A.12.B 13B 14.B 15D.16D.17.D18. B19.C 20.C 21. B 22.B

ASSERTION-REASON 1. A 2.D 3. B 4.C 5. A 6.D 7. D

DIAGRAM BASED QUESTION ANSWERS QUESTIONS:

1. Given diagram is the surgical methods of birth control. Answer the following related questions:



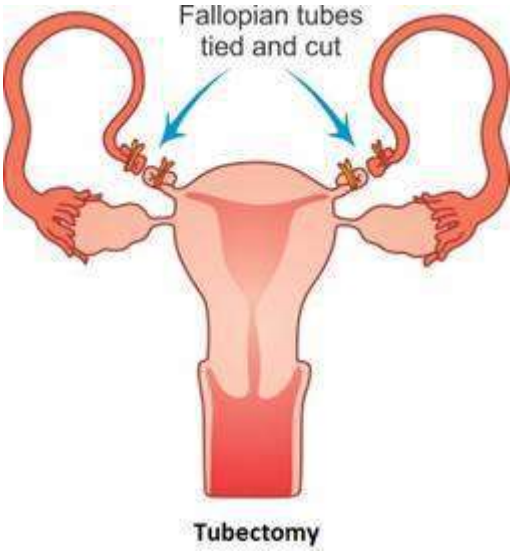
(a) What does the above figure depict?

(b) Does vasectomy prevent spermatogenesis in male?

(c) Which structure is removed or tied up during vasectomy?

(d) What type of semen is ejaculated by vasectomy in male?

2. Examine the given figure and answer the related questions that follows:



(a) What does the above figure depict?

(b) Does tubectomy prevent ovulation in females?

(c) Which structure of the fallopian tube is removed or tied up in tubectomy?

(d) How does tubectomy act as a contraceptive method in females?

ANSWERS:

1. (a) The figure depicts vasectomy in male human beings.

(b) No, vasectomy never prevents spermatogenesis but prevents the ejaculation of sperms.

(c) Two vasa deferens are interrupted by giving cuts or ligation.

(d) Nature of semen is azoospermia and discharge is only composed of seminal plasma i.e., sex gland‟s secretion.

2. (a) The given figure depicts tubectomy.

(b) No, tubectomy never prevents ovulation in female human beings but it blocks the movement of ovum toward the ampulla of fallopian tube or oviduct.

(c) Two oviducts or fallopian tubes are interrupted by giving cuts or ligation.

(d) It always prevents the passage of ovum to the ampulla i.e., site of fertilization. Thus, prevent contraception.

Very Short Answer Type Questions

1- Define reproductive health according to WHO. Which society will be called a reproductively healthy society?

Ans: According to the World Health Organisation (WHO) - reproductive health means a total Well-being in all aspects of reproduction i.e. physical, emotional, behavioral and social.

Reproductively healthy society includes people having physically and functionally healthy reproductive organs. They have normal behavioural and emotional interaction in sex-related matters.

2- Give the term for prenatal diagnostic technique aimed to know the sex of developing foetus and to detect congenital disorders.

Ans: Amniocentesis

3- Which research institute develops contraceptive pill "Saheli"?

Ans: CDRI (Central Drug Research Institute) located at Lucknow.

4- Why tubectomy is considered a contraceptive method?

Ans: In tubectomy, a small part of fallopian tube is cut and tied up to block the entry of sperm, so as to prevent fertilization.

5- Which methods of contraception are also known as sterilization method?

Ans: Tubectomy and Vasectomy

6- Expand ICSI.

Ans: Intra cytoplasmic sperm injection.

7- Categorize the following contraceptive methods as natural, IUDs, Barrier or hormonal-

Lippes loop, lactation amenorrhea, Vault, Saheli

Ans: Lippes loop- IUD, Lactational amenorrhea – Natural, Vault- Barrier, Saheli- Hormonal

8- Why has the Government imposed a statutory ban on amniocentesis?

Ans: The Government has banned amniocentesis to check on the incidences of female foeticides.

9- Name two STDs that can be transmitted through contaminated blood.

Ans: Hepatitis, HIV-AIDS

10- How can a possible pregnancy due to rape or casual unprotected intercourse avoided?

Ans: Administration of progestogens or progestogens-estrogen combinations or IUDs within 72 hours of coitus

Short Answer Types Questions

1- Removal of gonads cannot be considered as a contraceptive option. Justify.

Ans: Removal of gonads leads to sterility of individuals therefore it is not considered as a contraceptive option.

2- What do oral pills contain and how do they act as effective contraceptives.

Ans: Oral contraceptive or pills are either progestogens or progestogen- estrogen combinations.

They function as contraceptives by

(i) Inhibiting ovulation.

(ii) Inhibiting implantation.

(iii) Altering the quality of cervical mucus to prevent or stop the entry of sperms

3- Mention simple principles by which one could be free of STDs?

Ans- i- Avoid sex with unknown partner/ multiple partner.

Ii-Always use barrier method of contraceptive

Iii-Consult doctor in case of any symptom for early detection and treatment

4- Fill the a. b, c, d with appropriate answer in the given table-

Method of Birth Control	**Devic**e
1. Barrier	a
2. IUD **3. Surgical Technique**	b
3. Surgical Technique	c
4. Natural	d

Ans: a- Condom, b- Cu- t, Vasectomy d- Coitus interruptus

5- Mention at least four reason of sterility?

Ans: physical, congenital diseases, drugs, immunological or physiological

6- Expand ZIFT and IUT. How these are different from each other?

Ans: ZIFT (zygote intra fallopian transfer) – it is transfer of the zygote or early embryos (with up to 8 blastomeres) into the fallopian tube.

IUT– intra uterine transfer- in this Embryo with more than 8 blastomeres is transferred into the Uterus

7- Mention one positive and one negative application of amniocentesis.

Ans- Positive- helpful in detection of congenital disorder

Negative- used in sex determination and female foeticides

8- An infertile couple is advised to adapt test tube baby programme. Describe two principle procedures adapted to such technologies.

Ans: In-vitro fertilization (IVF): In this process, the fertilization takes place outside the body (test tube baby). The following techniques are included in IVF:

ZIFT - In this sperm from a male donor and ovum from a female donor are fused in the laboratory. The zygote (8 blastomere stage) so formed is transferred into the fallopian tube.

GIFT (Gamete Intrafallopian Transfer)- In GIFT, females who cannot produce ovum, but can provide suitable conditions for the fertilization of ovum, are provided with ovum from a donor.

9- Describe Lactational amenorrhea method of birth control.

Ans: Lactational Amenorrhea is a natural method of contraception. In lactating mother there is complete absence of menstruation and the chances of conceiving are almost negligible.

10- How are non-medicated IUDs different from hormone releasing IUDs? Give examples.

Ans. (a) Non- medicated IUDs - Lippes loop, Copper releasing IUDS (CuT, Multiload 375), these increase phagocytosis of sperms within uterus and release copper ions which suppress sperm motility and fertilizing capacity of sperm.

(b) Hormone releasing IUDs – Progestasert, LNG-20 -These makes uterus unsuitable for implantation and the cervix hostile to sperms.

Long Answer Type Questions

1- What is MTP? What is its safety concern and in what cases MTPs are allowed in India.

Ans: MTP is Medical termination of pregnancy or induced abortion.

MTPs are considered relatively safe during the first trimester, i.e., up to 12 weeks of pregnancy.

Second trimester abortions are much more risky.

Government of India legalized MTP in 1971 with some strict conditions to avoid its misuse. It is

to get rid of unwanted pregnancies either due to casual unprotected intercourse or failure of the contraceptive used during coitus or rapes. MTPs are also essential in cases where pregnancy could be harmful or even fatal to the mother/ foetus or both.

2- Some contraceptive can be taken orally. Give examples of such contraceptives and explain

mechanism of their action. In what dose it is advised to take by females?

Ans: Oral contraceptives (pills) contain progestogens or progestogen–estrogen combinations.

Pills have to be taken daily for a period of 21 days starting preferably within the first five days of

menstrual cycle. After a gap of 7 days (during which menstruation occurs) it has to be repeated

in the same pattern.

They inhibit ovulation and implantation as well as alter the quality of cervical mucus to prevent

retard entry of sperms.

Pills have to be taken daily for a period of 21 days starting preferably within the first five days of

menstrual cycle. After a gap of 7 days (during which menstruation occurs) it has to be repeated

in the same pattern.

Example- Saheli

3- Describe any three types of contraceptive methods widely used by couple to avoid pregnancy.

Ans:

Natural Method	
Periodic abstinence	couples avoid or abstain from coitus from day 10 to 17 of the menstrual cycle when ovulation could be expected
Withdrawal or coitus interruptus	Male partner withdraws his penis from the vagina just before ejaculation so as to avoid insemination
Lactational amenorrhea	as long as the mother breast-feeds the child fully, chances of conception are almost nil (up to 6 months)
IUDs	IUDs These are inserted by doctors in the uterus through vagina.
	IUDs increase phagocytosis of sperms within the uterus and the Cu ions released suppress sperm motility and the

	fertilizing capacity of sperms. It also make the uterus unsuitable for implantation and the cervix hostile to the sperms.
	Non-medicated -Lippes loop
	Copper releasing - CuT, Cu7, Multiload 375
	Hormone releasing - Progestasert, LNG-20
Injection	Progestogens alone or in combination with estrogen.

.

4- What are STDs? Give five examples of STDs and also suggest ways to prevent them.

Ans: Diseases or infections which are transmitted through sexual intercourse are collectively

called sexually transmitted diseases (STDs).

Examples- HIV-AIDS, Gonorrhoea, syphilis, genital herpes, chlamydiasis, genital warts, trichomoniasis, hepatitis-B.

Ways to prevent-

(i) Avoid sex with unknown partners/multiple partners.

(ii) Always use condoms during coitus.

(iii) In case of doubt, one should go to a qualified doctor for early detection and get complete

Treatment if diagnosed with disease.

5- Reproductive and Child Healthcare (RCH) programs are currently in operation. One of the

Major tasks of these programs is to create awareness amongst people about the wide range of

Reproduction-related aspects. This is important and essential for building a reproductive

Health society.

"Providing sex education in schools is one of the ways to meet this goal." Give four points in

support of your opinion regarding this statement. Also List any two indicators that

indicate a reproductively healthy society.

Ans: Sex education is important in schools:

(a) To aware about myths and misconceptions.

(b) For awareness about reproduction.

(c) To aware STDs

(d) Proper guidance about sex abuse, sex-related crimes, etc.

Indicators about a reproductively healthy society-

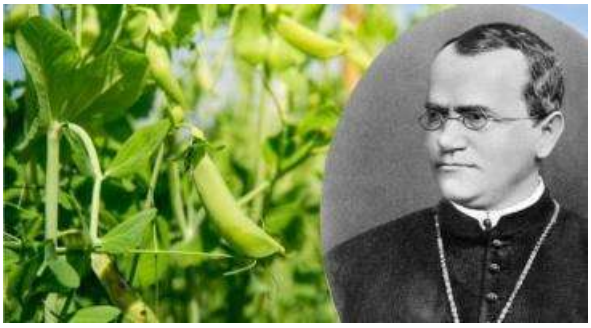
(a) Low infant mortality rate (IMR)

(b) Low maternal mortality rate (MMR)

CHAPTER – 5 : PRINCIPLES OF INHERITANCE AND VATIATION

1. Some definitions

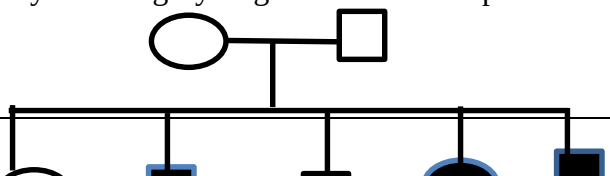
	Inheritance	Process by which characters are passed on from parents to progeny/offspring
	Variations	Differences existing among the individuals of a progeny and also with the parents
	Gene	Unit of inheritance
	Allele	Different form a single gene that occupy same loci on homologous chromosomes, and they are responsible for determining a trait.
	Homozygous	Has similar alleles for a trait
	Heterozygous	Has dissimilar alleles for a trait
	Dominant allele	the allele that expresses phenotypically in heterozygous condition
	Recessive alllele	The allel which fails to express in heterozygous condition
	Phenotype	External appearance of the individual
	Genotype	Genetic make up of the individual
	Monohybrid cross	Cross between 2 parents which differ for a pair of alleles/character
	Dihybrid cross	Cross between 2 parents which differ for 2 pairs of alleles/character
	Law of dominance	In a Hybrid, the allelic pair responsible for a trait is in heterozygous condition. One of the alleles expresses phenotypically and is called dominant

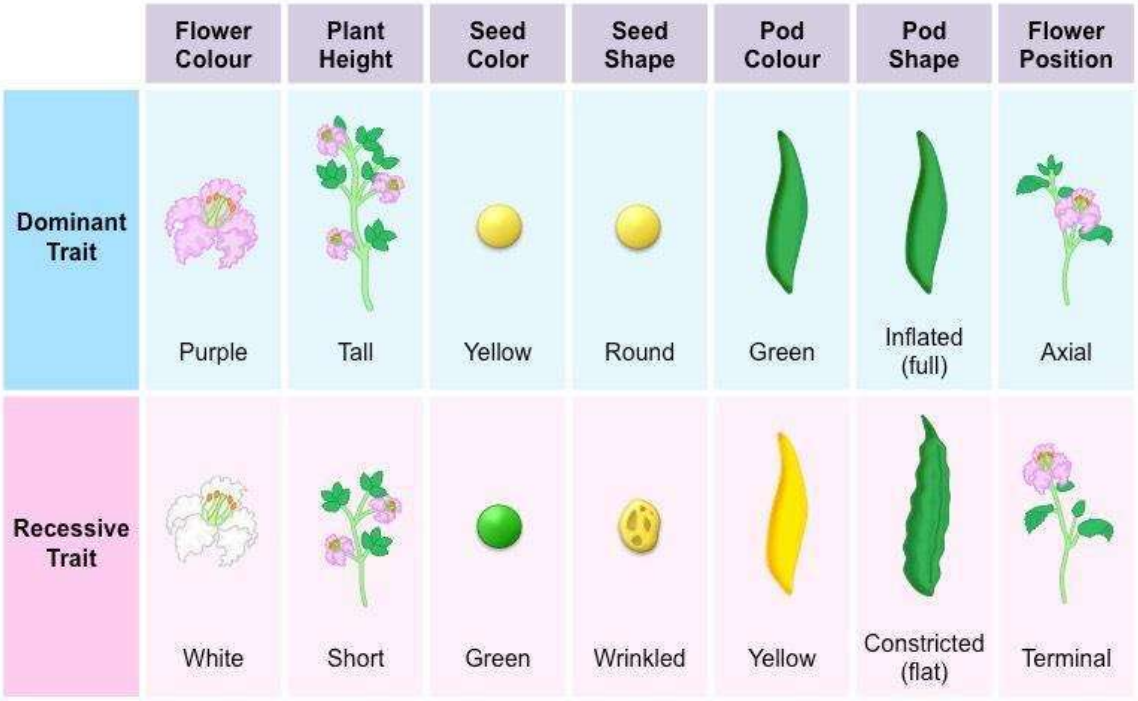
		allele. While the other fails to express and is called recessive allele . So, the progeny resembles only one of the parents i.e. dominant phenotype
	Law of incomplete dominance	In a Hybrid, the allelic pair responsible for a trait is in heterozygous condition. Neither of the alleles is recessive nor dominant and produces an intermediate phenotype of the parents
	Law of codominance	In a Hybrid the allelic pair responsible for a trait is in heterozygous condition. Neither of the alleles is recessive nor dominant. They express side by side and produces phenotype resembling both the parents
	Pleiotropy	Multiple effects of single gene
	Multiple alleles	2 or more allelic forms of a single gene, responsible for a trait
	Polygenic inheritance	2 or 3 genes govern a single trait
	Sexlinked inheritance	Alleles present on sex chromosomes inherit along with the sex chromosomes
		

1. Gregor Johann Mendel –father of genetics. He was the first one to demonstrate mechanism of transmission of characters from one generation to next by working on garden pea. He studied 7 contrasting pairs of characters.

CHAPTER 5

PRINCIPLES OF INHERITANCE AND VARIATION

S.NO	MCQ
1	A Snapdragon plant bearing pink colour flowers is crossed with a Snapdragon plant bearing white colour flowers.The expected phenotypic percentage of the offspring is (A)50% Red :50% (B) 25%Red :50% Pink :25%White (C)50%Pink: 50%White (D)25% Pink :50%Red :25%White.
2	Identify the category of gentic disorder depicted in the pedigree chart given below; 



TRAIT	DOMINANT	RECESSIVE
Seed shape	Round	wrinkled
Seed color	Yellow	green
Flower color	Purple	white
Flower position	Axial	terminal
Pod shape	Inflated	constricted
Pod color	Green	yellow
Stem height	Tall	dwarf

i) Reasons for selecting pea plant(Pisum sativum) for genetic experiments 2m

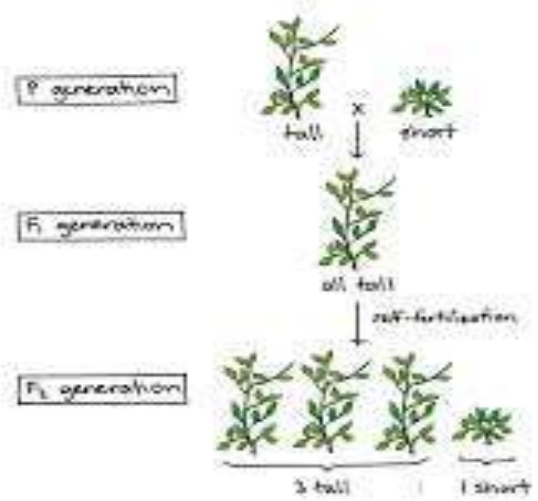
- It is annual plant with a short life cycle. So, several generations can be studied within a short period.
- Has easily observable contrasting pairs of characters.
- Has bisexual flowers, hence can produce pure lines by natural self pollination.
- Artificial cross pollination can be easily carried out.

ii) Mendel published his work in 1865. But it was unrecognized till 1900 2m /3m

- There was no wide publicity of his work
- Mathematical approach , he used to explain biological phenomenon was new to biologists
- Factors responsible for a trait were considered as stable and discrete units. This was not acceptable because, in the nature continuous variations and incomplete dominance was seen

- Chemical nature of factors was not explained.

Note: 3 scientists- de vries, Correns and von Tschermark independently rediscovered Mendel Laws in 1900.



iii) Mendel laws

a) Law of dominance:

- Characters are controlled by discrete units called factors
- Factors occur in pairs
- In a dissimilar pair of factors, one member of the pair is dominant and the other recessive

OR

In a Hybrid, the allelic pair responsible for a trait is in heterozygous condition. One of the alleles expresses phenotypically and is called dominant allele. While the other fails to express and is called recessive allele . So, the progeny resembles only one of the parents i.e. dominant phenotype

b)Law of segregation

In a hybrid there are heterozygous (dissimilar) alleles. These alleles remain together without mixing with each other and at the time of gamete formation they separate out. So, only one allele enters each gamete. Because of this, in F_2 generation both the parental phenotypes are observed in 3 : 1 ratio for a monohybrid cross.

Parents : **Tall vs Dwarf** **Allele T > t**

Genotype: **TT** **tt**

Gametes: **T** **t**

F1 generation: **Tt**

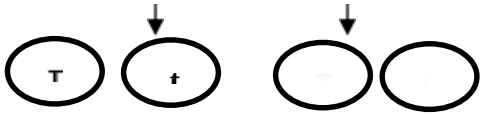
Tall

Selfing of F_1 hybrids

Tt vs Tt

Tall Tall

Gametes:



♀ / ♂	T	t
T	TT tall	Tt tall
t	Tt tall	Tt dwarf

F_2 generation:

Phenotype ratio Tall: Dwarf
3:1

Genotype ratio TT: Tt: tt
1:2:1

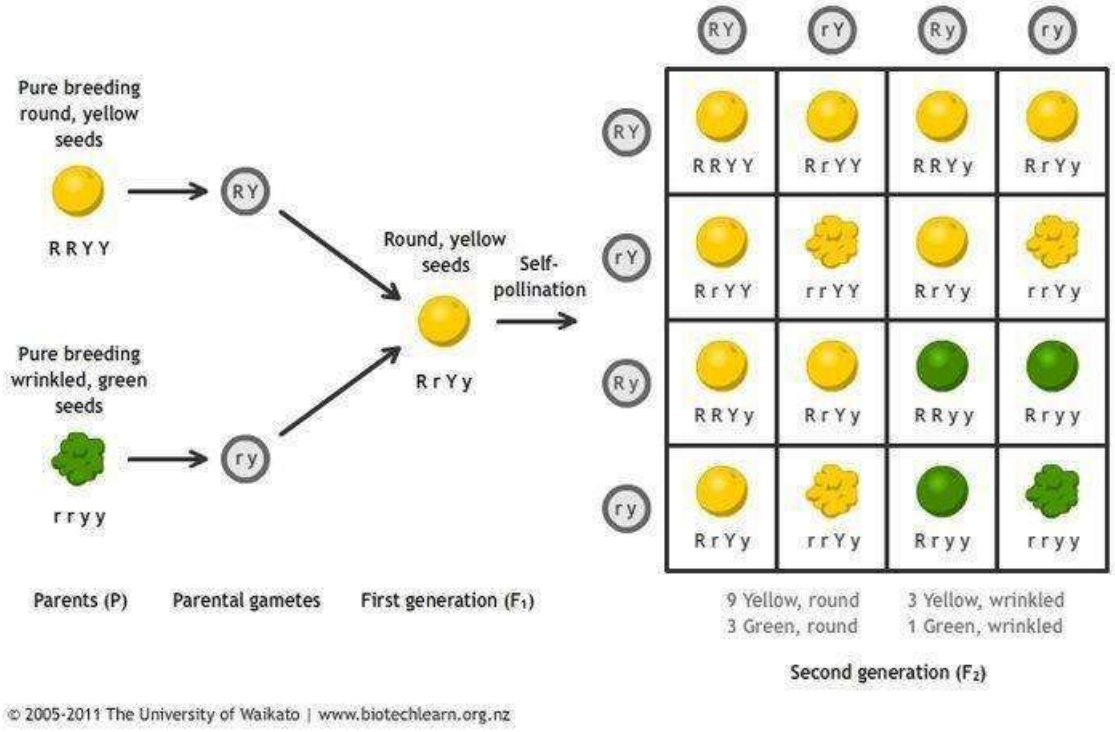
a)Law of independent assortment

This law states that 'when two pairs of traits are combined in a hybrid, segregation of one pair of traits is independent of the other pair of traits'.

OR

In a dihybrid cross, the plants differ for 2 pairs of alleles/traits. At the time of gamete formation the alleles responsible for a trait separate independent of the other pair of alleles for another trait.

	(A)X- Linked recessive (B) X- Linked dominant (C) Autosomal recessive (D)Autosomal dominant.
3	Hugo de Vries proposed the mutation theoryof organicevolution after his experiments on (A) Garden pea (B)Evening primerose (C)Fruit fly (D)Four o'clock plant.
4	Turner's syndrome in humans occurs due to (A) Aneuploidy (B)Euploidy (C)Polyploidy (D)Autosomal abnormality.
5	The fruit fly was found to be very suitable for experimental verification of chromosomal theory of inheritance by Morgan and his colleagues because (A) It reproduces parthenogenetically (B) It completes life cycle in about two weeks (C) A single mating produces two young flies (D) Smaller female is easily recognizable from larger male
6	Pedigree analysis can help in tracing which of the following set of genetic disorders?



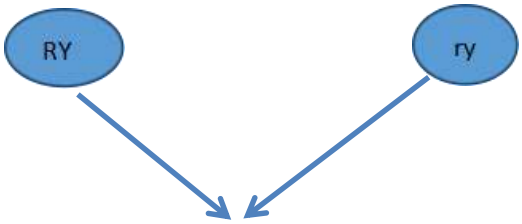
For example:

- When pea plant bearing round yellow seeds is crossed with wrinkled green seed pea plant, in the F1 generation round yellow seeds are produced.
- When F1 hydrids are selfed, in the F2 generation we get parental as well as new combinations in 9:3:3:1 ratio.
- This because the alleles of seed colour assort independent to that of seed shape.

Parents: Round yellow vs Wrinkled green

Genotype: RRYY rryy

Gametes:



F_1 generation: RrYy

Round yellow

Selfing F_1 hybrids

Round yellow **vs** **Round yellow**

RrYy RrYy

Gametes: **RY, Ry, rY, ry** **RY, Ry, rY, ry**

F2 generation

♂ / ♀	**RY**	**Ry**	**rY**	**Ry**

RY	**RRYY Round yellow**	**RRYy Round yellow**	**RrYy Round yellow**	**RrYy Round yellow**
Ry	**RRYy Round yellow**	**RRyy Round green**	**RrYy Round yellow**	**Rryy Round green**
rY	**RrYy Round yellow**	**RrYy Round yellow**	**rrYy wrinkled yellow**	**rrYy wrinkled yellow**
ry	**RrYy Round yellow**	**Rryy Round green**	**rrYy wrinkled yellow**	**Rryy wrinkled green**

Phenotype:

Round yellow seeds =9
Round green seeds =3
wrinkled yellow seeds =3
wrinkled green seeds =1

Q) A true breeding pea plant homozygous for axial violet flowers (AAVV) is crossed with another pea plant with terminal white flowers (aavv).

(i)What would be the phenotype and genotype of F1 and F2 generation?

(ii)Give the phenotypic ratio of F2 generation.

(iii)List the generalizations of Mendel that can be derived from the above cross.

Ans: Hint: Work out like above example

(i)Phenotype of F1 generation-all axial violet flowers

Genotype of F1 generation –AaVv

(ii)Phenotypic ratio of F2 generation 9:3:3:1

(iii)Law of independent assortment

Q) A true breeding pea plant homozygous for inflated green pods is crossed with another pea plant with constricted yellow pods (ffgg).

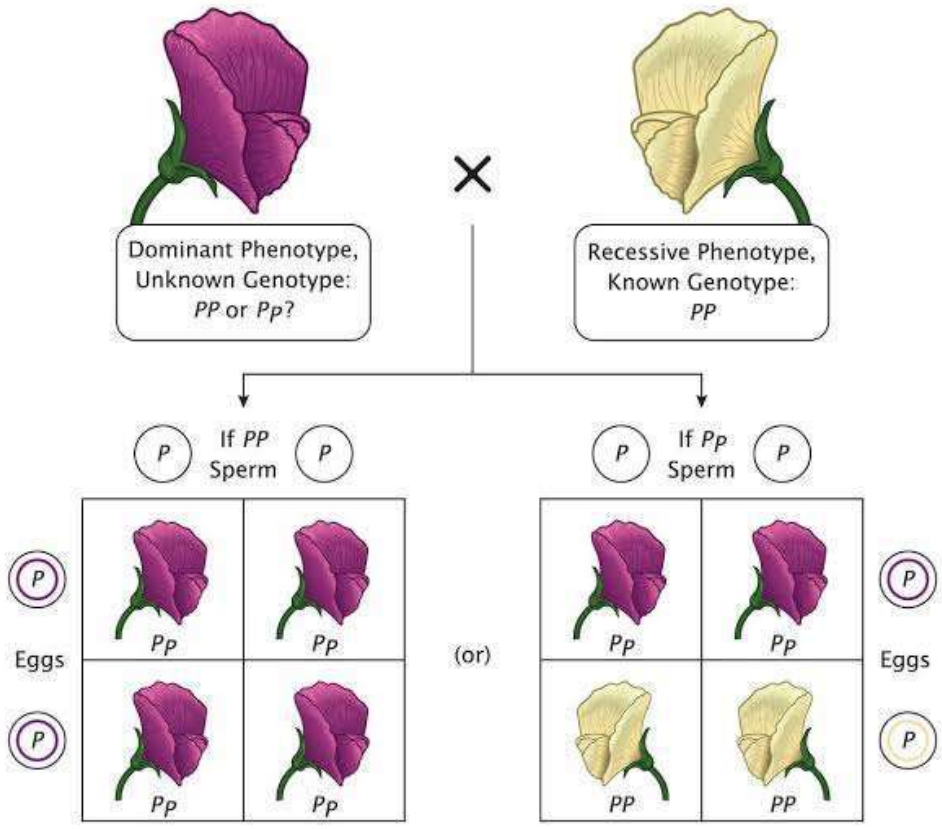
(i)What would be the phenotype and genotype of F1 and F2 generation?
(ii)Give the phenotypic ratio of F2 generation.

(iii)List the generalizations of Mendel that can be derived from the above cross.

1. **Test cross**

(A)Down's Syndrome & Klinefelter's syndrome

It is done to find out the genotype of a dominant phenotype individual. The given individual is crossed with a homozygous recessive individual.



For example:

In pea plant purple flower colour is dominant over white flower. Findout genotype of purple flower.

Case I:

- Cross purple flower plant, with a (homozygous) recessive plant with white flowers

Parents: **Purple flower vs white flower**

Genotype: **PP** **pp**

Gametes:

Progeny: **Pp**

Purple

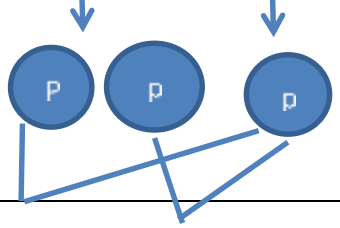
All the flowers of the progeny are purple, so the plant is homozygous dominant i.e. pure breed.

Case II:

Parents: **Purple flower vs white flower**

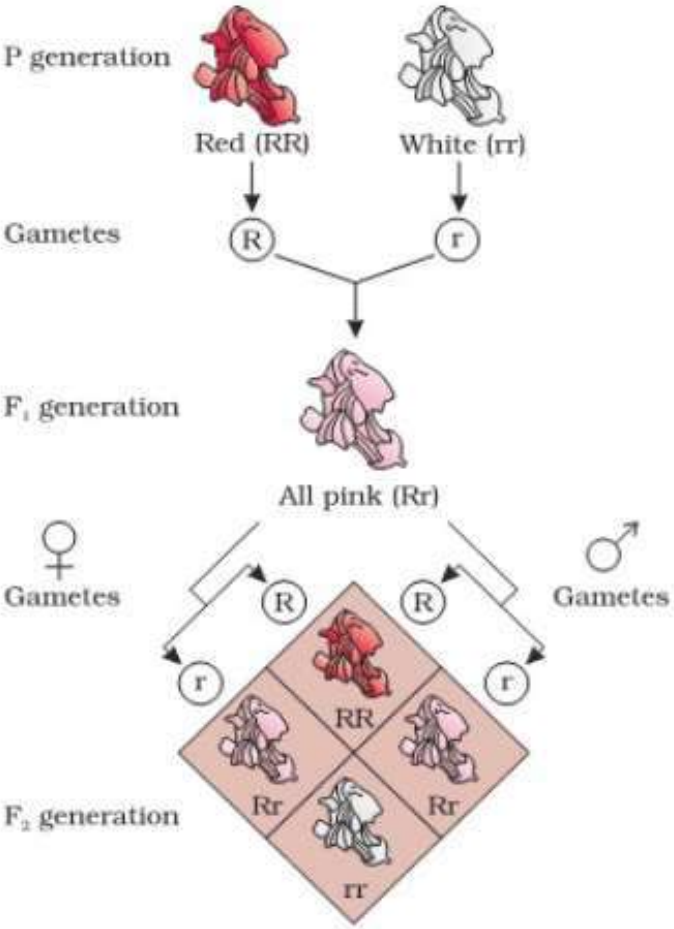
Genotype: **Pp** **pp**

Gametes:



	Progeny: Pp pp Purple White Progeny has purple: white flowers in 1:1 ratio. So, then plant is heterozygous dominant.
	Q) In a particular plant species, majority of the plants bear purple flowers. Very few plants bear white flowers. No intermediate colours are observed. If you are given a plant bearing purple flowers, how would you ascertain that it is a pure breed for that trait? Explain.
	1. **Incomplete dominance:In a Hybrid the allelic pair responsible for a trait is in heterozygous condition. Neither of the alleles is recessive nor dominant. They partially express and produce an intermediate phenotype of the parentsin F1 generation.**  Snapdragon

	(B)Myotonic dystrophy & Sickle cell anaemia (C)Turner's syndrome &Haemophilia (D) Klinefelter's syndrome & Turner's syndrome
7	In a certain species of insects, some have 13 chromosomes, and the others have 14chromosomes.The 13 and 14 chromosome bearing organisms are (A)Males and females, respectively (B) Females and males, respectively (C)All males (D) All females
8	Which of the following combination of chromosome numbers represents the correct sex determination pattern in honey bees? (A)Male 32, Female 16 (B) Male 16, Female 32 (C)Male 31, Female 32 (D)Female 32, Male 31
9	Which of the following statements indicates parallelism in genes and chromosomes? (i) They occur in pairs (ii) They segregate during gamete formation (iii) They show linkage (iv) Independent pairs segregate independently (A) (i) and (iii) (B) (ii) and (iii) (C) (i), (ii) and (iii) (D) (i), (ii) and (iv)
10	Rajesh and Mahesh have defective haemoglobin due to genetic disorders. Rajesh has too few globin molecules while Mahesh has incorrectly functioning globin



For example: Flower colour in Snapdragon/Antirrhinum

Parents : **Redflower** **vs** **white flower**

Genotype: **RR** **rr**

Gametes:

F1 generation: **Rr**

Pink

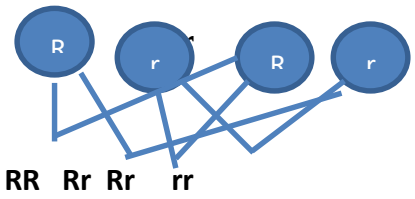
<u>Selfing of Fi hybrids</u>

Pink **Pink**

Rr **vs** **Rr**

Gametes:

F2 generation:



Gamete	R	r
R	RR (Red)	Rr (Pink)
r	Rr (Pink)	rr (White)

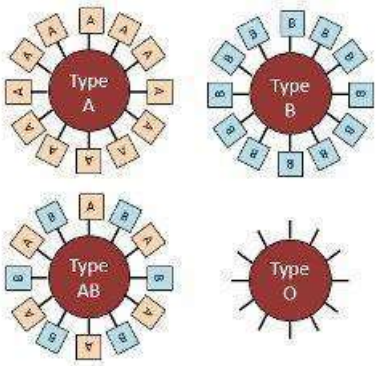
F2 generation:

Phenotype ratioà red: pink: white = 1:2:1

Genotypic ratioàRR:Rr:rr = 1:2:1

5

Multiple alleles and allelism:



Inheritance of the ABO Blood System in Humans

	I^A	I^B	i
I^A	I^AI^A A	I^AI^B AB	I^Ai A
I^B	I^BI^A AB	I^BI^B B	I^Bi B
i	iI^A A	iI^B B	ii O

• More than two allelic forms of a gene determine certain traits like blood group in human. These alleles are called multiple alleles and the inheritance pattern of these allesles is called multiple allelism.

• Blood group gene '*I*' has three alleles - I^A , I^B and *i*.

• But an individual with a specific blood group possess only two of such alleles

• The genotypes of 4 blood groups are:

A group genotype → I^AI^A **or** I^Ai.

B group genotype → I^BI^B **or** I^Bi.

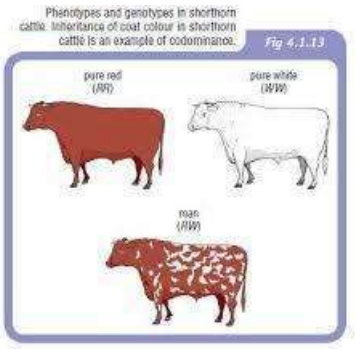
A B group genotype → I^AI^B

O group genotype → ***ii***.

• These alleles exhibit dominance and co-dominance.

I^A I^B are dominant and **i** is recessive.

Co-dominance :



CODOMINANCE 2M

In a Hybrid the allelic pair responsible for a trait is in heterozygous condition. Neither of the alleles is recessive nor dominant. They express side by side and produces phenotype resembling both the parents.

For example: In AB blood group both I^A and I^B genes equally influence the formation of antigens A and B.

Parents : Father 'A' group vs Mother 'B' group

Genotypes I^AI^A I^BI^B

Gametes I^A I^B

I^AI^B

molecules.Identify the disorder they are suffering from.

AB group

Q) A man with blood group A married a woman with B group. They have a son with AB blood group and a daughter with blood group O. Work out the cross and show the possibility of such inheritance.

Ans: Since, son has blood group AB and daughter has blood group O then the possible genotype of man will be I^A i and that of female will be I^B i. The desired cross would be as follows:

Parents :

Man vs woman

Genotypes $I^A i$ $I^B i$

Gametes

F1 generation

gametes	I^A	*i*
I^B	I^AI^B AB group	I^Bi B group
i	I^Ai A group	i i O group

Thus, the F1 progeny can have all the four possible blood groups, *i.e.*, A, B, AB and O.

8

PLEIOTROPY:

Multiple effects of a single gene is pleitropy. That means a single gene is able to control more than one trait.

Example 1: In pea plant a single gene controls shape of the seed as well as size of the seed.

It has 2 alleles B and b.

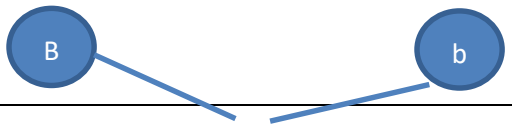
B is more efficient in starch synthesis than b. So, B is dominant over b.

Parents :

Round large seeds vs wrinkled small seeds

Genotype: BB bb

Gametes:



F1 generation: **Bb**

Round medium seeds

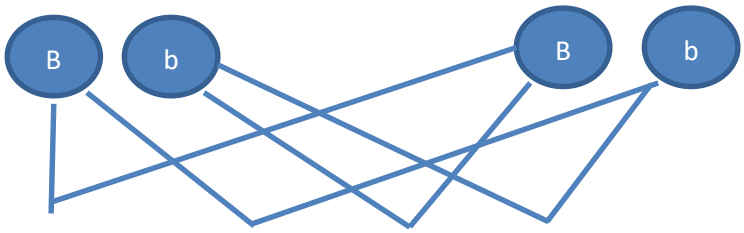
Gamete	B	b
B	BB Round large	Bb Round medium
b	Bb Round medium	bb wrinkled small

Selfing of Fi hybrids

Bb **vs** **Bb**

Round medium **Round medium**

Gametes:



BB **Bb** **Bb** **bb**

F2 generation:

Phenotype ratio→Round large : Round medium: wrinkled small = 1:2:1

Example 2: - Phenylketoneuria : It is a metabolic disorder caused by autosomal recessive allele. In normal individuals the gene is functional and it produces phenyl alanine hydroxylase enzyme, which converts phenylalanine into tyrosine. In phenylketonuria patients , in the absence of the enzyme, phenyl alanine gets converted into phenyl pyruvate and its derivatives. These get accumulated in the brain causing mental retardation. Other effects of it are reduction in hair growth and skin pigmentation.

There is no cure for PKU, but **treatment** can prevent intellectual disabilities and other health problems.

Polygenic inheritance:

• Certain traits in human like skin colour, height and intelligence are controlled by more than 2 genes. These genes are called polygenes and the inheritance pattern is known as polygenic inheritance.

• These gens exhibit continuous variations and produce a bell shaped curve in F2

generation.

• They show cumulative effect on phenotype. Greater the No. of dominant genes , higher the phenotypic expression. That's why it is also known as quantitative inheritance.

• Skin colour in human is determined by 3 genes (3 pairs of alleles Aa, Bb ,and Cc)

The person with all 6 dominant alleles (AABBCC) has dark colour

The person with all 6 recessive alleles (aabbcc) has white colour

The person with 3 dominant alleles (AaBbCc) has intermediate colour.

Parents : **Darkest** **vs** **Fairest**

Genotype: **AABBCC** **aabbcc**

Gametes: **ABC** **abc**

F1 generation: **AaBbCc**

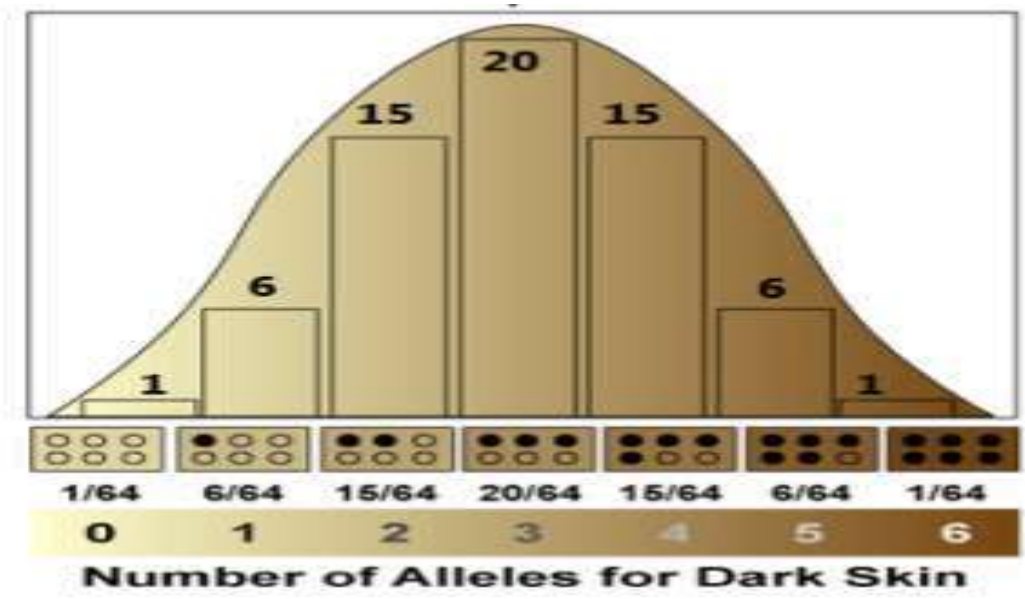
Intermediate colour

Selfing of Fi hybrids

AaBbCc **vs** **AaBbCc**

ABC, ABc,AbC,Abc
aBC, aBc,abC,abc

ABC, ABc,AbC,Abc
aBC, aBc,abC,abc



Fairest → **Darkest**

Chromosomal theory of inheritance:

Sutton and Boveri proposed the theory.

Main concepts:

• Genes are arranged in linear order on chromosome.

• In a dipoid individual, the homologous chromosomes occur in paired condition. So also the genes responsible for a trait occur in paired condition as they are present on homologous chromosomes.

• At the time of gamete formation meiosis occurs. So, chromosomes pairs as well as gene pair separate and move to gametes. Hence the gemetes are haploid

• The paired condition of the chromosomes/ genes gets restored by fertilization process.

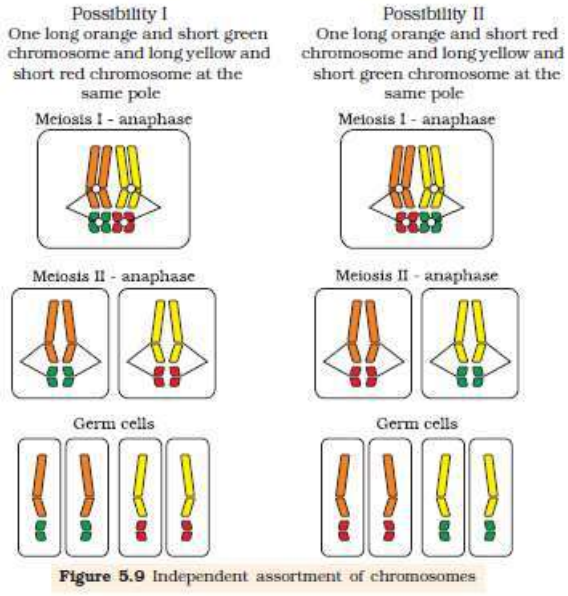


Figure 5.9 Independent assortment of chromosomes

T.H. Morganexperimentally verified chromosomal theory of inheritance by working on *Drosophila mealnogstor*.

A) Reasons for selecting Drosophila for genetic experiments by T.H. Morgan.

• It can be grown on simple synthetic medium in a lab.

• They have short life span of about 2 weeks. So, several generations can be

Studied.

• Single mating produces large number progeny.

• Phenotypic characters can be observed easily with low power microscope.

B) Linkage and recombination:

Morgan carried out dihybrid cross b/w a yellow body,white eye female and brown body,red eye male.

	He did not get in F2 generation 9:3:3:1 ratio. He explained this deviation by a phenomenon called linkage and recombination • Genes which are closely placed on a chromosome would tend to move together to the offspring as a single block of genes. This phenomenon is known as linkage and the genes are called linked genes. • Linked genes produce more parental combinations and less recombinants (non-parental or new combinations). • Tightly linked genes produced only less (1.3%) recombinants. Eg: Body colour and eye colour genes. • loosely linked genes produced more (37%) recombinants.Eg: body color and wing size genes . • Genes that are present on different chromosomes or widely placed on a chromosome would tend to separate independently and produce recombinants.

	Rajesh	Mahesh
A.	Sickle cell anaemia - an autosome linked recessive trait	Thalassemia – an autosome linked dominant trait
B	Thalassemia – an autosome linked recessive blood disorder	Sickle cell anaemia - an autosome linked recessive trait
C.	Sickle cell anaemia - an autosome linked recessive trait	Thalassemia – an autosome linked recessive blood disorder
D.	Thalassemia – an autosome linked recessive blood disorder	Sickle cell anaemia - an autosome linked dominant trait

	MCQ ANSWERS
1	(C)50%Pink: 50%White
2	(C) Autosomal recessive
3	(B)Evening primerose
4	(A)Aneuploidy
5	(B) It completes life cycle in about two weeks
6	(B)Myotonic dystrophy & Sickle cell anaemia
7	(A)Males and females, respectively
8	(B) Male 16, Female 32
9	(D) (i), (ii) and (iv)
10	(B) Thalassemia -An autosome linked recessive blood disorder.

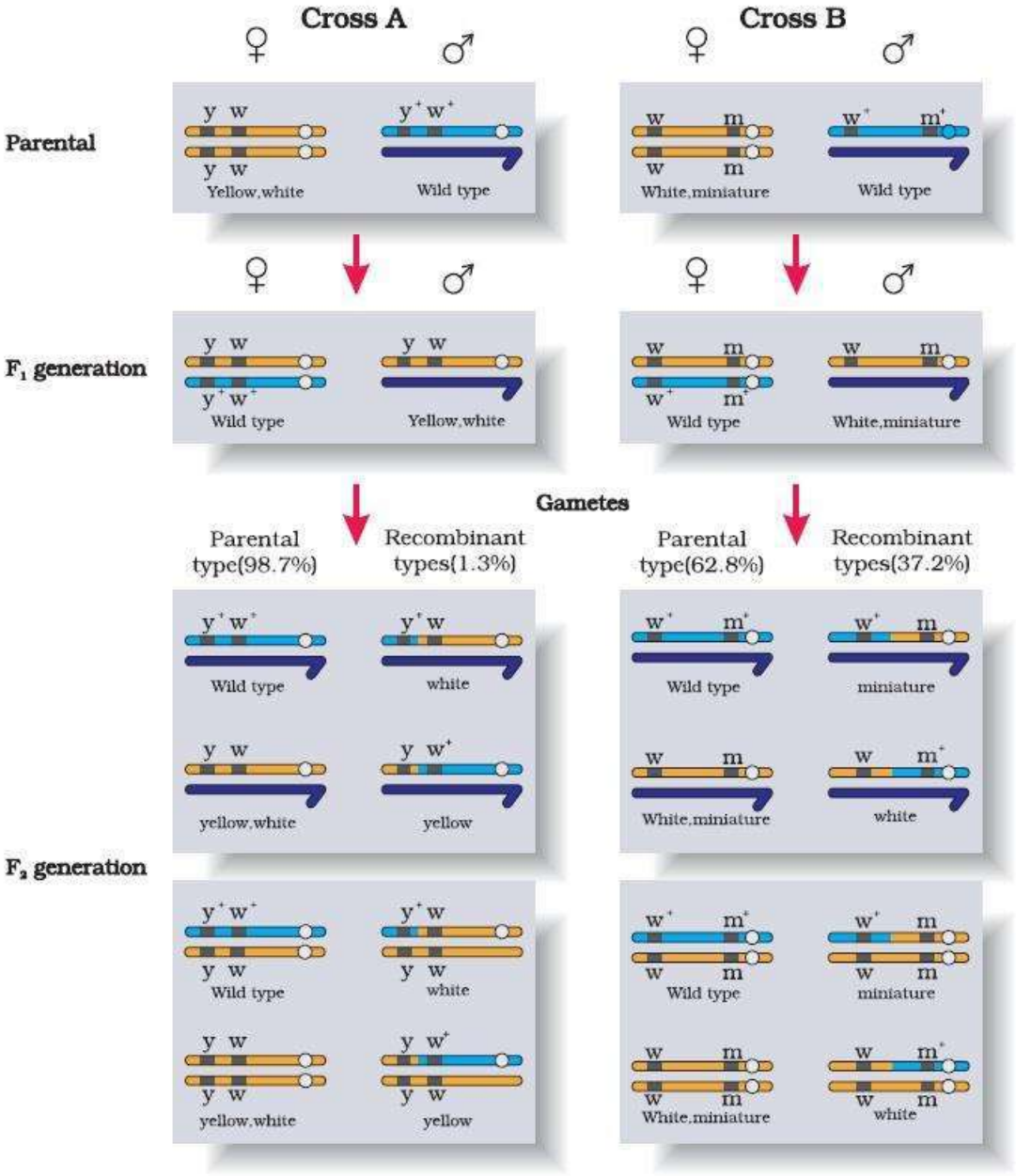


Figure 5.11 Linkage: Results of two dihybrid crosses conducted by Morgan. Cross A shows crossing between gene y and w; Cross B shows crossing between genes w and m. Here dominant wild type alleles are represented with (+) sign in superscript
Note: The strength of linkage between y and w is higher than w and m.

C) Gene mapping 2m/3m

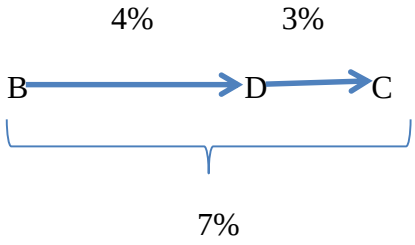
• Determing the sequence of genes on a chromosome is gene mapping

-Alfred Sturtevant used recombination frequency to determine the position of genes on a chromosome.

-percentage of recombination ∝ distance between the genes on a chromosome.

- Gene maps are used in sequencing of human genome.

Q) Make a gene between B, C and D genes. When recombination frequency b/w B&C=7%, b/w B&D= 4% and C&D=3%



Sex determination:

a) Male heterogamy : Male produces two types of gametes.

Example 1:

XX- XY type of sex determination **in humans** and Drosophila

• Male is heterogametic produces two types of sperms i.e. 'X' and 'Y' sperms, hence decides the sex of new born child.

• Female produces only one type of eggs i.e. 'X' eggs, hence it is homogametic

• When Y sperm fertilizes with X egg, a boy (XY) is born. When x sperm fertilizes with x egg, a girl (XX) is born.

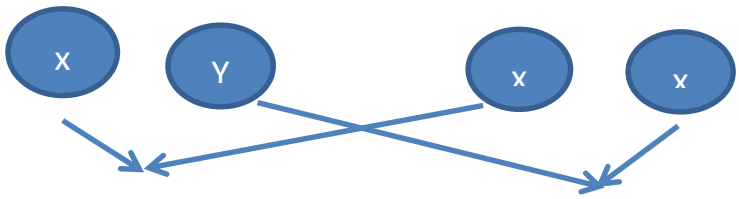
Or

Father **Vs** **Mother**

Genotype: **XY** **XX**

Gametes:

Progeny:



XX XY

Girl Boy

Example 2:

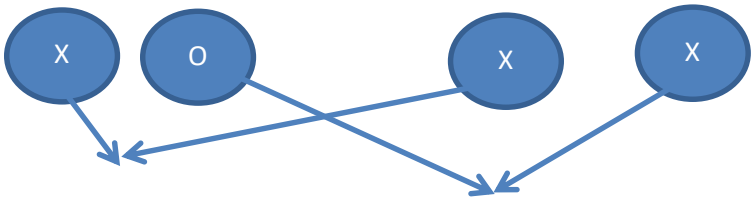
XX- XO type of sex determination **in grosshopper**

• Male has XO chromosomes and produces 2 types of sperms one with X chromosome and the other without X chromosome.

Father **Vs** **Mother**

Genotype: **XO** **XX**

Gametes:



Progeny: XX XO

Female Male

b) **Female heterogamy**: Female produces two types of gametes.

Example: ZZ-ZW mechanism in birds

• Female is heterogametic and produces two types of eggs i.e. 'Z' and 'W' eggs. Female determines the sex of the offspring.

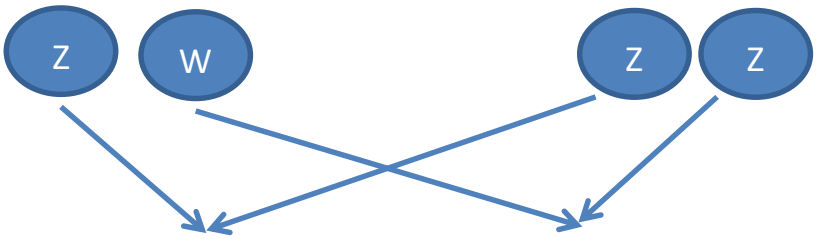
• Male produces only one type of sperms i.e. 'Z' sperms, hence it is homogametic

• When W egg fertilizes with Z sperm , a female(ZW) is born. When Z egg fertilizes with Z sperm , a male(ZZ) is born.

Female bird **vs** **Male bird**

Genotype: **ZW** **ZZ**

Gametes:



Progeny:

ZZ ZW

Male Female

c) Haploid-diploid mechanism in honey bee

• There are 3 types of bees- Queen, Workers and Drones

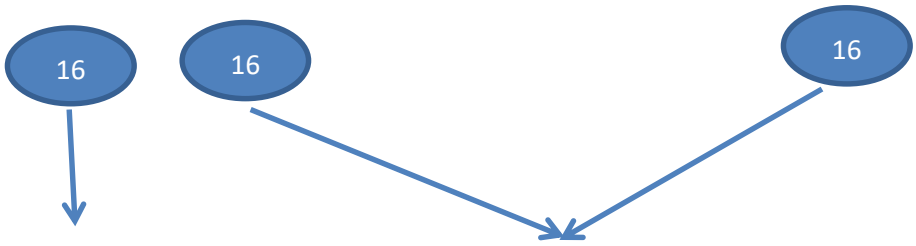
• Queen and Workers are developed from fertilized eggs. So, they are diploid with 32 chromosomes.

• The drones(males) are developed from unfertilized eggs parthenogetically . So, they are haploid with 16 chromosomes.

Queen(2n) **Drone(n)**

Chromosomes: **32** **16**

Gametes:



Progeny: PARTHENOGENESIS **FERTILIZATION**

16 **32**

MALE **FEMALE**

Q) In our society the women are blamed for giving birth to daughters. Can you explain why this is not correct?

Ans:Hint: Expain sex determining mechanism in human

Q) What is female heterogamy? Is the egg or sperm responsible for the sex of individual in humans?

Ans:Hint: Expain sex determining mechanism in birds

Q3) The male fruit fly and female fowl are heterogametic while the female fruit fly and the male fowl are homogametic. Why are they called so?

Ans: The male fruit fly has XY sex chromosomes and produces two types of gametes hence it is called heterogametic while female fowl has ZW sex chromosomes thereby producing two types of gametes thus they are called heterogametic.

Female fruit fly has two X chromosomes, i.e., XX and produces similar gametes hence they are called homogametic. Also, male fowl has two Z chromosomes and produces similar gametes thus they are called homogametic.

MUTATION

A sudden, heritable, permanent and irreversible change in DNA sequences resulting in changes in the

genotype and the phenotype of an organism is called mutation.

Mutation is 2 types:

1.Gene Mutation: Mutation within a gene. It may be:

a. Deletion-A part of gene is deleted

b. Duplication-A part of gene is deleted and joined on the sister chromatid

c. Insertion-One or more pair of nucleotides are inserted within the gene.

d. Substitution-One or more pairs of nucleotides are replaced by the same number of nucleotide pairs. It may be transition or transversion.

i. Transition- If purine is replaced by purine and pyrimidine is replaced by pyrimidine.

ii. Transversion- If purine is replaced by pyrimidine and vice versa

Point mutation: The mutation due to change (substitution) in a single base pair of DNA. E.g. sickle cell anaemia.

Frame-shift mutation: It is the deletion or insertion of base pairs resulting in the shifting of DNA sequences.

2.Chromosomal Aberration- Mutation among the genes (a part of a chromosome or DNA segment)

1.Loss (deletion) or gain (insertion/ duplication) of DNA segment cause Chromosomal abnormalities (aberrations).

2.When there is a change in chromosomal number that leads to

a. Aneuploidy-Gain or loss of one or two chromosomes. This may be

i. Nullisomy- 2n – 2

ii. Monosomy- 2n – 1

iii. Trisomy- 2n + 1

iv. Tetrasomy- 2n + 2

b. Polyploidy-Gain of one or more sets of chromosomes. It may be

i. Triploidy- 2n + n

ii. Tetraploidy- 2n + 2n

Chromosomal aberrations are seen in cancer cells. The agents which induce mutation are called mutagens. They include

-Physical mutagens: UV radiation, α, β, γ rays, X-ray etc.

-Chemical mutagens: Mustard gas, phenol, formalin etc.

Genetic disorders :

Mendelan disorders(gene disorders)	**Chromosomal disorders**
Caused due to change in base sequence of a gene or mutation of a gene	**Caused due to addition or deletion of individual chromosomes or addition or deletion of complete set of chromosomes from the diploid condition** - **Do not follow**

-Follow Mendilian principles of inheritance **-they may be recessive or dominant in nature** **EG: haemophilia, Sickle cell anaemia**	**- They are always dominant in nature** **- Downs syndrome, turners syndrome**

Mendelian disorders(gene disorders): Colour blindness, Haemophilia, Phenyl ketoneuria ,sickle cell anaemia, Thalassemia

i) Sickle-cell Anaemia

- It is an **autosomal linked recessive allele** disorder.

- Both **males and females** are equally affected.

- It is controlled by a pair of alleles-Hb^A and Hb^S

$Hb^A > Hb^S$

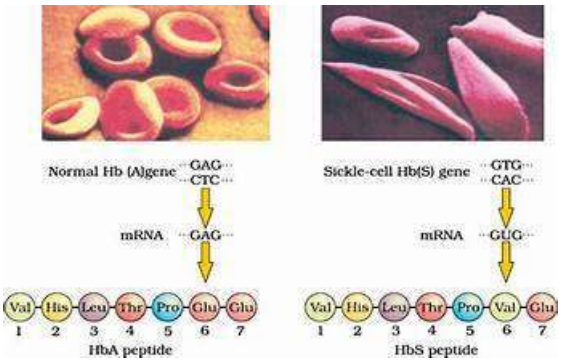
- Only the homozygous individuals (Hb^SHb^S) show the disease.

- The heterozygous individual are carriers (Hb^AHb^s)

How it is caused

- Due to point mutation, Glutamic acid (Glu) is replaced by Valine (Val) at sixth positions of beta globin chain of haemoglobin molecule.

- The mutant haemoglobin undergoes polymerization under low oxygen tension making RBC to become sickle-shaped. As a result, the RBC cannot pass through narrow capillaries. Blood capillaries are clogged and thus effects blood supply to different organs .



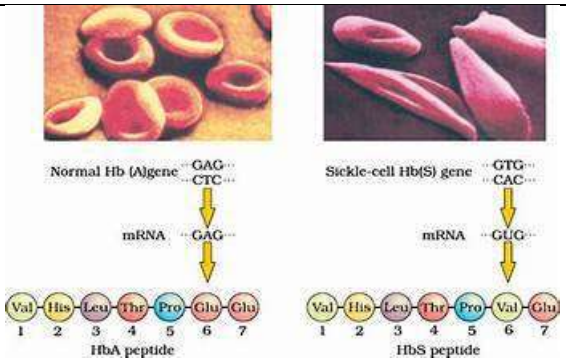
Sickle-cell anaemia an autosome linked recessive disorder.

ASSERTION AND REASON

The following questions consist of two statements-Assertion (A)and Reason (R).Answer these questions selecting the appropriate option given below.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is ***not***



Phenotype : Carrier mother vs Carrier father

Genotype: Hb^AHb^S Hb^AHb^s

Gametes: Hb^A , Hb^s Hb^A , Hb^s

Progeny:

gametes	Hb^A	Hb^S
Hb^A	Hb^AHb^A Normal	Hb^AHb^S Carrier
Hb^S	Hb^AHb^S Carrier	Hb^sHb^S Sickle cell anaemic

Ratio of Normal: carrier, sickle cell anaemic = 1:2;1

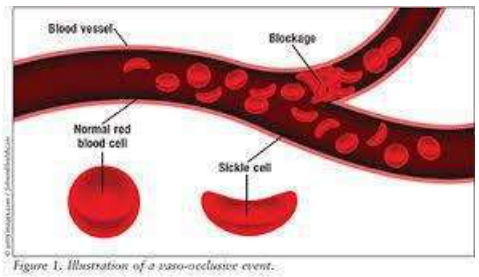


Figure 1. Illustration of a vaso-occlusive event.

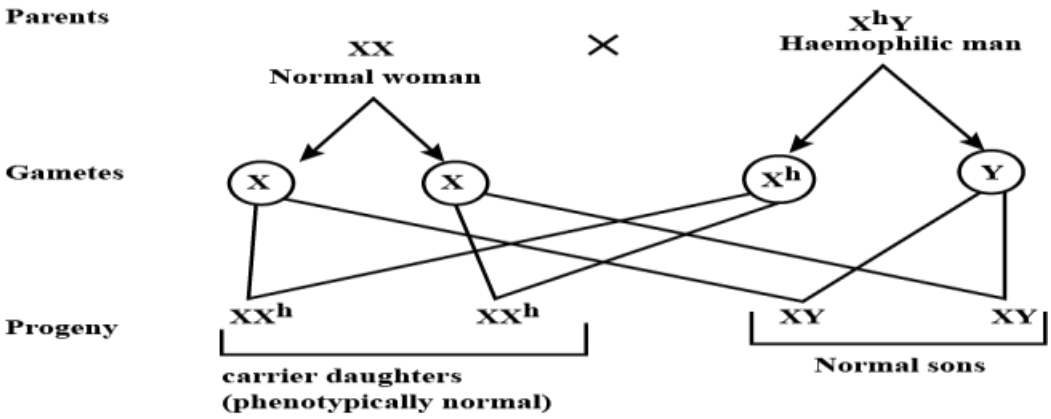
2.Haemophilia (Royal disease):

It is a sex linked (X-linked) recessive disease. In this, a protein involved in the blood clotting is affected.

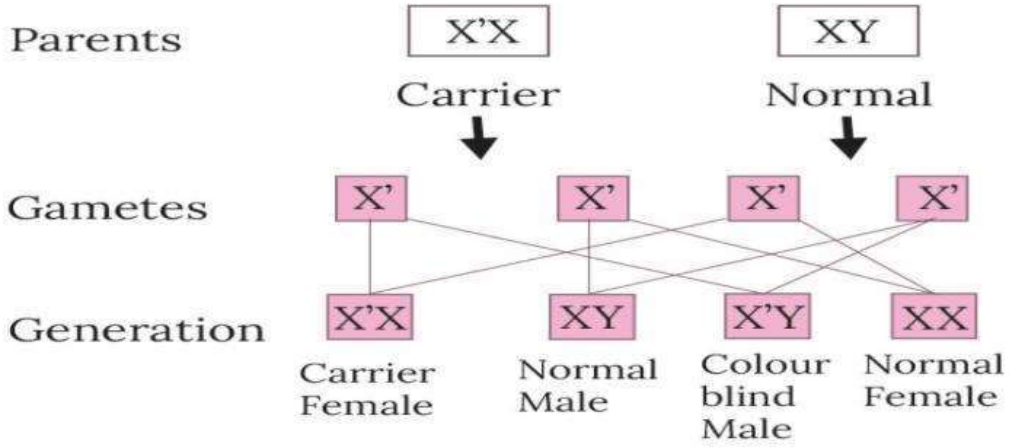
A simple cut results in non-stop bleeding. The disease is controlled by 2 alleles, H & h. H is normal

allele and h is responsible for haemophilia.

X X -Normal female

	X X ^{h} -Heterozygous female (carrier). She may transmit the disease to sons. X ^{h}X ^{h} -Hemophilic female X Y -Normal male X ^{h}Y -Hemophilic male In females, haemophilia is very rare because it happens only when mother is at least carrier and father haemophilic (unviable in the later stage of life). Queen Victoria was a carrier of hemophilia. So her family pedigree shows many haemophilic descendants. 
	Colour blindness: 1.It is a sex-linked (X-linked) recessive disorder due to defect in either red or green cone cells of eye. 2.It results in failure to discriminate between red and green colour. 3.It is due to mutation in some genes in X chromosome. 4.It occurs in 8% of males and only about 0.4% of females. This is because the genes are X-linked. 5.Normal allele is dominant (C). Recessive allele (c) causes colour blindness. The son of a heterozygous woman (carrier, XCX c) has a 50% chance of being colour blind. A daughter will be colour blind only when her mother is at least a carrier and her father is colour blind (XcY)

the correct explanation of the Assertion (A). (c) Assertion (A) is true, but Reason (R) is false. (d) Assertion (A) is false, but Reason (R) is true.	
11	**Assertion(A**):In Thalassemia is an abnormal myoglobin chain is synthesized due to a gene defect. **Reason(R)**:Alpha Thalassemia is controlled by genes HBA1 and HBA2 on chromosome 16.
12	**Assertion(A)**: Incomplete Dominance can be seen in Snapdragon. **Reason (R):** The phenotype and genotype ratios are similar in incomplete dominance.
13	**Assertion (A)**: When white eyed, yellow bodied *Drosophila* females were hybridized with



Thalassemia

• It is **autosome linked recessive allele** disorder

• The defective or mutated gene synthesizes **either less α or less β globin chains**.

• Because of this less Hb will be synthesized causing **anaemia** . Hence, it is also called quantitative disorder of Hb.

• There are 3 types

α thalassemia	**β thalassemia**
Few α chains are synthesized -extra β globin chains produced are unstable and they form tetramers, which cause abnormal oxygen disassociation curve -Caused by 2 genes HBA^1 and HBA^2 present on 16^{th} chromosome - severity of the disease is directly proportional to the No. of defective genes	Few β chains are synthesized - extra α globin chains bind to RBC membrane and damage it. - Caused by a genes HBB present on 11^{th} chromosome

Delta (□) Thalassemia

Alpha and beta chains being present in haemoglobin, about 3% of adult hemoglobin is made of alpha and delta chains. Just as with beta Thalassemia, mutations can occur which affect the ability of this gene to produce delta chains.

Differences b/w **Sickle cell anaemia and thalassemia**

sickle cell anemia is a qualitative disorder of Hb, wherein defective globin is produced.

Thalassemia is quantitative disorder of Hb, wherein few Hb molecules are produced.

red eyed, brown-bodied males; and F1 progeny was intercrossed, F2 ratio deviated

Sex linked inheritance/ X-linked inheritance:

Alleles present on sex chromosomes (X and Y) inherit along with the sex chromosomes.

Example 1:

Haemophilia: is caused due to the recessive allele present on X-chromosome. In these individuals the recessive allele fails to produce a clotting protein. So, blood fails to clot when there is a minor injury to blood vessels. This leads to profuse bleeding and death

• **Father passes the allele to only to daughters but not to sons**, as the son inherits Y

chromosome from father. Mother passes this allele to both sons and daughters.

• **More males affected than females** by this disorder.

- Females with single dose of haemophilic allele act as carriers (X^hX) and with double dose of the allele are haemophilic (X^hX^h).

-While males with single dose of this allele (X^hY)are haemophilic as they possess only one X chromosome.

• **Females are rarely haemophilic**, as they require double dose of this allele.

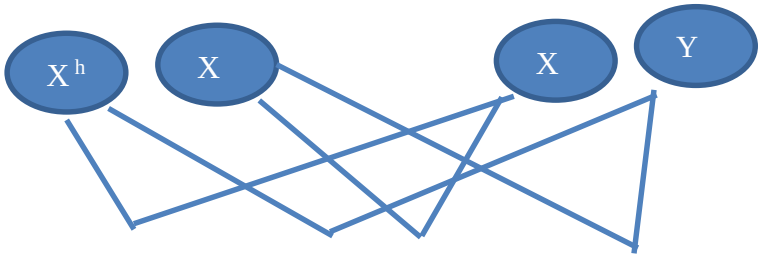
This is possible only when father is haemophilic (who may not reach to reproductive age) and mother is at least a carrier.

Example:

Phenotypes : Carrier mother vs normal father

Genotype: (X^h X) (XY)

Gametes:



Progeny: X^hX X^hY XX XY

gametes	X^h	*X*
X	X^hX Carrier daughter	XX Normal daughter
Y	X^hY Haemophilic son	XY Normal son

25% daughter normal (XX)

25% daughter carrier (X^hX)

25% son normal (XY)

25% son haemophilic (X^h Y)

R) A non-haemophilic couple was informed by their doctor that there is possibility of a haemophilic child be born to them. Draw a checker board and find out the percentage of possibility of such child in the progeny.

Q2) Explain the possibility of daughters becoming haemophilic with an example.

Phenotypes : Carrier mother vs Haemophilic father

Genotype: (X^h X) (X^hY)

Gametes: X ^{h}X X ^{h} Y

Progeny:

gametes	X^h	*X*
X^h	X^hX^h Haemophilic daughter	X^hX carrier daughter
Y	X^hY Haemophilic son	XY Normal son

Example2:

Colour blindness

It is an X linked recessive allele disorder X^c .

Persons with colour blindness fail to differentiate generally red and green colours.

substitute X^h allele(haemophilic allele) with X^c allele(colour blind allele) for rest of the explanation

Q) A normal visioned woman, whose father is colour blind, marries a normal visioned man.what would be the probability of her sons and daughters to be colour blind?

Hint: Woman is carrier for colour blindness, as her father is colour blind.

Solve the problem just like haemophilia by substituting X^h allele(haemophilic allele) with X^c allele(colour blind allele).

	from 9 : 3 : 3 : 1. **Reason (R)**: When two genes in a dihybrid are on the same chromosome, the proportion of parental gene combinations is much higher than the non-parental type.
14	**Assertion (A):** Genetic make up of sperm determines the sex of human child.

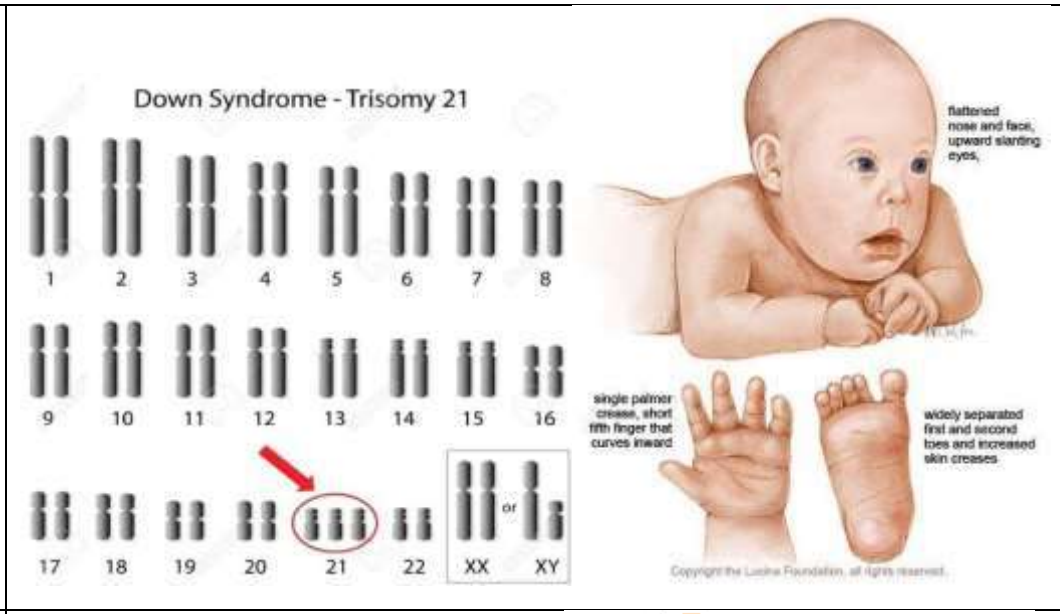
c) **Chromosomal disorders:** They are of 2 types

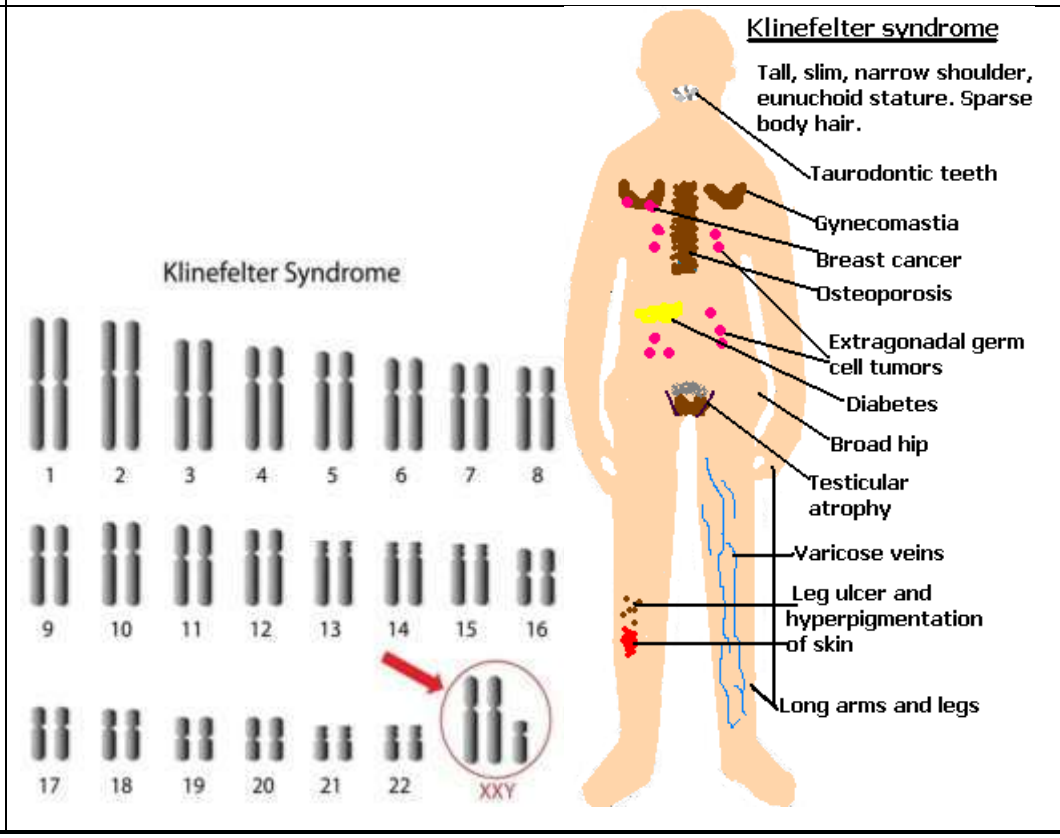
Aneuploidy	Euploidy/polyploidy
-Addition or deletion of individual chromosomes from 2n condition . 2n+1=trisomy 2n - 1= monosomy • Failure of segregation of chromatids during cell division cycle results in the gain or loss of individual chromosomes(Noo-dysjunction of homologous pair during anaphase of cell division)	Addition or deletion of complete set of chromosomes from 2n condition . 2n+n =triploidy 2n - n= monoploidy -Failure of cytokinesis after telophase of cell division results in polyploidy

Examples of chromosomal disorders

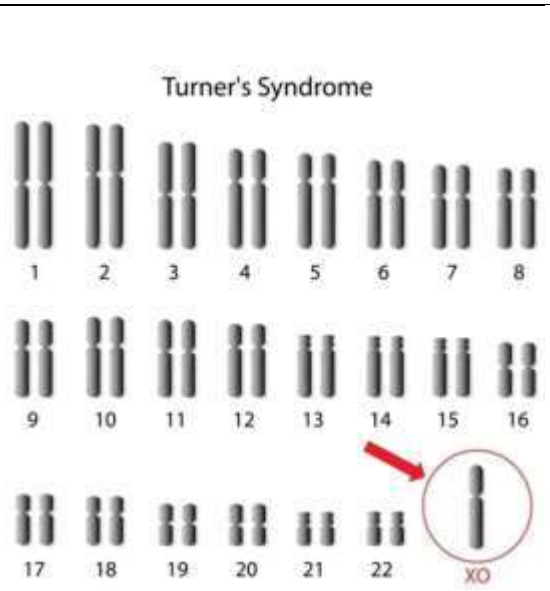
Down's syndrome(Mangolian idiocy)	Klinefelter's syndrome syndrome	Turner's syndrome
-Caused by an extra autosome.Trisomy of 21st chromosome results in total 47 chromosomes. - both males and females are equally affected. -Symptoms: * The individual is short statured with small round head, furrowed tonghu& partially open mouth, * Palm is broad with characteristic palm crease *Physical, psychomotor and mental development is retarded.	-caused by an extra X chromosome. Show 44+ XXY karyotype with total 47 chromosomes. - only males are affected -Symptoms: * individual has overall masculine development. * also express feminine development like development of breast, *i.e.*, gynaecomastia. *they are sterile.	-caused by the absence of one of the x chromosomes. Show 44+ XO karyotype with a total 45 chrommosomes. - Only females are affected -Symptoms: * Sterile females * Rudimentary ovaries *Lack of secondary sexual characters

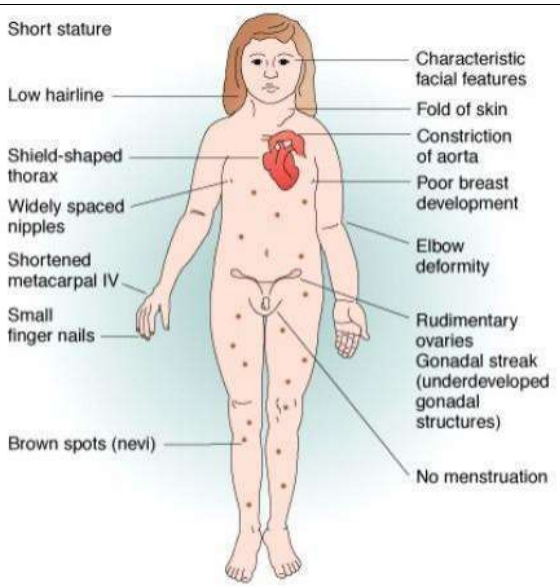
	Reason (R): Males are homogametic in humans.
15	**Assertion (A):** Starch grain size is controlled by gene B in pea seed is an example of





	incomplete dominance. **Reason (R):** Starch grain formed by genetic constitution Bb is of intermediate size.
	ANSWERS
	11d 12 b 13a 14c 15 a
	SECTION-B (2Marks)
16	In Mendel's breeding experiment on garden pea, the offspring of F2 generation are obtained in the ratio of 25% pure yellow pod, 50% hybrid green pods and 25% green pods. State (i) which pod colour is dominant (ii) Workout the cross. **ANS;** i) Green pod colour is dominant. ii)

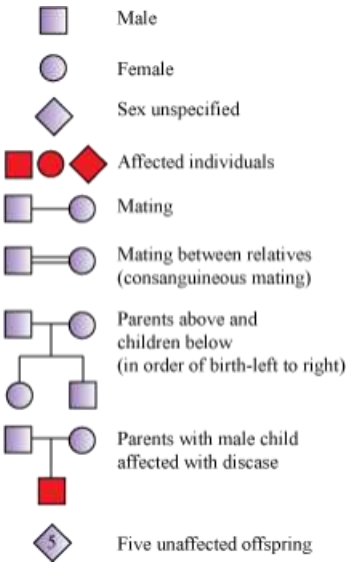




13

Pedigree analysis:

Study of inheritance of traits in human family for several generations and depicting these in the form of a family tree is pedigree analysis.



Significance in human :

-It is done in human as they long life span and studying several generations is not possible.

- Controlled matings is not possible.

Uses:

- It prevents inheritance of harmful genetic traits by councelling prospective parents

- We can predict harmful effects of closely related individuals who act as carriers.

- We can predict the origin of a genetic trait and its flow through the generations.

- This analysis is widely used in medical research.

Types of pedigree charts:

a) Autosomal dominant pedigree chart:

One of the parent show the disorder

Disorder is seen in each generation

Ex: myotonic distropy

b) Autosomal recessive allele pedigree chart:

Neither parent show the disorder as they are heterozygous

Both sons and daughters are equally affected

Ex: Sickle cell anaemia

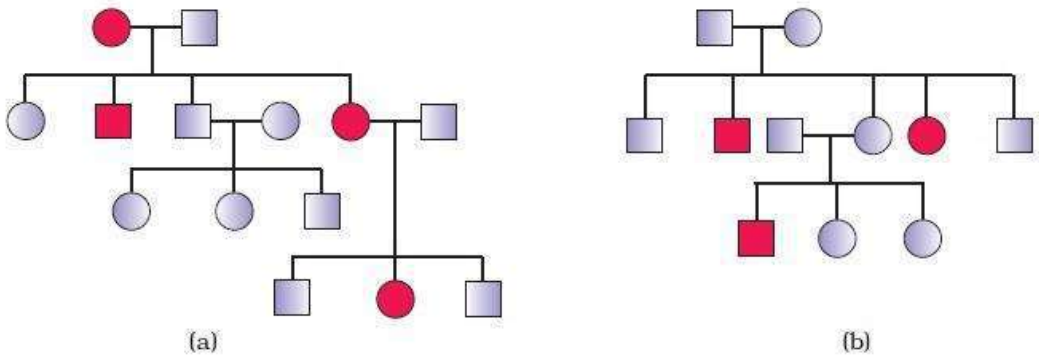


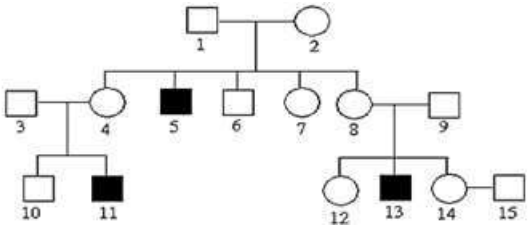
Figure 5.14 Representative pedigree analysis of (a) Autosomal dominant trait (for example: Myotonic dystrophy) (b) Autosomal recessive trait (for example: Sickle-cell anaemia)

c) Sex linked recessive allele pedigree chart:

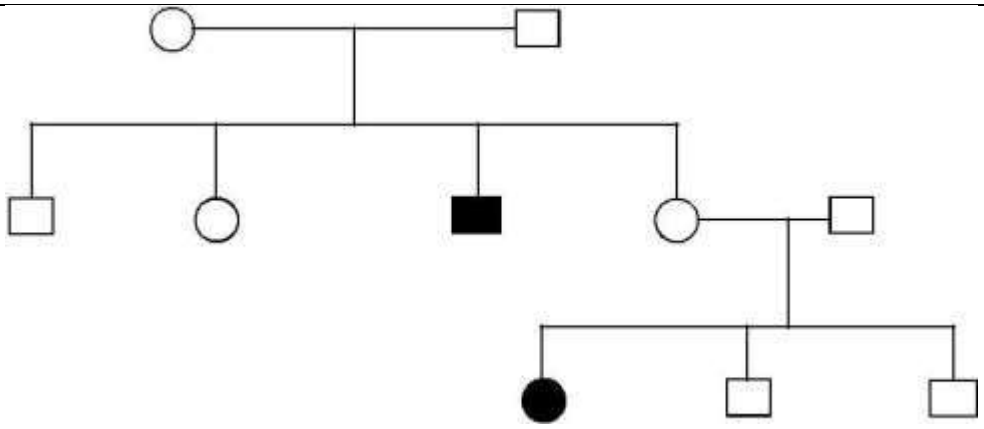
Neither parent show the disorder as they are heterozygous

More sons affected than daughters

Ex: Haemophilia



Q1.



Study the pedigree chart and answer the questions

(a) Is the trait recessive or dominant? Recessive

(b) Is the trait sex-linked or autosomal? Autosomal

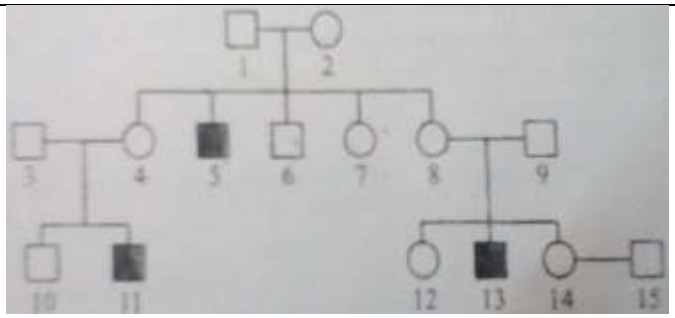
(c) Give the genotypes of the parents in generation I and of their third and fourth child in generation II.

Parents : mother Aa vs Father Aa

3 rd child aa

4 th child Aa

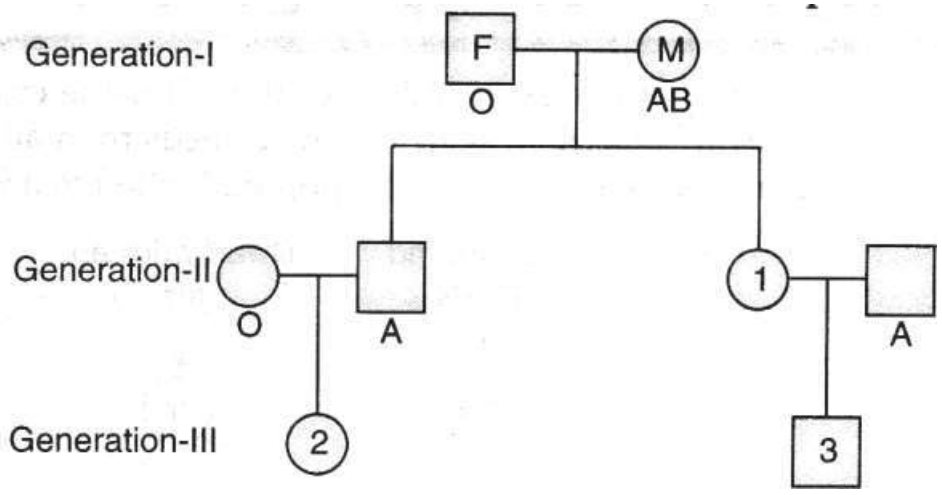
Q2



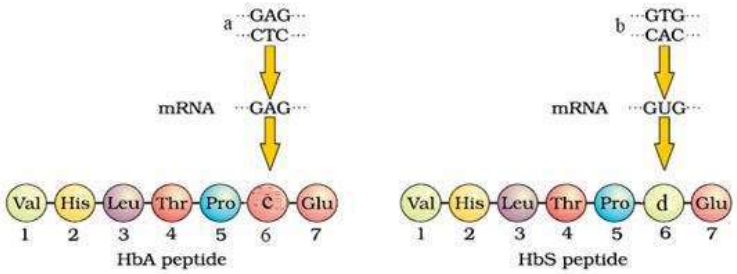
Haemophilia is a sex linked recessive disorder of humans. The pedigree chart given shows the inheritance of haemophilia in one family. Study the pattern of inheritance and answer the questions given.

(a) Give all the possible genotypes of the members 4, 5 and 6 in the pedigree chart.

(b) A blood test shows that the individual 14 is a carrier of haemophilia. The member numbered 15 has recently married the member numbered 14. What is the probability that

	their first child will be a haemophilic male? (a) Genotypes of member 4 – XX or XX^h Genotypes of member 5 – X^hY Genotypes of member 6 – XY (b) The probability of first child to be a haemophilic male is 25%.
Q3	Study the following pedigree chart of a family, starting with mother with AB blood group and father with O blood group. (a) Mention the blood group as well as its genotype of the offspring numbered 1 in generation II. (b) Write the possible blood groups as well as their genotypes of the off springs numbered 2 and 3 in generation III  a) In generation II-----Blood group B; Genotype - I^Bi b) In generation III----- No.2 Blood group = A; Genotype = I^Ai No.3 Blood group - 'AB' Genotype → I^AI^B

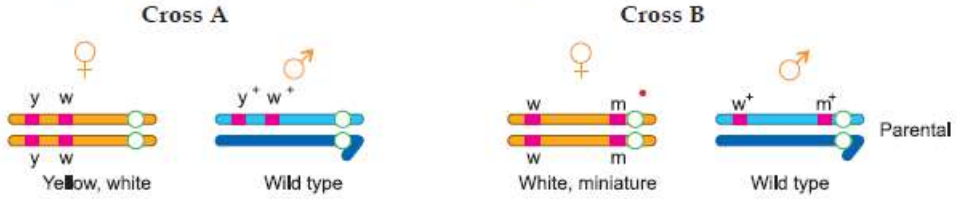
	(iii) Parents GG(green) X gg (yellow) Gametes G g F1 generation Gg (Hybrid green) Gametes G g X G g F2 generation GG Gg Gg gg Phenotypic ratio 3 : 1 **(1+1=2)** Genotypic ratio 1 : 2 : 1
17	Study the given figure and answer the questions that follow.



a)Name disorder that is shown in the figure.
b) How is this disorder inherited?
c)What is the cause of this disease?
d)What are the possible phenotypes of children born to a couple of Carrier woman and hemophilic man.

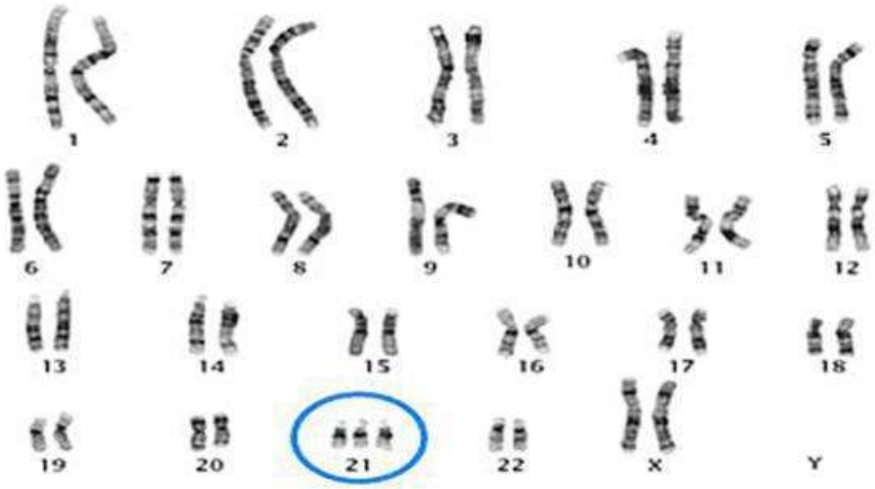
ANS;
(a) Sickle cell anemia.
(b) Inherited as Autosome linked recessive trait.
(c) Substitution of Glutamic acid by Valine at the sixth position of the beta globin chain of the hemoglobin molecule.
d)Normal, Carrier and Sickle celled children. **(4*1/2=2)**

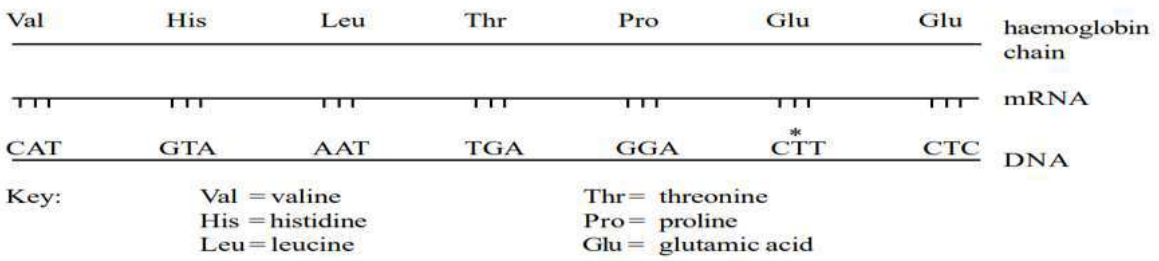
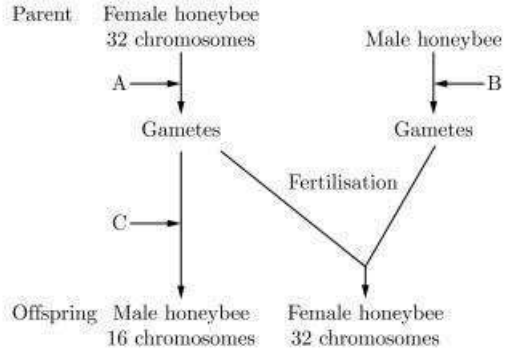
18 Study the figures given below and answer the question.

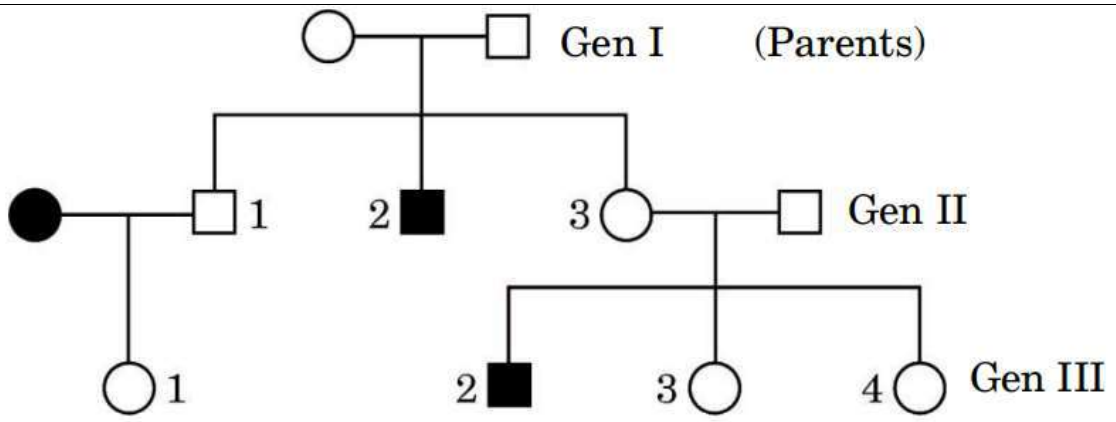


Identify in which of the crosses is the strength of linkage between the genes higher.
Give reasons in support of your answer.
ANS;In CrossA
Because the genes are closely placed. Lesser the distance **(1+1=2)**

19 During a study an infant's karyotype was found to possess an extra chromosome .



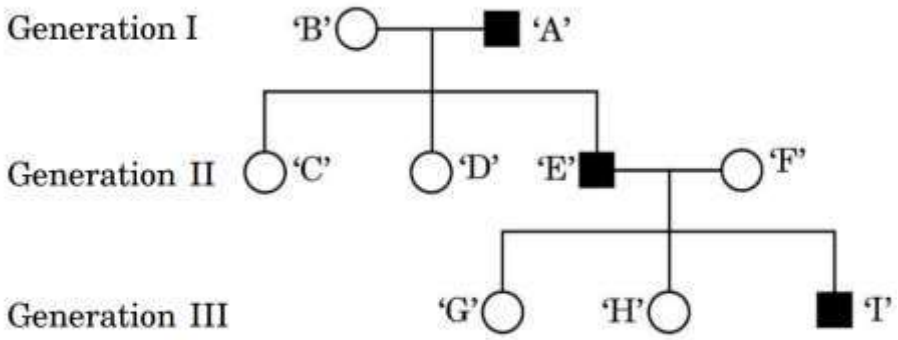
	a)Name the disorder which an infant is suffering from.Mention any 2 the symptoms the child is likely to develop later in the life. b)What will be the genotype of the person suffering from this disease? c)State its cause. **ANS;** (a)X= Down's syndrome , Short stature,Low IQ(Any 2) **(4*1/2=2)** (b**)**genotype of male= 45 +XX/45+XY c) cause- inheritance of extra 21st chromosome
20	The diagram below shows the sequence of amino acids in part of a haemoglobin molecule.  a)If the base T* was substituted with A, how would it affect the haemoglobin chain? b) Name the condition and the effects associated with the above substitution. **ANS;** CTT would become CAT which codes for valine. Thus ,valine would replace glutamic acid at that point and causes point mutation. **(1+1=2)**
	3MARKS
21	'The cytological observations made in a number of insects led to the development of the concept of genetic/ chromosomal basis of sex determination mechanism. Honeybee is an interesting example to study the mechanism of sex-determination. Study the schematic cross between the male and the female honeybees given below and answer the questions that follow:  (a) Identify the cell divisions 'A' and 'B' that lead to gamete formation in female and male honeybees respectively. (b) Name the process 'C' that leads to the development of male honeybee (drone). (c)If the no. of chromosome in male honeybee is 48 and female honeybee is 32 than find no. of chromosome in their progeny which is form by fusion of gametes. **ANS ;** (a) 'A' Meiosis and 'B'- Mitosis (b) 'C'- Parthenogenesis- ovum develops into an individual without fertilisation. **(3*1=3)** (c) 64
22	Study the given pedigree chart and answer the questions that follow.



(a) Is the trait given in the chart dominant or recessive ? Give reason in support of your answer.
(b) Is this trait autosomal or sex-linked ? Give reason in support of your answer.
(c) Write the possible genotypes of the children numbers'1 and 3' of the second generation.

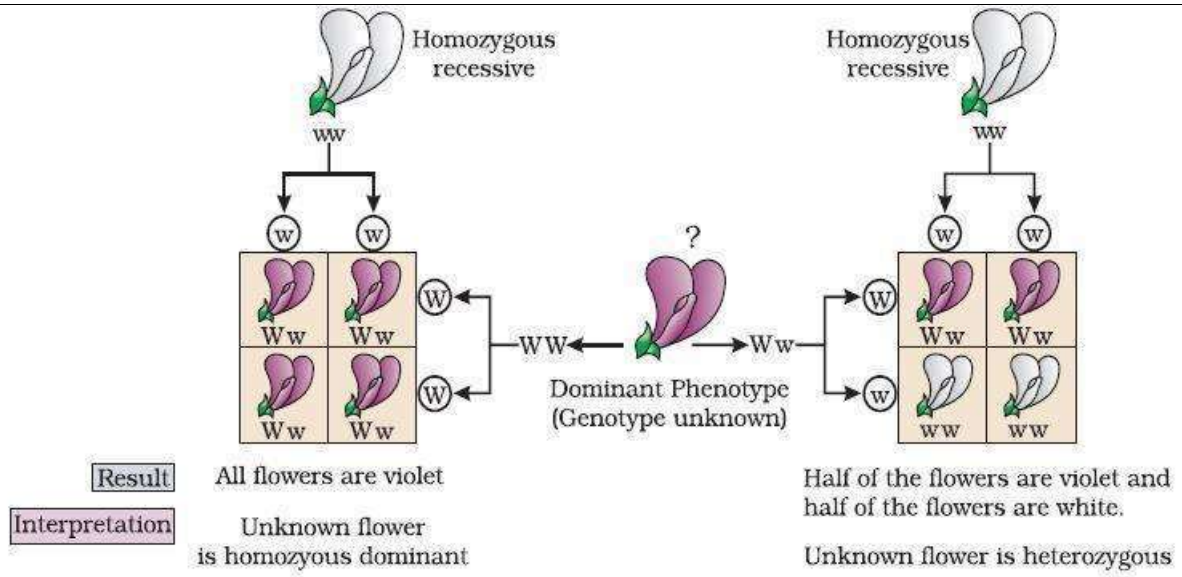
ANS;
(a) Recessive trait, both the parents in generation I do not express the trait yet it appears in the progeny.
(b) Autosomal trait, both male and females have equal chances of getting the trait.
(c) Child '1' : Aa/AA , Child '3' : Aa **(1+1+1+1=3)**

23 The following pedigree chart shows the inheritance of a genetic disorder up to three generations of a family. Observe the chart and answer the questions that follow.



(i) Is the disease sex-linked or autosomal as per the chart ? Give reasons in support of your answer.
(ii) Is it a recessive or a dominant disorder ?
(iii)Write the genotypes of the individuals 'C', 'D' and ' H'.
ANS;
(i) Sex linked disorder.More males are affected in the family as males have only one X chromosome which if affected expresses
(ii) Recessive disorder
(iii) C -XX^c ; D- XX^c ; H- XX^c **(1+1+1=3)**

24 Observe the diagram given below and answer the following questions-



(a) What is this cross known as? Write the genotype of the F1 generation.
(b) Based on the above observations Mendel proposed two general rules. what are these rules?
(c) When does a geneticist need to carry out the above cross?What ratio did you get from the above cross?
ANS;
(a) Test cross.F1 Genotype-Ww
(b) law of dominance,law of segregation
(c) to study the unknown genotype of the parent. ratio =1 : 1. **(1+1+1=3)**

25 A woman with blood group O married a man with AB group. Show the possible blood groups of the progeny. List the alleles involved in this inheritance.
ANS;

Female O * Male AB
ii $I^A I^B$
Gametes i
Progeny

Gametes	I^A	I^B
i	I^Ai	I^Bi

Blood group of progeny;A,B andO
Alleles involved ;I^A,I^B and I. **(1+1+1=3)**

CASE BASED QUESTIONS

26 The chromosome number is fixed for all normal organisms leading to species specification whereas any abnormality in the chromosome number of an organism results into abnormal individuals.For example ,in humans 46is the fixed number of chromosomes both in male and female .In maleit is 44+XY and in female it is 44+XX.Thus the human male is heterogametic ,in other words produces two different types of gametes one with 22+X chromosomes and the other with 22+Y chromosomes respectively. Human female, on the other hand is homogametic i.e produces only one type of gamete with 22+X chromosomes only.

Sometimes an error may occur during meiosis of cell cycle, where the sister chromatids fail to segregate called nondisjunction, leading to the production of abnormal gametes with altered chromosome number. On fertilization such gametes develop into abnormal individuals.
(a)State what is aneuploidy.

(b)If during spermatogenesis ,the chromatids of sex chromosomes fail to seggregate during meiosis ,write only the different types of gametes with altered chromosome number that could possibly be produced.
(c)A normal human sperm (22+Y) fertilises an ovum with karyotype 22+XX.Name the disorder the offspring thus produced would suffer from and write any 2 symptoms of the disorder.

(OR)

(C)Name a best known and most common autosomal aneuploid abnormality in human and write any 2 symptoms.

ANS;

(a) Gain or loss of chromosome due to failure of segregation of chromatids during cell division cycle is known as aneuploidy. **(1)**

(b) 22 + XY, 22 + 0 **(1)**

(c) Klinefelter's syndrome **(1)**

Gynacomastia/ feminine development, sterile individual, tall stature, overall masculine development **(Any two)** **(1/2+1/2=1)**

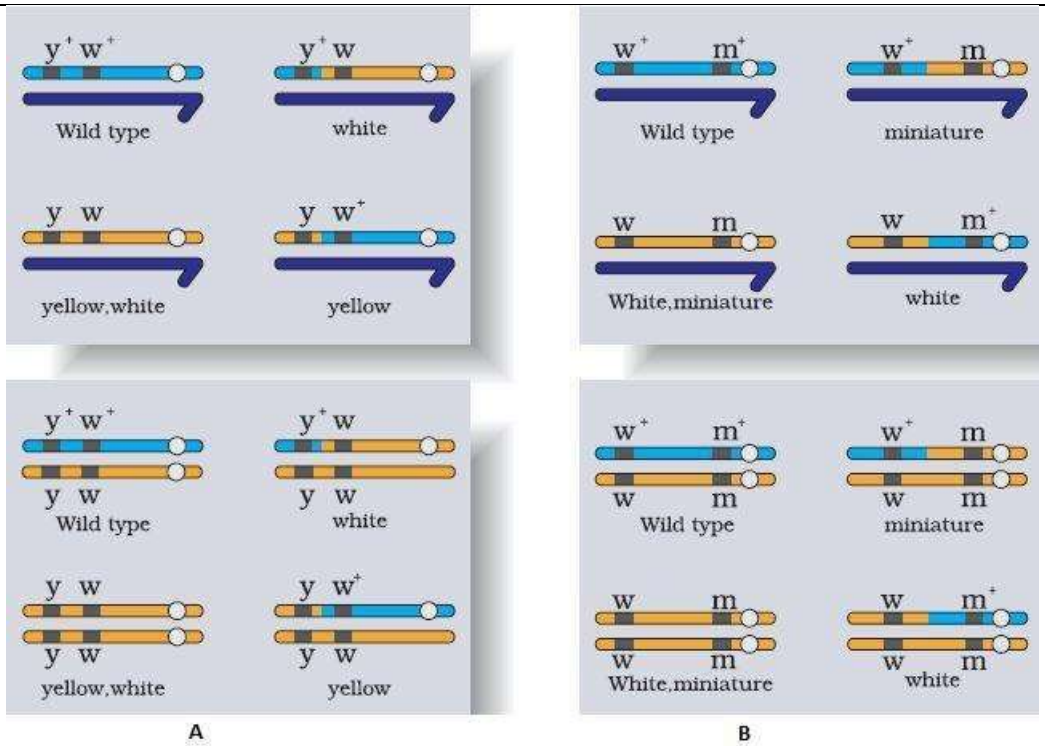
OR

(c) Down's Syndrome:

Short statured with small round head , furrowed tongue , partially open mouth , broad palm with palm crease , physical/ psychomotor/mental retardation , flat back of head , loops on finger tips , congenital heart disease , big and wrinkled tongue , broad flat face

(Any two)

27



Observe the above F2 generation Results of two dihybrid crosses conducted by Morgan and answer the following questions-

(i)What do the above crosses 'A' and 'B' illustrate?

(ii) What does (+) sign in superscript represent?

(iii)How is the strength of linkage between **y** and **w** is different than **w** and **m**.

(iv)What is the strength of linkage with increase in age?

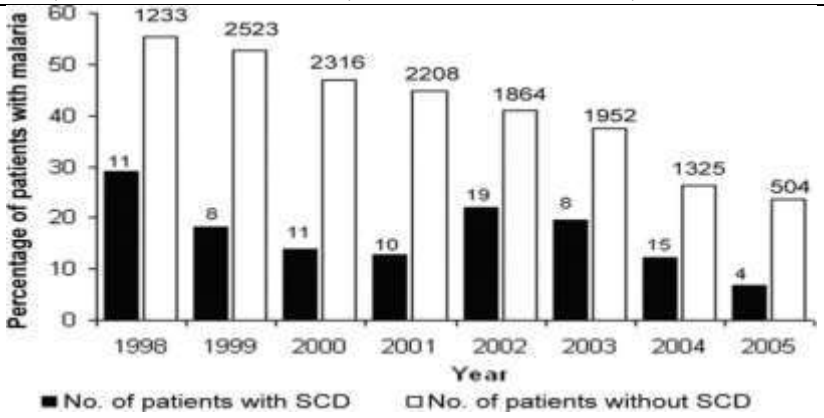
ANS;

(i) Cross A shows crossing between gene y and w; Cross B shows crossing between genes w and m.

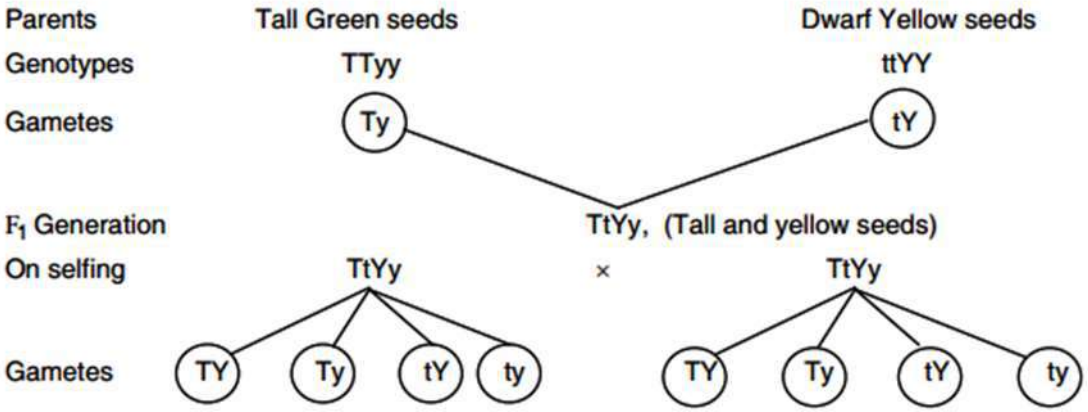
(ii) (+) sign in superscript represent dominant wild type alleles

(iii) The strength of linkage between y and w is higher than w and m.

(iv) increases. **(4*1=4)**

28	Read the following and answer any four questions from 28(i) to 28(v) given below:Answer any 4. Sickle cell anemia is a genetic disorder where the body produces an abnormal hemoglobin called hemoglobin S. Red blood cells are normally flexible and round, but when the hemoglobin is defective, blood cells take on a "sickle" or crescent shape. Sickle cell anemia is caused by mutations in a gene called HBB. It is an inherited blood disorder that occurs if both the maternal and paternal copies of the HBB gene are defective. In other words, if an individual receives just one copy of the defective HBB gene, either from mother or father, then the individual has no sickle cell anemia but has what is called "sickle cell trait". People with sickle cell trait usually do not have any symptoms or problems but they can pass the mutated gene onto their children. There are three inheritance scenarios that can lead to a child having sickle cell anemia: - Both parents have sickle cell trait - One parent has sickle cell anemia and the other has sickle cell trait - Both parents have sickle cell anemia
i	Sickle cell anemia is a/ an _____ disease. a. X linked b. autosomal dominant c. autosomal recessive d. Y linked
ii	If both parents have sickle cell trait, then there is _____of the child having sickle cell anemia. a. 25 % risk b. 50 % risk c. 75% risk d. No risk
iii	If both parents have sickle cell trait, then there is _____of the child having sickle cell trait. a. 25 % risk b. 50 % risk c. 75% risk d. No risk
iv	If one parent has sickle cell anemia and the other has sickle cell trait, there is _____that their children will have sickle cell anemia and _____will have sickle cell trait. a. 25 % risk, 75% risk b. 50 % risk, 50% risk c. 75% risk, 25% risk d. No risk
v	 The following statements are drawn as conclusions from the above data (Kenya). I. Patients with SCD (Sickle Cell Disease) are less likely to be infected with malaria. II. Patients with SCD (Sickle Cell Disease) are more likely to be infected with malaria. III. Over the years the percentage of people infected with malaria has been decreasing. IV. Year 2000 saw the largest percentage difference between malaria patients with and without SCD. Choose from below the correct alternative. a. only I is true b. I and IV are true c. III and II are true d. I and III are true **ANS;** i c. autosomal recessive ii a. 25 % risk iii b. 50 % risk iv b. 50 % risk, 50% risk V I and III are true **(4*1=4) Any FOUR.**
	5 Marks

29 A homozygous tall pea plant with green seeds is crossed with a homozygous dwarf pea plant with yellow seeds.
(i) Write the possible phenotype and genotype of F1 generation.
(ii) Work out the phenotypic ratio of F2 generation with the help of a Punnett Square.
(iii) Mention the F2 phenotypic ratio along with their possible phenotypes.
ANS;
(i) Phenotype of F1—Tall plants with yellow seed.
Genotype of F1 generation TtYy



(ii)

F_2 generation

	TY	Ty	tY	ty
TY	TTYY Tall, Yellow seeds	TTYy Tall, Yellow seeds	TtYY Tall, Yellow seeds	TtYy Tall, Yellow seeds
Ty	TTYy Tall, Yellow seeds	TTyy Tall, Green seeds	TtYy Tall, Yellow seeds	Ttyy Tall, Green seeds
tY	TtYY Tall, Yellow seeds	TtYy Tall, Yellow seeds	ttYY Dwarf, Yellow seeds	ttYy Dwarf, Yellow seeds
ty	TtYy Tall, Yellow seeds	Ttyy Tall, Green seeds	ttYy Dwarf, Yellow seeds	ttyy Dwarf, Green seeds

(ii)Phenotypic ratio of F2 generation:
Tall plants with Yellow seeds =9
Tall plants with green seeds =3
Dwarf plants with yellow seeds =3
Dwarf plants with green seeds =1 **(1+1+2+1=5)**

30 (i) Why is sickle cell anaemia ,a human blood disorder so named?
(ii)Explain the genetic basis that results in the expression of this disorder.
(iii)Work out a cross to explain how normal parents may have a sickle cell anaemic child.
ANS;
(i) The RBC in such patients takes up a sickle shape instead of biconcave **(1)**
(ii) 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 proteinresults due to the single base substitution at the sixth codonof the beta globin gene,fromGAG to GUG. **(2)**

(iii) Phenotype ♀ carrier * carrier♂

Genotype Hb^AHb^s Hb^AHb^s **(2)**

Gametes	Hb^A	Hb^s
Hb^A	Hb^AHb^A	Hb^AHb^s
Hb^s	Hb^AHb^s	Hb^sHb^s

Genotypes Hb^AHb^A Hb^AHb^s Hb^sHb^s
Unaffected Carrier Sickle cell anaemia
It is an autosomal recessive disorder.

CHAPTER – 6 : MOLECULAR BCASIS OF INHERITANCE

CHAPTER 7 EVOLUTION

Gist of the Lesson

volutionary Biology: Study of the history of life forms on Earth.
volution: Gradual heritable changes in population over millions of years leading to diversity of rganisms on Earth.

Origin of Life

unique event in the history of the universe.
he universe originated **20 billion years ago and** comprises of huge cluster of galaxies.
alaxies contain stars and clouds of gas and dust.
he Big Bang Theory explains the origin of the earth.

- Proposed by Abbe Lamaitre in 1931.
- A huge thermonuclear explosion occurred, the universe expanded, the temperature came down, and hydrogen and helium formed later.
- The galaxies were formed due to the condensation of gases under gravitation.
- Earth belongs to Milky Way galaxy.

Origin of Earth

- Earth was formed **4.5 billion years** ago.
- No atmosphere on early Earth.
- The surface was covered with water vapour, methane, carbon dioxide, and ammonia released from the molten mass.

- Inheritable molecule is generally DNA except in retroviruses, which have RNA
- It has a number of base pairs (bp).
- phi **X 174** (or ΦX174) **bacteriophage--**5386 nucleotides SS DNA, The virus infects Escherichia coli, and the first DNA-based genome to be sequenced
- *Escherichia coli have 4.6 x 10^6 bp
- Haploid content of human DNA is 3.3×10^9 bp.
- Diploid content of human DNA is 6.6×10^9 bp.

1.

Differences b/w DNA and RNA 2m

DNA	RNA
Double helical structure	Generally single stranded
It is genetic material	Except in retroviruses, it helps in synthesis of proteins
Chemically less reactive and structurally stable	Due to presence of OH group at 2' position of ribose, highly reactive and less stable
Deoxy-ribose sugar	ribose sugar
A T G C bases	A U G C bases
Has no catalytic role	Acts as catalyst(ribozyme) and forms peptide bond b/w amino acids

Note:few viruses have ds RNA- eg; rotavirus causing childhood diarrohea)

2. **Polynucleotide chain**

a) Nucleotide has 3 components

- Nitrogenous base: Purines-A, G
  Pyrimidines – C,T,U
- Pentose sugar : Ribose / Deoxy-ribose sugar
- Phosphate

	components	bond

Nucleoside → (adenosine, guanosine, cytidine, thymidine, uridine)	N.Base + sugar	N-glycosidic linkage
Nucleotide---→ (Adenylic acid,Guanylic acid Cytidilic acid,Thymidilic acid, Urydilic acid)	Nucleoside + phosphate	Phospho-ester linkage
Di nucleotides	Has 2 nucleotides	3'-5' Phospho-diester linkage

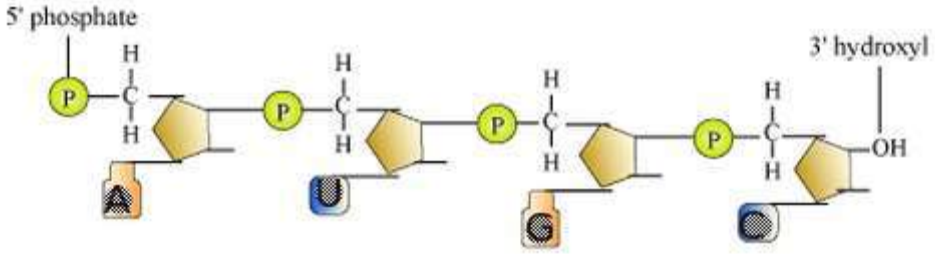
5' and 3' ends of polynucleotide chain : 1m

- free phosphate moiety is at 5" end

-free OH group at 3' end

3. **Diagram of RNA structure showing all four bases** **or**

Diagram of a polynucleotide chain



4.

a) Basis for double helical structure of DNA 2m

b) X-ray diffraction data produced by Wilkin and Rosalind

c) Base pairing rule…. A=T and G≡C

A/T=1 and C/G=1

b) **DNA structure(silent features)** 5m

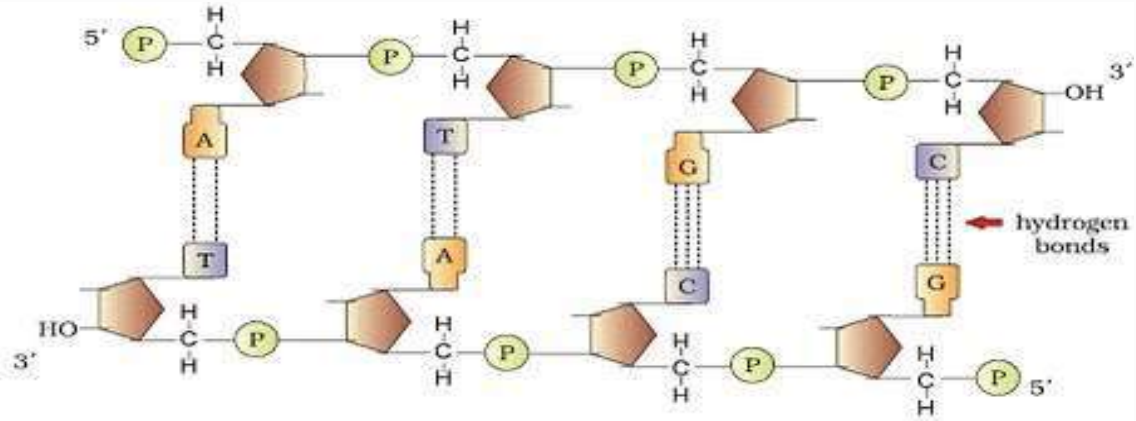
a) It has two polynucleotide chains. Two chains have anti-parallel polarity. One 5'→3' and another 3'→5'.

b) Backbone is made up of sugar-phosphate and bases projected inside it.

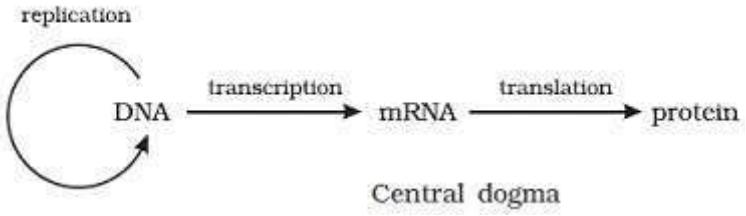
c) The bases in two strands are paired through H-bonds. A=T and G≡C

d) The pitch of helix is 3.4 nm and has 10 bp per turn. The distance b/w 2 adjacent bp is 0.34nm

e) Stacking of bp one over the other and H-bonds b/w opposite strands bases confer stability to the double helix



C) Francis Crick proposed the **Central dogma in molecular biology**, which states that the genetic information flows from DNA ——> RNA ——> Protein. 1m



Central dogma

The **central dogma** of biology describes just that. It provides the basic framework for how genetic information flows from a DNA sequence to a protein product inside cells. This process of genetic information flowing from DNA to RNA to protein is called gene expression.

Dogma-----a principle or set of principles laid down by an authority as incontrovertibly true.

5. **Packing of DNA helix**-

In Prokaryotes (E.coli) : 2m

- -well defined nucleus is absent.
- -vely charged DNA is held in the form of loops by +vely charged proteins

in the cytoplasm called nucleoid region

Packaging of DNA In eukaryotes: 2m/ 3m

- Histones are +vely charged proteins, as they are rich in the basic amino acid residues lysines and arginines.

8 histone molecules together form histone octomer.

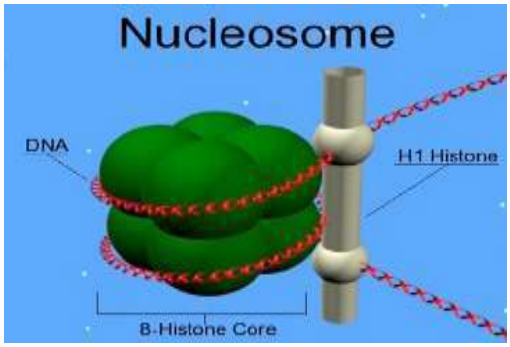
⇓

about 200 bp of DNA wraps around histone octomer to form nucleosome.

Nucleosomes stack one over another to form a thread like structure called chromatin

Chromatin further coils to form thick chromosomes in presence of NHC(non-histone complex proteins)

Diagram of nucleosome 2m



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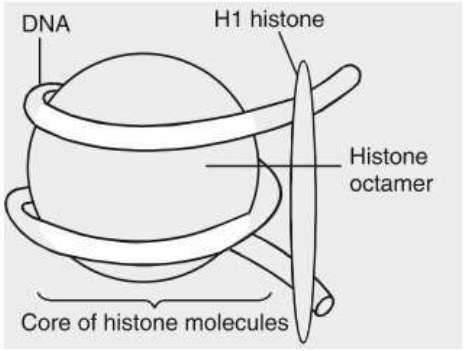


EXTRA ___Histones are basic proteins--- two types:

- Core Histones
- Linker Histones

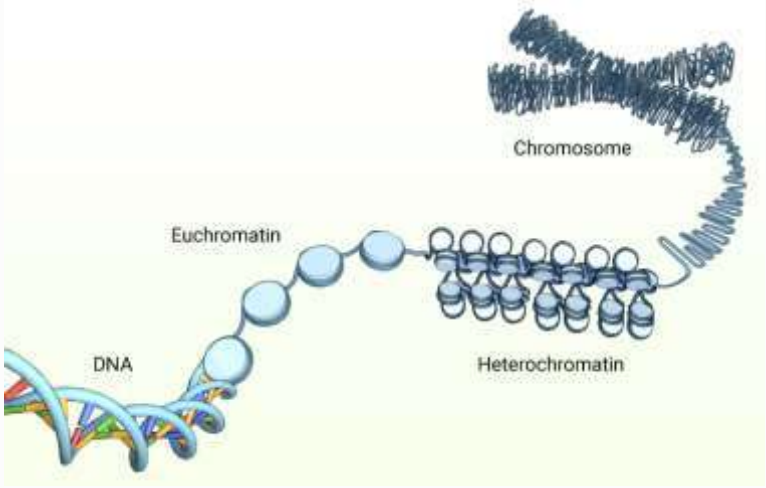
H2A, H2B, H3 and H4 are the core histones. Two H3, H4 dimers and two H2A, H2B dimers form an octamer.

Linker histones lock the DNA in place onto the nucleosome and can be removed for transcription.

Histones can be modified to change the amount of packaging a DNA does. The addition of methyl group increases the hydrophobicity of histones. This results in tight DNA packaging.

In addition to binding to the nucleosome, the H1 **protein** binds to the "linker DNA" (approximately 20-80 nucleotides in length) region between nucleosomes, helping stabilize the zig-zagged 30 nm chromatin fiber

Six Nucleosomes are assembled into a Solenoid in association with H1 **histones**.



Euchromatin and heterochromatin 2m

Euchromatin	heterochromatin

-region of chromatin which loosely packed and lightly stained. -trancriptionally active	Densely packed and darkly stained - trancriptionally inactive

6. **Search for genetic material**

A) Transforming principle – Frederick Griffith Expt: 3m

- Did expts with a bacteria 'Streptococcus pneumoniae' that causes pneumonia.
  It has 2 strains . S strain – Has smooth polysaccharide coat and is virulant
  R strain – lacks polysaccharide coat and is avirulant
- Series of expts are

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

- **Conclusion-**

He could recover live S strain from the dead mice in the last expt.

He assumed that R strain is transformed into S strain , by synthesizing a polysaccharide coat.

A substance present in S strain is responsible for this transformation.

Hence, he named the substance as transforming principle.

B) Biochemical Characterisation of Transforming Principle 2m

- Oswald Avery, Colin MacLeod and Maclyn McCarty determined 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.

  Protein of heat killed S + Live R----→ mice survives
  RNA of heat killed S + Live R----→ mice survives
  DNA of heat killed S + Live R----→ mice dies

DNA of heat killed S caused transformation

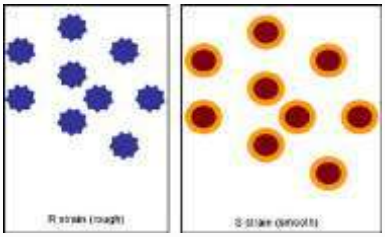
- They further treated the Heat killed S with enzymes like proteases, RNAase and DNA ase and concluded that DNA is the transforming principle

heat killed S treated with protease + Live R----→ mice survives

heat killed S treated with RNAase + Live R----→ mice survives

heat killed S treated with DNAase + Live R----→ mice dies

So, they concluded that DNA is the transforming principle



R strain S strain

The search for genetic material –Griffith expt by 7 active studio , 3.36 min

7.

DNA is the genetic material in bacteriophages - Hershey and Chase expt 5m

a) Bacteriophage has got protein coat and DNA .
When it infects bacteria only DNA enters, but not the protein coat.
The viral DNA molecule replicates and also synthesis a new protein coat around it. Thus, a large No. of phase particles are synthesized in bacteria

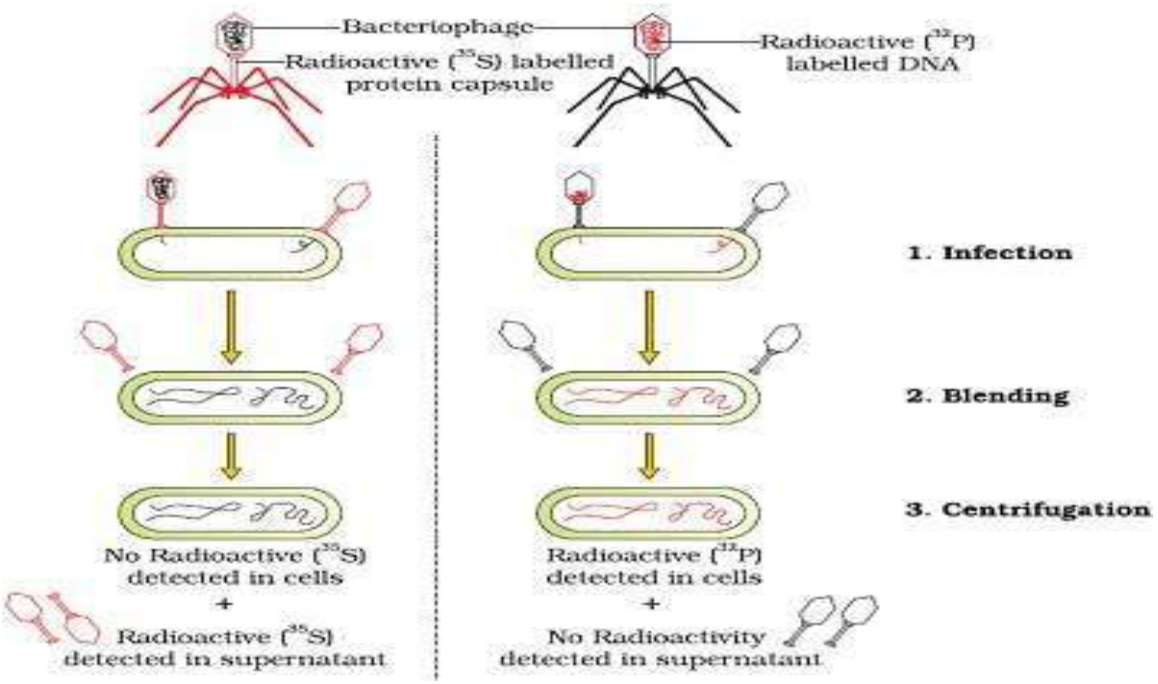
b) **In the first set of expt**,

- They labelled protein coat with radioactive ^{35}S.
- This phage particle was allowed to infect the bacteria.
- The bacteria was then agitated in a blender to detach protein coat from the bacteria
- Later, they centrifused and checked for radioactivity.
- Found that radioactive sulphur was detected in the supernatant (that contains only protein coats), but not in bacterial cells.

c) **In the 2nd set of expt**

- They labelled DNA with radioactive ^{32}P.
- They allowed this viral particle to infect the bacteria.
- Here, they found that radioactive phosphorus was detected within the bacterial cells, but not in the supernatant.

d) This expt proved that DNA is the genetic material, but not the protein in bacteriophages.



The search for genetic material part 2(Hershey and Chase expt) by 7 active studio , 2.47 min

8.

i) Properties of Genetic Material: 2m

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'.

ii) DNA is the better genetic material than RNA **2m**

a) RNA is chemically and structurally less stable as compared to DNA .
2'OH group present in ribose sugar of RNA is highly reactive.
And also presence of U in place of T makes it less stable.

b) RNA(ribozyme) acts as a catalyst.

c) RNA being single stranded mutates faster

d) DNA being double stranded resists any change in base sequence

iii) RNA was the first genetic material **3m**

a) RNA directly takes part in protein synthesis and easily expresses the character. It is the genetic material in many viruses.

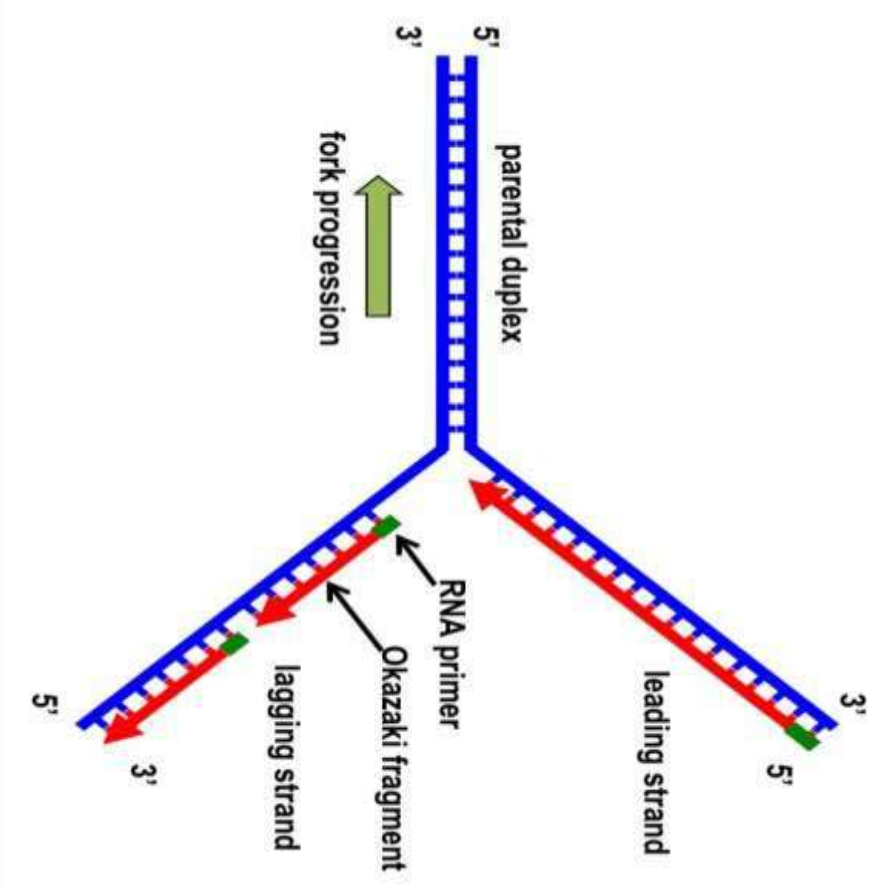
b) It acts as a catalyst. Some important biochemical reactions are catalyzed by RNA and not by protein enzymes. Eg: Ribozyme catalyses peptide bond formation.

c) Essential life processes like metabolism, translation and splicing are evolved around RNA.

9.

DNA replication:

It is the process of making new DNA molecules from parental DNA molecule by complementary base pairing mechanism. After the completion of replication each DNA molecule would have one parental and one newly synthesised strand, this method is called semiconservative replication.



Steps:

a) **Unwinding of double helix to form 'template strands'**

- Helicase enzyme cuts and opens double helix at a specific point called'**Ori'**.
- It **breaks H-bonds** and separates both strands.
- The single stranded DNA molecule is known as template strand.

- Partially unwound double helix looks like aY shaped structure known as ' **Replication fork'**

b) Primer synthesis

Primase enzyme synthesizes a short segment of RNA close to the origin.

c) Synthesis of new DNA strand

DNA dependent DNA polymerase adds deoxy-ribonucleotides to the primer in 5'→ 3' direction

Continuous synthesis:

On the template strand that runs in **3'→ 5'** direction, there is continuous synthesis of DNA .

And this template is called leading strand.

Dis-continuous synthesis:

On the template strand that runs in **5'→ 3'** direction, there is dis continuous synthesis of DNA resulting in the formation of short segments of DNA called '**okazaki fragments'**. .

And this template is called **lagging strand.**

d) Repacement of primer

Primer is replaced a new DNA segment by DNA polymerase I

e) Joining of DNA fragments

Okazaki fragments are joined **by DNA ligase**.

At the end we obtain 2 daughter DNA molecules from a single parental DNA molecule

****

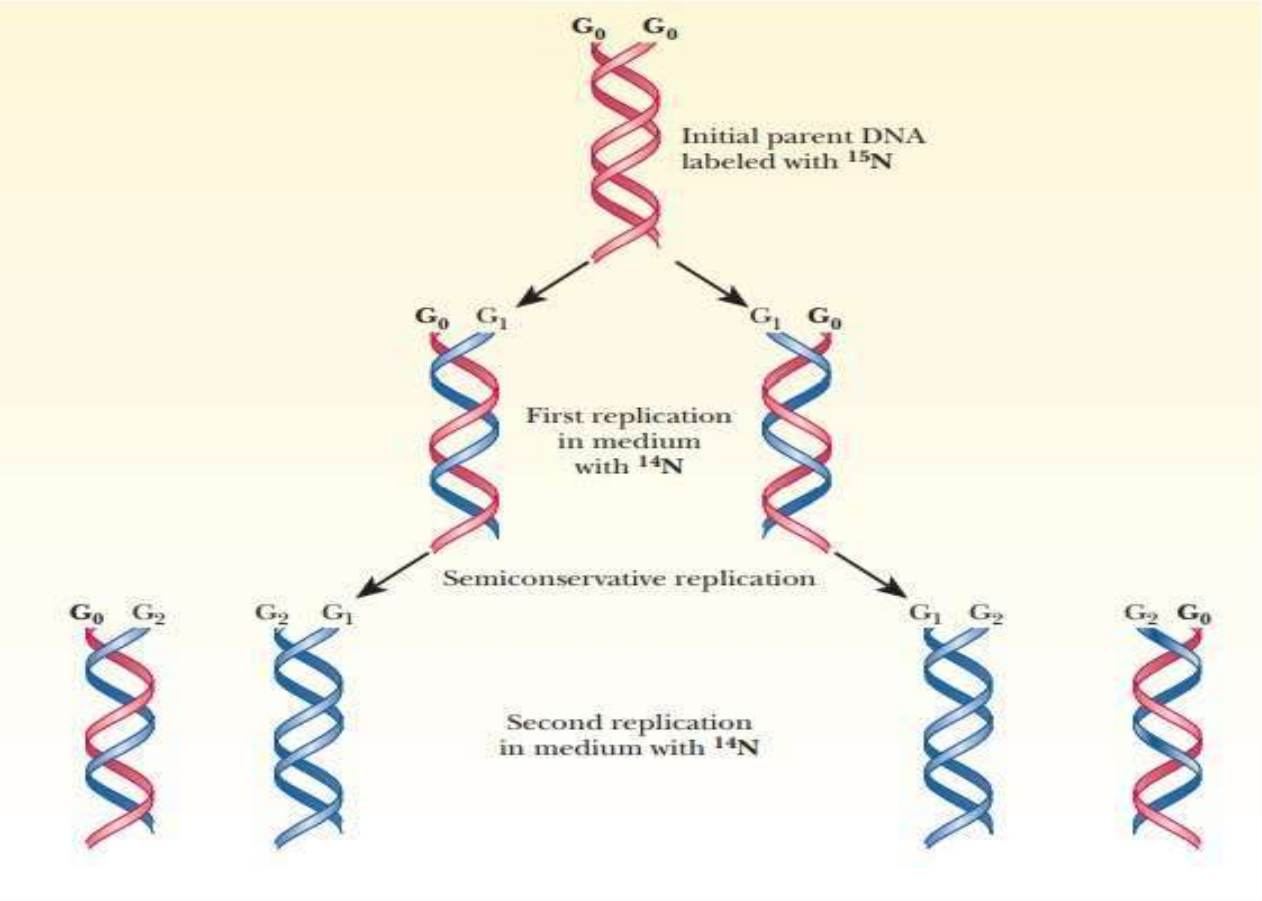
Differences between leading and Lagging strands for DNA replication. **2m**

Leading strand	Lagging strand
-It runs in 3'→5 -Synthesis of new complimentary DNA strand is continuous - only one RNA primer is required -DNA ligase is not required	-In 5′→3′ . -Synthesis of new complimentary DNA strand is discontinuous forming okazaki fragments. - Every fragment requires one primer. - DNA ligase isrequired for joining DNA fragments

DNA replication 3D animation by yourgenome 3.28min

10.

Messelson and Stahl's Expt. - Semiconservative nature of DNA replication 5m



In a daughter DNA molecule, one of the strands is **parental one** and the other is strand is newly synthesized. It means only one of the parental strand is conserved during replication.

a) **Obtaining ^{15}N bacteria**:

- They grew E coli in a medium containing $^{15}NH_4Cl$ as the only nitrogen source for several generations.
- ^{15}N got incorporated into the newly synthesized bacterial DNA.
- ^{15}N -DNA is heavier as compared ^{14}N DNA. So, it settled at the bottom in a density gradient CSCl solution.

b) Culturing of ^{15}N bacteria in ^{14}N medium

- ^{15}N E coli was cultured in a medium containing $^{14}NH_4Cl$.
- They studied the density of DNA molecule by extracting the DNA of E coli at intervals.
- In the **1st generation** (after 20 min) , the density of DNA molecule **was intermediate** between that of the heavier ^{15}N-DNA and the lighter ^{14}N-DNA (as it possessed one ^{15}N strand and one ^{14}N strand).
- **In the 2nd generation** (after 40 min) they noted that the ratio of Intermediate density DNA : lighter DNA =1:1

Meselson and Stahl experiment by quick biochemistry basics, 3.04 min

11. **Q. If the E coli was allowed to grow for 80 min , then what would be the proportion of light and hybrid DNA molecules**.

Hint: after 80 min = 3rd generation

Ans: light: hybrid DNA molecules = 2:14= 1:7

Semi-conservative replication in Plants 2m

- Taylor etal worked on Vicia faba(faba beans).
- Using radioactive thymidine., they proved that DNA present in the chromosomes also replicate semi-conservatively.

Heavier DNA molecule could be distinquished from the normal DNA molecule by centrifugation in a CSCl density gradient, but not by radioactivity. Why? 1m

^{15}N is not radioactive. So, it can be separated from 14N only based on densities.

12. **Transcription:** **1m**

It is process of copying genetic information present on template atrand of DNA into RNA . This occurs in presence of RNA polymerase by complimentary base pairing mechanism.

i) Differences b/w replication and transcription 2m

replication	transcription
-Making carbon copies of DNA is replicaton. -DNA polymerase is needed -Entire DNA molecule gets replicated -Both the strands of DNA undergo replication	Making RNA from template strand of DNA is transcription. -RNA polymerase is needed - Only a segment of DNA is transcribed - Only one strand (template strand) undergoes trancription

ii) Why both the strands of DNA are not copied during transcription? 2m

a) If both the strands are copied , then they would form 2 different RNA molecules, which inturn code for 2 different proteins.

b) If both the strands are of DNA are transcribed simultaneously, then they produce 2 RNA molecules which are complimentary to each other. So, they form ds RNA, which can not take part in translation process.

iii) Various components of Transcription unit: 3m

It has 3 regions

a) Promoter: present at the 5' end of coding strand

- RNA polymesrase binds to the promoter and begins transcription

b) Terminator: present at the 3' end of coding strand

- it stops transcription process

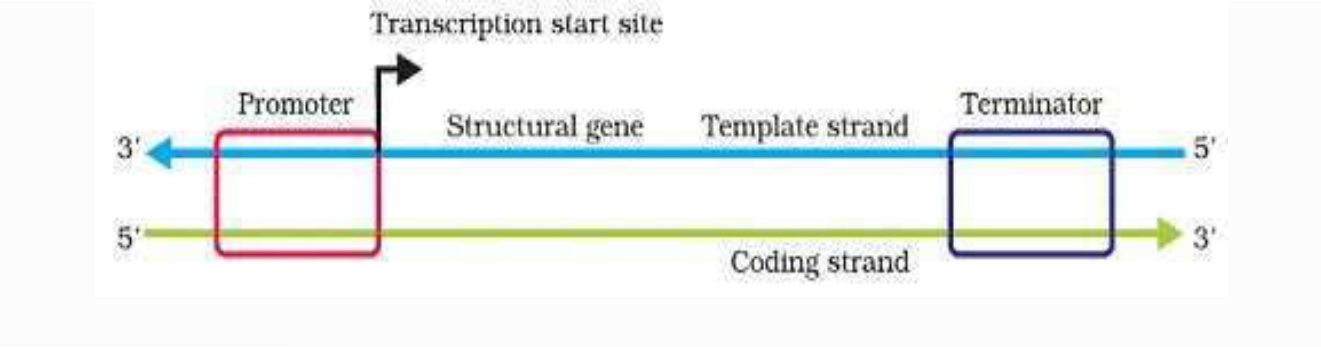
c) Structural gene (cistron):

- Present in b/w promoter and terminator regions.

- has template strand and coding strands

-template strand runs in 3→ 5 direction and takes part in transcription.

-coding strand runs in 5→ 3 direction takes and does not part in transcription.



iv) Differences b/w prokaryotic and eukaryotic cistron: 2m

Cistron is segment of DNA that codes for polypeptide chain via mRNA

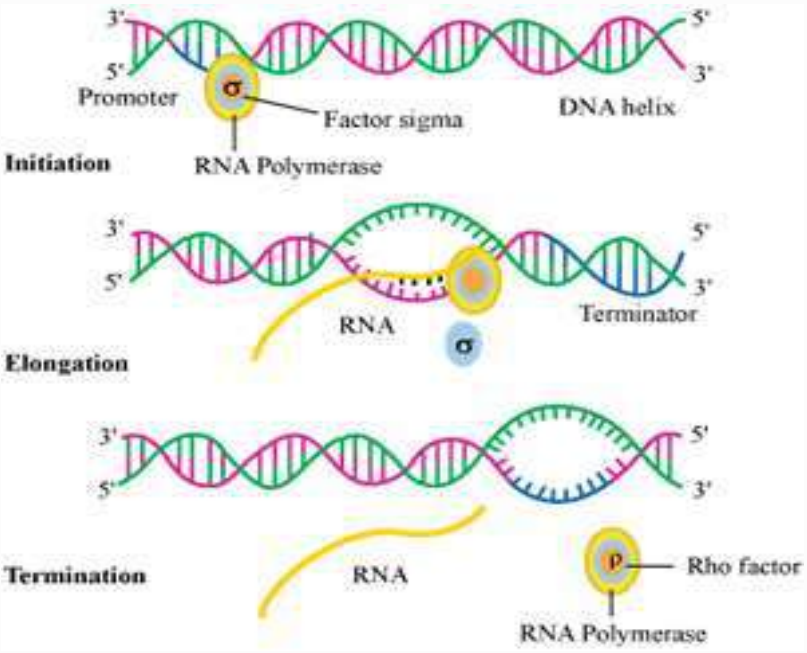
Prokaryotic cistron	Eukayotic cistron
It is polycistronic- codes for more than one polypeptide chain -It does not possess any interrupting non-coding sequences called introns	monocistronic- codes for only one polypeptide chain

	-shows split gene arrangement. It possess interrupting non-coding sequences called introns in b/w coding sequences called exons

v) Differences b/w introns and exons 2m

Introns	Exons
• they are interrupting non-coding sequences – • they are deleted during processing and hence do not appear in the mature/ processed m RNA . • Do not take part in protein synthesis -No role in protein synthesis	• coding sequences • They are retained during processing and present in the mature m RNA • take part in protein synthesis

13. **vi) Transcription in Prokaryotes/Bacteria: 3m/5m**



All the 3 types of mRNA (mRNA, tRNA and rRNA) are synthesized by a single enzyme –DNA dependent DNA polymerase.

a) Initiation:

RNA polymerase transiently binds with **σ** factor to form holoenzyme.

The enzyme attaches to promoter and initiates transcription by opening the DNA double helix

b) Elongation:

σ factor gets disassociated from RNA polymerase.

The enzyme adds on ribonucleotides in 5→3' direction, till it reaches terminator

c) Termination:

When RNA polymerase reaches the terminator, ρ factor (***Rho factor***) attaches to the enzyme and makes it to dis-lodge from the template strand. This stops transcription

vii) Differences b/w prokaryotic and eukaryotic transcription/ complexities involved in eukaryotic transcription 3m

prokaryotic	Eukaryotic
• A single RNA polymerase transcribes mRNA, tRNA and rRNA • Both transcription and translation occur simultaneously as there is no demarcation b/w nucleus and cytoplasm • m RNA formed by transcription need not undergo processing as it does not contain introns.	• RNA polymerases I, II,III transcribe rRNA, mRNA and tRNA respectively. • translation occurs after transcription • m RNA transcribed is nonfunctional and is known as primary transcript. It contains both introns and exons and hence called as hnRNA. It undergoes processing to form functional mature mRNA.

viii) Transcription in eukaryotes

or

Processing of hnRNA into functional mRNA

- RNA polymerases I, II and III respectively synthesise rRNA, mRNA and tRNA.

- mRNA transcribed is nonfunctional and is known as precursor mRNA/ primary transcript/ hnRNA.
- It undergoes processing to form functional mRNA

Steps:

- **Capping:**

  When mRNA comes out of the nucleus into the cytoplasm, it may be degraded by RNase.

  So, to the 5' end of hnRNA, methylguanosine triphosphate is added as a cap.

- **RNA spilicing:**

  hnRNA contains non-coding sequences called introns, which do not take part in translation.

  A pair of spliceosomes cut and remove the introns and join all exons in sequence.

  Exons are retained in the mature mRNA as they code for proteins.

- **Tailing:**

  Around 200-300 adenylate residues are added at the 3'end of RNA.

  It is done at the end of transcription, to protect the **mRNA** molecule from enzymatic degradation in the cytoplasm.

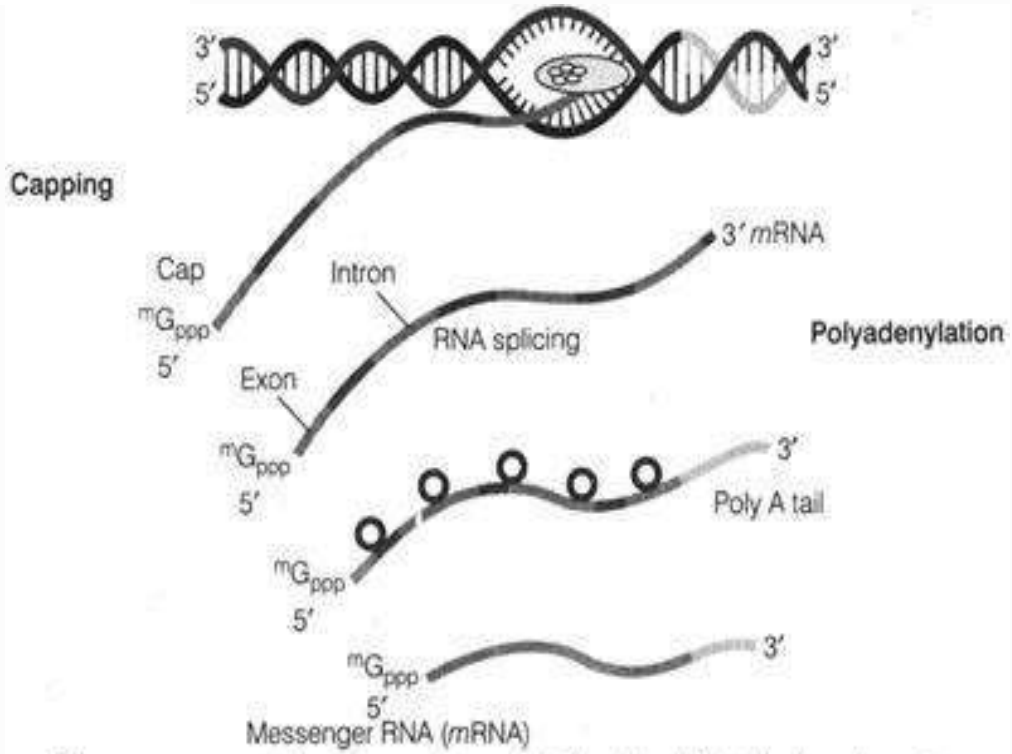


Diagram representation of a post transcriptional modification in eukaryotes

Q) Base sequence on one strand of DNA is:

5'ATGCATGCATGC3'

Write the mRNA transcribed from DNA segment.

ANS: Template strand : 3'TACGTACGTACG5'

mRNA : 5'AUGCAUGCAUGC3'

14. **Genetic code :**

A set of rules that tell about the co-relation b/w the codon sequence on mRNA and amino acid sequence in a protein.

i) **Deciphering of genetic code** 2m/3m

- **George Gamow** : the code should have a combination of bases as there are only 4 bases for coding 20 amino acids.
  He suggested a permutation combination of 4^3(4x4x4), to generate 64 codons.
  So, the codon is triplet- made of 3 nucleotides
- **Har Gobind Khorana** : synthesized RNA molecule with definite combination of bases(homoplymers and copolymers)
- **Marshel Nirenberg:** synthesided proteins in a cell free system.
- **Severo Ochao**: identified polynucleotide phosphorylase helped in the synthesis of RNA.

Genetic Code- Table

1st letter	Second Letter: U		C		A		G		3rd letter
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	U
	UUC		UCC		UAC		UGC		C
	UUA	Leu	UCA		UAA	Stop	UGA	Stop	A
	UUG		UCG		UAG	Stop	UGG	Trp	G
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg	U
	CUC		CCC		CAC		CGC		C
	CUA		CCA		CAA	Gln	CGA		A
	CUG		CCG		CAG		CGG		G
A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	U
	AUC		ACC		AAC		AGC		C
	AUA		ACA		AAA	Lys	AGA	Arg	A
	AUG	Met	ACG		AAG		AGG		G
G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly	U
	GUC		GCC		GAC		GGC		C
	GUA		GCA		GAA	Glu	GGA		A
	GUG		GCG		GAG		GGG		G

ii) **Salient features of genetic code: 3m/5m**

- The codon is triplet: 3 nucleotides/bases form a codon.
  61 codons code for amino acids and 3 codons (UAA, UGA, UAG) are stop/non-sense codons as they do not code for any amino acids.
- Unambiguous and specific:
  One codon codes for only one amino acid. UUU- Phe, AUG- met
- Code is degenerate:
  Some amino acids are coded by more than one codon.

UUU and UUC both code for Phenyl alanine

- Without punctuations:

  The codon on mRNA is read in a contiguous manner without any commas. The **code** is read sequencially three bases at a time without any commas

- Universal:

  From bacteria to human UUU codes for phenyl alanine only.

  Exceptions: codons found in mitochondria and some protozoans

iii) Dual function of AUG 2m

- codes for methionine
- Acts as initiation codon and begins protein synthesis

iv) **Frameshift insertion/deletion mutation**: 2m

- Insertion or deletion of one or two bases to a DNA sequence, changes the reading frame from the point of insertion/deletion. This results in synthesis of non-sense protein .
- Insertion/deletion of 3 or its multiple bases results change at that particular point only. And reading frame remains unaltered from that point.

  Eg: In sickle cell anaemia, there is a single bp substitution(GAG→ GUG) resulting in substitution of glutamic acid by valine in beta globin chain.

15.

tRNA molecule

- Francis Crick discovered tRNA as adaptor molecule
- there are no tRNAs for stop codons
- Its secondary structure is depicted as clover leaf. Actually it looks like inverted L
- The 61 codons used to code **amino acids** can be read by 61 distinct **tRNAs**.

tRNA-the adaptor molecule 2m

- It has anticodon loop that has bases complimentary to the code and it also has an amino acceptor end (3'end) to which a specific amino acid binds
- tRNA on one hand binds to the codon present on mRNA with its anticodon loop and on the other hand brings in to the ribosome, a specific amino acid required for protein synthesis.

t RNA diagram 2m

- The UV rays of the sun broke water into Hydrogen and oxygen, Hydrogen being lighter escaped, and Oxygen combined with ammonia and methane to form water, CO_2, and other gases, also forming ozone layer.

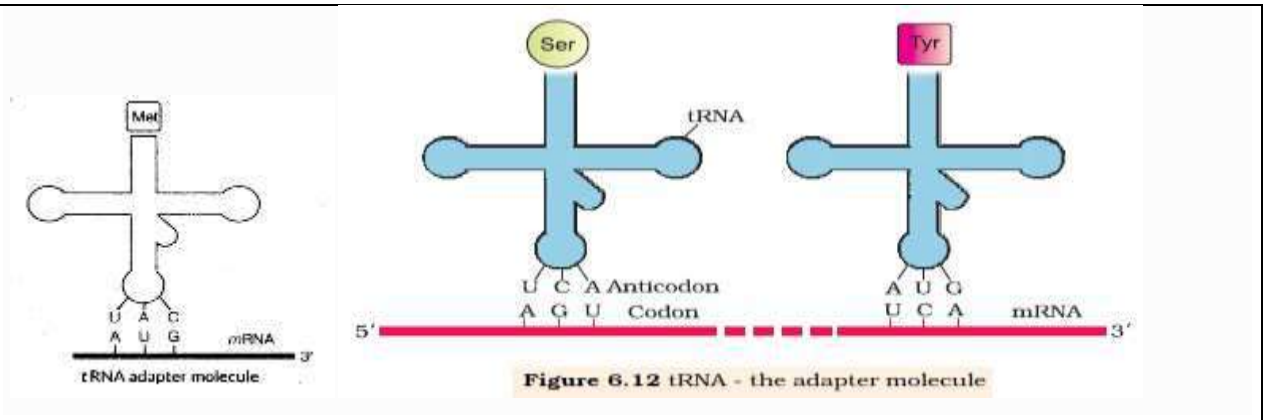


Figure 6.12 tRNA - the adapter molecule

Translation (protein synthesis):

Process of converting codon sequence present on mRNA into amino acid sequence in protein.

i) Requirements:

- mRNA determines the amino acid sequence in aprotein
- tRNA transports amino acids to the site of protein synthesis
- rRNA (ribosomes) cellular factory of protein synthesis.
- Amino acids
- IFs,EFs and TFs , Mg++, GTP

ii) **Aminoacylation of tRNA/ Charging of tRNA**: 2m

Amino acid + ATP→Amino acyl AMP (activated amino acid)

Amino acyl AMP + cognate tRNA→amino acyl tRNA (tRNA charged with amino acid)

Significance: it facilitates peptide bond formation b/w amino acids as bond formation requires energy.

iii) Polypeptide chain synthesis :

a) Initiation of chain synthesis:

- 30s unit of ribosome attaches to mRNA at 5'end where initiation codon is present.
- Initiator tRNA (**fmet tRNA)** attaches to initiation codon
- 50S subunit attaches to mRNA to form initiation complex.
- IFs, Mg++ and GTP are required

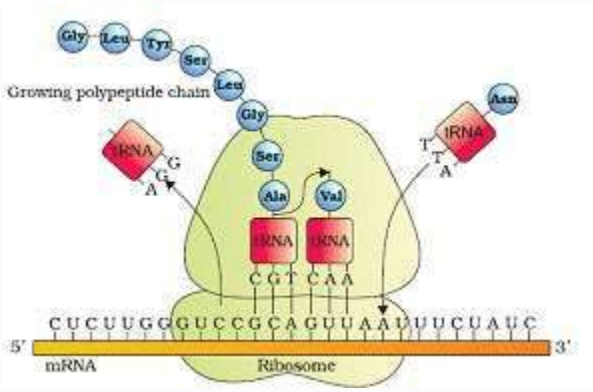
b) Chain elongation:

- 50S subunit has two sites. A site(**acceptor/*aminoacyl* site**) and P site(**peptidyl site**)

- **P site** is occupied by the **initiator tRNA**, where as **A site is vacant for 2nd tRNA**
- 2nd tRNA molecule specifis to the codon comes and occupies A site
- **Aminoacid gets shifted** from P site to A site and **a peptide bond** is formed b/w amino acids in presence of ribozyme/peptidyl transferase.
- Initiator tRNA is ready to **exist**
- Ribososome gets **translocated** in 5→3' direction on mRNA by a codon length
- This results in exit of 1st tRNA and shifting of 2nd tRNA **from A site to P site**
- Again A site becomes vacant for 3rd tRNA.
- This process requires Mg++ and GTP

c) Chain termination:

- When A site is occupied by any of **the 3 stop codons** (UAA,UGA,UAG) termination occurs
- **RFs bind to the stop codon**. This results in disassociation of ribosomal subunits,polypeptide chain and mRNA



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UTRs (untranslated regions): **2m**

- Additional base sequences present on mRNA **at the 5' end**(before the start codon) and **at 3' end** (after the stop codon).
- They donot get translated. But required for **efficient translation process.**

Regulation of gene expression:

By switching on and off the gene its expression is regulated.

i) In eukaryotes: gene expression can be regulated at 4 levels **2m**

- Transcriptional level(formation of hnRNA
- Processing level(regulation ofsplicing)
- Transport of mRNA from nucleus to cytoplasm

- Translational level

ii) In prokaryotes: gene expression can be regulated at 2 levels 1m

- Transcriptional level
- Translational level

iii) Components of Lac operon 5m

Lac operon model is proposed by Jacob and Monad

a) Polycistronic structural gene: has 3 genes Lac z,y and a

- Lac z - gene-produces β galactosidase, that hydrolyses lactose(galactosides) into glucose and galactose
- Lac y- gene-produces permease. It increases the permeability of the cell to lactose
- Lac a -gene-produces transacetylase. catalyzes the transfer of an acetyl group from one molecule to another

b) Operator region(O) :

- Present adjacent to the structural genes.
- When it is blocked by repressor protein , the RNA polymerase fails to move over structural genes and therefore no transcription occurs
- When it is not blocked transcription occurs

c) Promoter region(p)

RNA polymerase binds to this region and begins transcription

d) Repressor gene(igene)

It produces a repressor protein which is inhibitory in nature

Repressor can bind with the operator and block the path of RNA polymerase to stop transcription of structural genes.

e) Inducer(lactose):

When lactose is present in the medium, some of the lactose moecules bind with the repressor and make it inactive

This inactive repressor cannot bind to operator.

Therefore transcription and translation occurs to produce enzymes required for lactose digestion

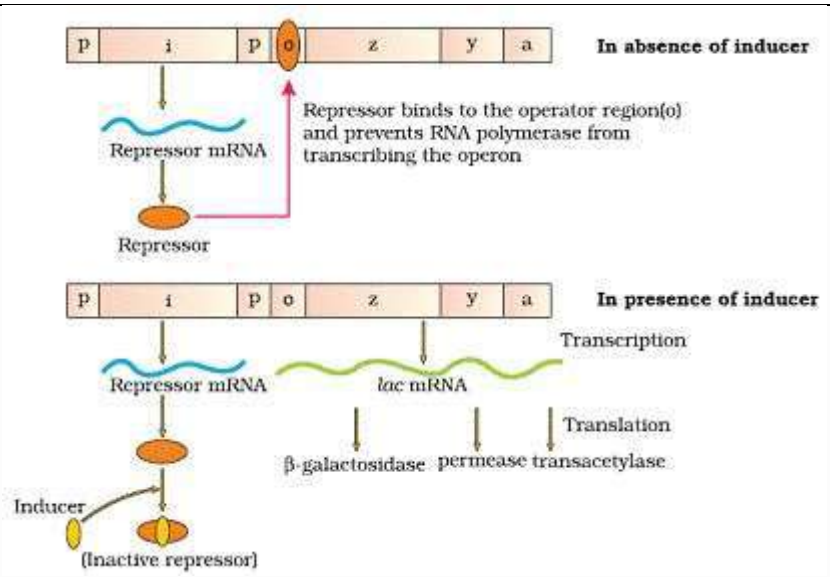
iv) Switching 'on' and 'off' of Lac operon diagrams 3m/5m

- Cooling of water vapour led to rain which filled the depressions on Earth's surface, forming water bodies.

THEORIES OF THE ORIGIN OF LIFE

ife originated on Earth almost 4 billion years ago

- ✓ **Theory of Special creation**: It states that living things were created by some supernatural power.
- ✓ **Theory of Panspermia**- It states that the units of life (spores) were transferred to different planets including earth.



Switching 'on' in the presence of inducer-lactose **2m**

- Some of the lactose molecules bind with the repressor protein
- Repressor becomes inactive and fails to bind with the operator
- So, RNA polymesase moves on structural genes. Trancription and translation occurs to produce enzymes(β galactosidase, permease, transacetylase)
- Lactose is digested into glucose and galactose

Switching 'off' in the absence of inducer-lactose **2m**

- Repressor protein binds with the operator
- Blocks RNA polymesase movement on structural genes.
- No Trancription and translation occurs and enzymes are not produced.

The Human Genome Project (HGP):

- It was an international scientific research **project to** determine the bp sequence of **human** DNA and say location of genes on chromosomes.
- It was coordinated by the U.S. Department of Energy (DOE) and the National Institutes of Health. Wellcome Trust (U.K.) became a major partner; later Japan, france,Germany, China contributed to this project .

i) HGP was a megaproject: 3m

- 13 year project -was launched in 1990 and completed in 2003
- Estimated cost was 9 billion US dollars for sequencing 3x109 bp present in haploid human genome.

- Development of high speed computational devices required for data storage, retrival and analysis. This lead to the development of Bioinformatics.

ii) Goals of HGP: 2m

- Identify all the genes (approx. 20,000 to 25,000) in human DNA.
- Determine the sequence of the 3 billion chemical base pairs (3x109 bp) that make up human DNA.
- Store this information in data base.
- Improve tools for data analysis.
- Transfer related information to other sectors.
- To address the legal, ethical and social issues that may arise due to project.

iii) Salient features of HGP 2m/3m

a) The human genome consists of about 30,000 genes.

b) Average gene size is 3000 bp. But sizes vary greatly. Eg: the largest human gene dystrophin (gene that causes muscular dystrophy)has 2.4 million bases

c) Total No. of bp present in haploid human genome =$3x10^9$ bp

d) Chromosome I has maximum genes (2968) while Y-chromosome has few genes (231)

e) The function of over 50% of discovered genes is unknown

f) Less than 2% of the genome represents structural genes that code for proteins

g) Repeated sequences make up very large portion in the human genome 2m

Repetitive sequences are nucleotide sequences that are repeated many times. Sometimes hundred to thousand times.

They have no direct coding function but provide information on chromosome structure, dynamics and evolution.

h) SNPs - single nucleotide polymorphism: 2m

Nucleotide sequences that differ from one another by a single base. They help in finding the location of disease associated sequences on a chromosomal also in and tracing human history.

HGP Applications and future challenges: 2m

- It helps locating disease related genes on a chromosome and helps in providing possible remedies for genetic diseases
- Help in making designer drugs/ genetically modified diets
- Gene sequencing information on non-human organisms—helps in overcoming the challenges in agriculture,health care, energy production.

. Note: Gene sequencing is available on Coenorhabditis elegans (free living non-pathogenic nematode), Droso- phila (fruitfully), Rice, Arabidopsis etc

Methodology involved in human genome sequencing : 1m/ 2m/5m

i)Two major approaches adopted for analysing the human genome, 2m

(a) Expressed sequence tags or ESTs – to identify all the genes that are expressed as RNA .that means finding out the base sequence of only coding regions(exons)

(b)Sequence annotation- Sequencing the whole genome (both coding and non-coding regions) and later assigning the different regions with functions -.

ii) HGP followed the second methodology which involve following steps.

- The whole DNA of the cell is isolated and broken randomly into fragments
- DNA fragments are inserted into specialised vectors like BAC (bacterial artificial chromosomes) and YAC (yeast artificial chromosome),
- The fragments are cloned in suitable hosts like bacteria and yeast.Now, PCR can also be used for cloning or making copies of DNA fragments,
- The base sequence of DNA fragments is found using automated DNA sequencer developed by Frederick Sanger,
- The sequences were then arranged on the basis of some overlapping regions using computer base.

Note: for 22 autosomes, X and Y sex chromosomes sequencing is done. Chromosome I was last to be sequenced in May, 2006.

Contribution of Frederick Sanger in molecular biology 2m

- He developed automated DNA sequencer. It determines the sequence of bp in DNA fragments
- And a method to determine amino acid sequences in proteins.

DNA finger printing 5m

Developed by Alec Jeffrey

It is a very quick way to compare the DNA sequence of any two individual by identifying differences in repetitive DNA

Principle: Variable Number of Tandom Repeats (VNTRs) or mini Sat DNA, is the basis for DNA finger printing.

- A short stretch of base sequence gets repeated a No. of times. The repetition number varies from chromosome to chromosome and person to person
- Shows high degree of polymorphism, so forms the basis for DNA finger printing
- This sequence has no coding functions and inheritable from parents to offspring

Steps:

- **Isolation of DNA**

  DNA is isolated from a sample of human material (blood) in a high speed refrigerated centrifuge
- **Digestion of DNA:**

  DNA is cut into fragments of varied lengths using restriction endonucleases
- **Separation of DNA fragments by electrophoresis:**

  DNA fragments are separated according to their lengths on agarose porous gel
- **Transpering of DNA fragments by southerin blotting:**

  Fragments are transferred (blotted) from the fragile gel on to a nylon membrane/nitrocellulose memebrane.

  Using alkaline chemicals single strands of DNA are produced.
- **Hybridisation using labelled VNTR probes :**

  -The nitrocellulose membrane is placed in a bath containing probes.

  -A probe is a DNA segment with known base sequence and radioactivity.

  - Probe gets hybbridised with a complimentary DNA fragment present on the membrane.
- **Detection of hybridized DNA fragments by autoradiography:**

  When nylon membrane is exposed to X-ray film. It produces dark bands on the X ray film, where labelled probe is present. This pattern is DNA fingerprint

Applications: **2m**

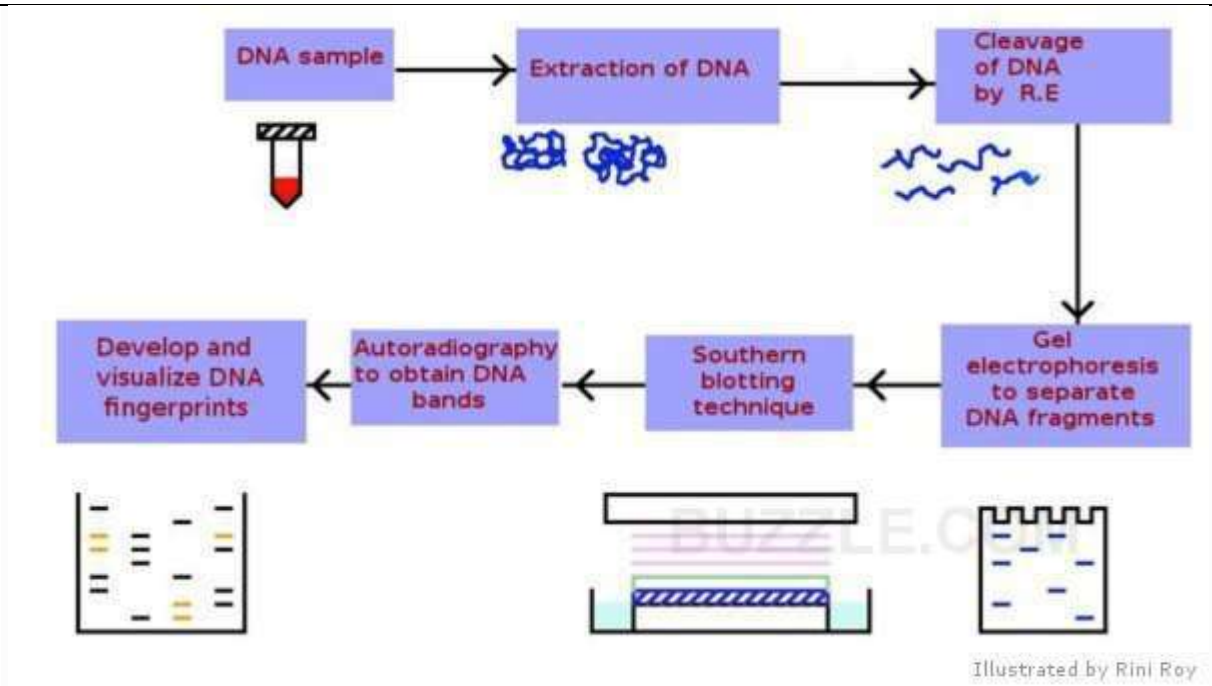
Solving crime: Small traces of living material found in the crime spot help in indentifying the criminal.

Solving disputed parentage: by comparing DNA finger prints.

In finding blood lineage(legal heir)

Note: To compare two or more different DNA fingerprints the different DNA samples are run side-by-side on the same electrophoresis gel.

- ✓ **Theory of spontaneous generation (Abiogenesis)**: Life came out of decaying and rotting matter like straw, mud, etc. It was disproved by **Louis Pasteur.**
- ✓ **Theory of biogenesis** -Proposed by **Louis Pasteur.** He demonstrated that life comes only from pre-existing life.



Repetitive DNA: 2m

- A small stretch of nucleotide sequence that gets repeated many times. It forms a large portion of DNA
- It does not code for any protein.
- Shows high degree of polymorphism, so it forms the basis for DNA finger printing.
- Does not undergo any changes in ones life time and is heritable from parents to offspring.

Satellite DNA: 2m

- Repetitive DNA is called satellite DNA, because during density gradient centrifugation , the bulk DNAforms a major peak and repetitive DNA forms small peaks.
- Depending on DNA base composition, length of DNA segment and No of repetitive units, the sat DNA is two types

Mini Sat DNA (VNTRs)	Micro Sat DNA
▪ It is of 10-50bp length ▪ Can be repeated upto 100-1000times	▪ Less than 10bp length ▪ Repeated upto 10-100 times

DNA polymorphism: 2m

- A gene can exist in 2 or more allelic forms. Base sequence variations seen in these alleles constitute DNA polymorphism. Eg. Variation in alleles of blood group gene.
- Similarly different **DNA** sequences noticed among individuals/populations is also DNA polymorphism.
- Various classes of DNA polymorphs are-SNPs, VNTRs, STRs(Short Tandem Repeats)
- plays a very **important** role in speciation and evolution

Multiple Choice Questions (1 mark each)

1.The process of DNA replication is semi-conservative because:

a. The two resulting DNA molecules are identical

b. Each resulting DNA molecule contains one strand from the original DNA molecule

c. The process involves the creation of new DNA strands from scratch

d. None of the above

2.Which of the following is the function of tRNA?

a. To carry amino acids to the ribosome for protein synthesis

b. To transcribe DNA into RNA

c. To carry the genetic code from the nucleus to the cytoplasm

d. None of the above

3. The genetic code is degenerate, meaning:

A) Each amino acid has only one codon.

B) Each codon codes for multiple amino acids.

C) Multiple codons can code for the same amino acid.

D) The genetic code is constantly changing.

4.Which was the last human chromosome to be completely sequenced ?
(a) Chromosome 1
(b) Chromosome 11
(c) Chromosome 21
(d) Chromosome X

5.If the sequence of initrogen bases of the coding strand of DNA in a transcription unit is: 5' – ATGAATG – 3', the sequence of bases in its RNA transcript would be
(a) 5' – AUG A AUG – 3'
(b) 5' – UACUU AC – 3'
(c) 5' – CAUUCAU – 3'
(d) 5' – GUAAGUA – 3'.

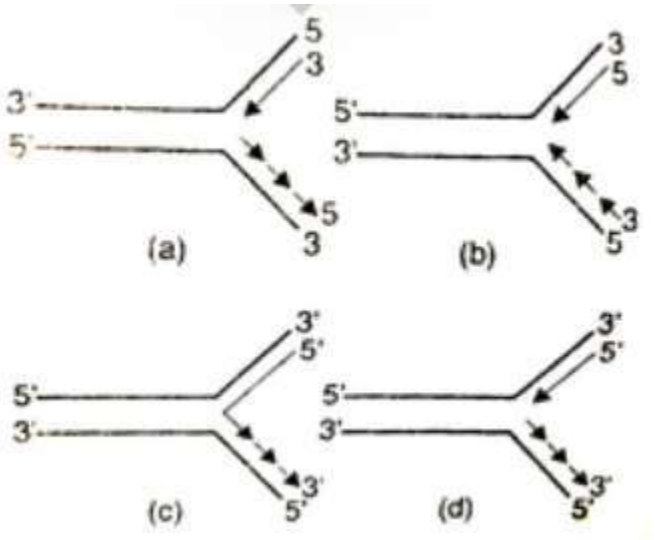
6.Find out the wrong statement about heterochromatin,
(a) It is densely packed
(b) It stains dark.
(c) It is transcriptionally active.
(d) It is late replicating.

7.Select the incorreclty matched pair.
(a) Initation codons – AUG,GUG
(b) Stop codons – UAA, UAG, UGA
(c) Methionine – AUG
(d) Anticodons – mRNA

8.Chemically, RNA is (i) reactive and (ii) stable as compared to DNA.
(a) (i) equally, (ii) equally
(b) (i) less, (ii) more
(c) (i) more, (ii) less
(d) (i) more, (ii) equally

9.The sequence of structural genes in lac operon is
(a) Lac A, Lac Y, Lac Z
(b) Lac A, Lac Z, Lac Y
(c) Lac Y, Lac A, Lac A
(d) Lac Z, Lac Y, Lac A

10.which of the following correctly represents the manner of replication of DNA?



Answers:

1.b	2.a	3.c	4.a	5.a	6.c	7.d	8.c	9.d	10. d

Assertion & Reason Questions:

Point out if:

- (a) Both, A and R, are true and R is the correct explanation of A
- (b) Both, A and R, are true but R is not the correct explanation of A
- (c) If A is true but R is false
- (d) If A is false but R is true

1.A: Adenine cannot pair with cytosine.

R: Adenine and cytosine do not have a perfect match between hydrogen donor and hydrogen acceptor sites.

Hence, they cannot pair.

2.A: Histones are basic in nature.

R: Histones are rich in the amino acids lysine and arginine.

3.A: Operator gene is functional when a repressor does not block it.
R: Regulator gene produces active protein only, which acts on the operon system in E.coli.

4. A : Transcription is synthesis of RNA over DNA template

R : Transcription and translation takes place at different sites in prokaryotes.

5.A : Synthesis of mRNA takes place in 5'→3' direction
R : Reading of mRNA is always in 3'→5' direction

Answers:

1.a	2.a	3.a	4.c	5.c

CASE BASED QUESTIONS

1.two researchers are studying the lac operon in E. coli bacteria. They perform an experiment where they grow the bacteria in a medium containing lactose and glucose. However, they observe that the lac operon is not induced even though lactose is present in the medium.

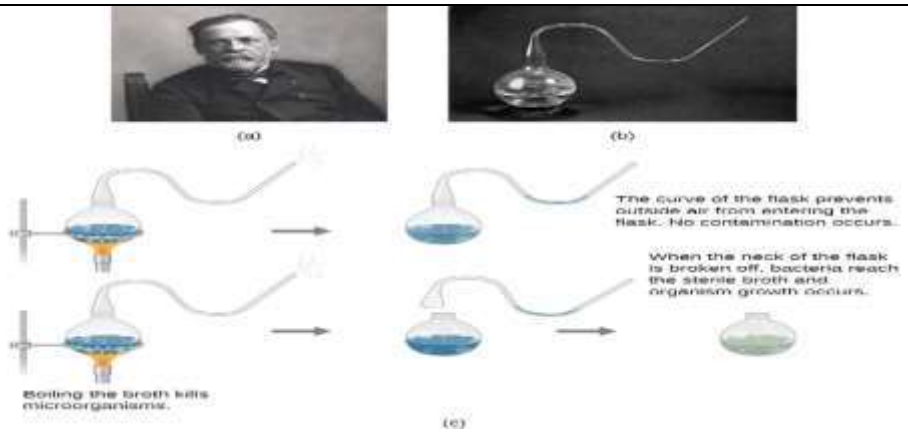
A.What could be the possible reasons for the lac operon not being induced in this scenario?
b. How could the researcher modify the experimental conditions to induce the lac operon expression?
(hint: The lac operon of E. coli contains genes involved in lactose metabolism. It's expressed only when lactose is present and glucose is absent)

2.A crime scene investigation involves a burglary at a jewelry store where valuable items were stolen. The police collected several pieces of evidence, including blood stains found at the crime scene. They also obtained blood samples from three suspects who were seen in the vicinity of the store around the time of the burglary. The police want to use DNA fingerprinting to match the blood stains to one of the suspects.

A.Explain the molecular basis of DNA fingerprinting, including the techniques and principles involved.
B.. Outline the steps the forensic team would take to perform DNA fingerprinting analysis on the collected samples.

C.. what could be the e potential limitations or challenges faced during the process.

3. Sarah is studying mRNA processing and its relation to translation efficiency. She discovers that alternative splicing occurs in certain mRNA molecules, resulting in different exon combinations being translated into proteins.
a. What are exons?
B.How does alternative splicing affect protein diversity?(hint: one gene generating multiple distinct protien isoforms)



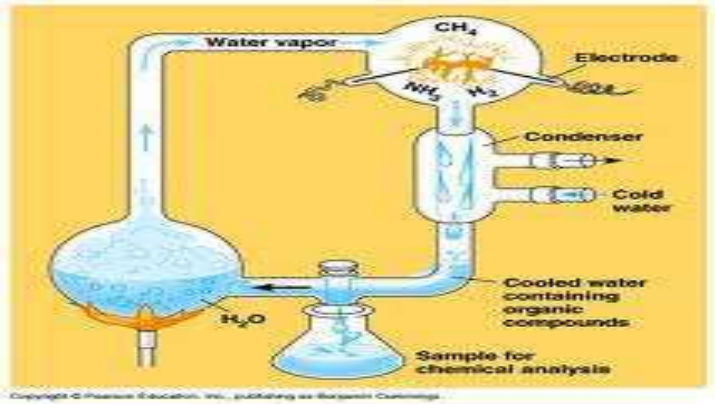
- ✓ **Theory of chemical evolution**- Proposed by **Oparin & Haldane**. It states that the first form of life originated from non-living inorganic & organic molecules.

The conditions on Earth favoring Chemical evolution were

- High temperature.
- Volcanic storms
- Reducing atmosphere containing CH_4, NH_3 etc.,

Experimental Evidence of Chemical Evolution/Miller's Experiment

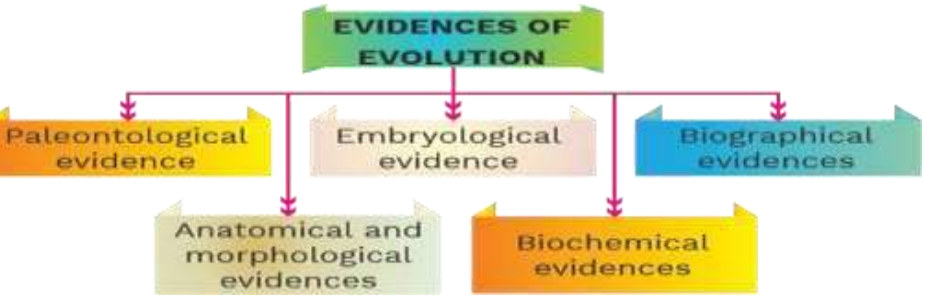
Harold Urey & Stanley Miller Experiment: They experimentally proved **the theory of chemical evolution in 1953.** They created conditions like that of primitive earth (i.e. high temperature, volcanic storms, reducing atmosphere with CH_4, NH_3, H_2O, H_2, etc). When an electric discharge is produced in a closed flask containing CH_4, NH_3, H_2, and water vapor, at 800^0 C, biomolecules (amino acids) like present-day were formed.



Conclusions:

- Provides experimental evidence for the theory of chemical evolution.
- The first non-cellular form of life was created about 3 billion years ago.
- Non-cellular biomolecules exist in the form of DNA, RNA, polysaccharides, and proteins.

<u>Evidences of Evolution</u>:

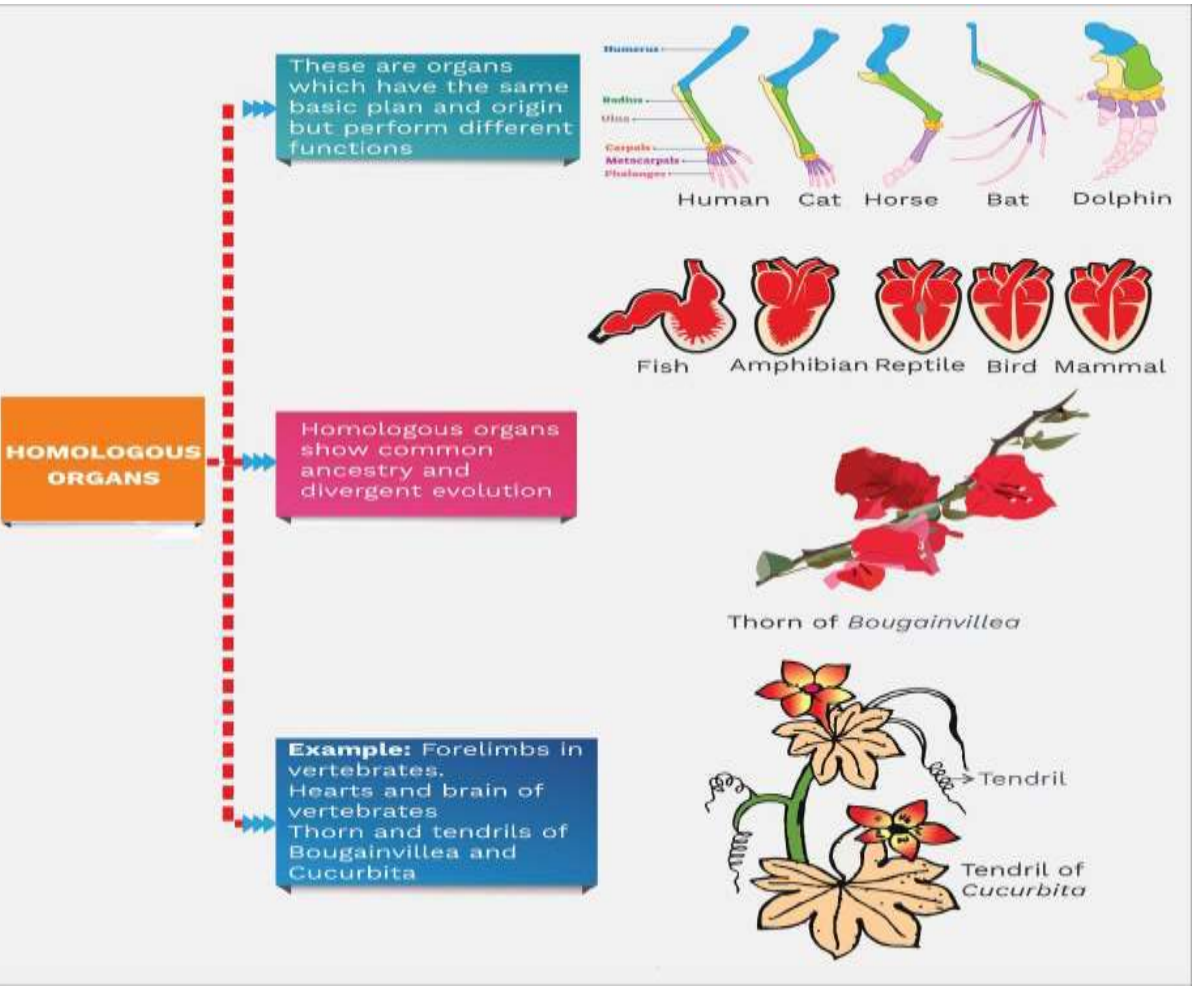


A. Paleontological evidence: (fossil evidence)

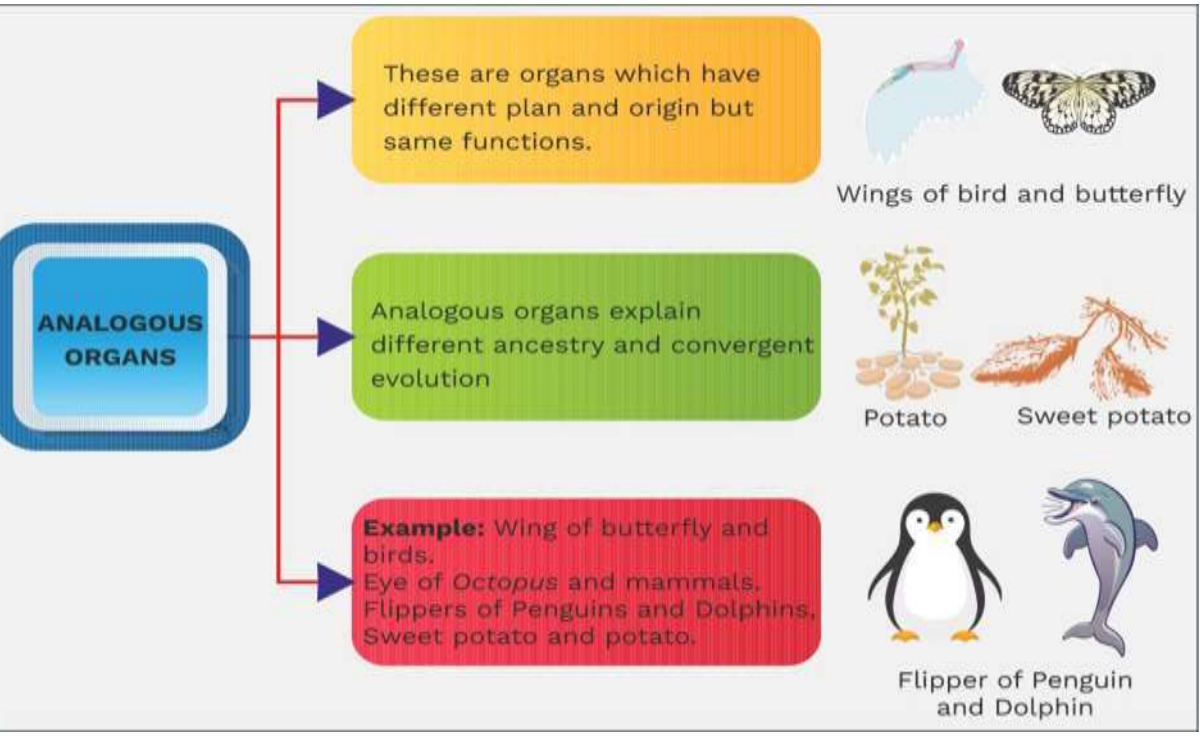
- Study of fossils is paleontology
- Fossils are dead remains of life forms preserved in the sedimentary rocks of Earth's crust.
- Different sedimentary layers of rock contain different life forms. Hence fossils study helps in knowing about the geological time period they existed.
- Bottom most rock layers contain primitive life forms, while top most contain recent complex organisms.
- Fossils of successive sedimentary layers show greater similarity
- They reveal about extinct organisms Eg: Dinosaurs
- Provide missing links between two groups of organisms. Eg: Archeopteryx is the link between birds and reptiles.

B. **Morphological and Anatomical Evidences:**

a) Homologous organs



b) Analogous organs



C) Biochemical evidence (Molecular Homology)

- The base sequence of DNA and amino acid sequence of proteins show similarity in various groups of organisms. This indicates common ancestry.
- Human DNA differs from Chimpanzee only in 0.8% bp
- Structure of Cytochrome C, actin, and tubulin proteins is similar in all animals.
- The genetic code is universal
- There is a similarity in metabolic reactions. The substrate and end products of respiration are similar

D) Evidences from embryology:

- ***Ernst Heckel*** stated that ***'ontogeny recapitulates Phylogeny'***: It means that the developmental stages of an individual right from zygote reveal, the evolutionary history of ancestors.
- Eg., Tadpole of amphibians possesses gill slits. It indicates that amphibians are evolved from fishes.
- Karl Ernst von Baer disproved Heckel's law, by saying that the embryos do not pass through the adult stages of other animals.

Convergent and divergent evolution

Convergent evolution	***Divergent evolution***
In the same habitat, different structures are evolved to carry out the same function, in different groups of organisms	In different habitats, the same structure develops for different functions in different groups of animals. This occurs as an adaptation to those habitats/needs. It results in new species' origin
Unrelated species become more and more similar in appearance, as they adapt to the same kind of environment	related species become more and more dissimilar, as they adapt to different environments,
Analogous organs support this evolution	Homologous organs support this evolution

Evolution by Natural selection

<u>ndustrial melanism</u>:**<u>In England, 2 types of moths inhabited tree trunks</u>**-white winged and melonised. irds predated them.

• **<u>Before industrialization</u>**	• **<u>After industrialisation</u>**

Tree trunks appeared white because of the growth of lichens	Tree trunks appeared dark as they were coated with smoke and soot
White moths camouflaged with a white background and escaped from predators. They increased in number by differential reproduction	Melanized moths camouflaged with a black background and escaped from predators. They increased in number by differential reproduction
Where as the melanized moths were easily seen against the white background and were predated by birds.	Whereas the white moths were easily seen against the black background and were predated by birds.

Evolution by Anthropogenic Action

- Excessive use of herbicides and pesticides has resulted in the evolution of resistant varieties of microbes in a much lesser time scale.
- Microbes becoming resistant to antibiotics and drugs due to excessive use.

Adaptive radiation (divergent evolution)

- The process of evolution of different species in a given geographical area starting from a point and radiating to other areas of geography (habitats) is called **adaptive radiation.**
- It means creating several new species out of a single parent species. A population of given species X, moves into a new habitat and establishes itself in that habitat. In doing so, it adapts to its new environment and becomes different from the parent species.

i. Darwins finches

- The finches are small black birds present in Galapagos islands.
- He observed many varieties of finches with different types of beaks on the same island.
- Seed-eating birds were the original ones. From these birds, many other forms with altered beaks arose. Some became insectivorous/vegetarian finches.
- Darwin explained that these finches, to avoid competition for food, moved to different areas and developed a variety of beaks for other food habits. Hence they are all derived from the original ancestral stock –seed-eating birds.

ii. Australian Marsupials (pouched mammals)

- Within the Australian continent, a number of Marsupials, each different from the other, evolved from an ancestral stock.
- From the ancestral stock, some of the organisms moved to different habitats. They adapted to the new habitat and developed into new species. This is called Convergent evolution.

Parallel evolution

- When more than one adaptive radiation appear to have occurred in an isolated geographical area representing different habitats and two or more groups of unrelated animals come to resemble each other for a similar mode of life or habitat is called **convergent or parallel evolution.**
- For example: Australian Marsupials and placental mammals show parallel evolution.

Theories of evolution:

a) **Lamarck's theory:** The evolution of life forms occurred due to the use and disuse of organs and the inheritance of acquired characters.

- Lamarck observed the Giraffe's neck and said that in an attempt to eat leaves on tall trees, their necks got elongated and this acquired character is passed on to the next generation.

b) Darwin's theory (theory of natural selection)

- **Enormous fertility:** Every living organism has an inherent capacity to produce large offspring.

- **Struggle for existence:** The entire progeny produced by an individual will not reach up to the adult stage. It faces competition at 3 levels - with the environment, inter and intra-specific competition. Due to this competition, only some of them survive and others perish.
- **Variations**: The individuals possessing useful variations will withstand the struggle and survive.
- **Natural selection and survival of the fittest:**The individuals with beneficial variations are the fittest ones. They are favored by the nature and so they increase their number by differential reproduction.
- **Origin of new species**: By gradual accumulation of variations a new species arises from the existing one.
- Key concepts of Darwin: **Branching descent and natural selection**

c) Mutational theory

- Proposed by **Hugo de Vries**. He worked on **"Evening Primrose"(*Oenothera lamarckiana*).**
- Mutations are large inheritable changes in the genetic material that arise suddenly in a population
- A new species arises as a result of a single-step large mutation called saltation.
- Mutations are directionless and random
- Nature selects beneficial mutations over lethal mutations.

Differences between Darwin's theory and Hugo de Vries theory

Hugo de Vries theory	Darwin's theory
Mutational theory	Theory of natural selection
Mutations are large and sudden	variations are Small and gradual
Mutations are random and directionless	Variations directional
Single-step large mutations called saltation are responsible for speciation	A gradual accumulation of variations favored by nature over generations is responsible for speciation

HARDY-WEINBERG PRINCIPLE

- It states that the allelic frequencies (of a particular trait) in a gene pool of a population remain constant from generation to generation. This stability is called genetic equilibrium.
- The sum total of all the allelic frequencies is 1.
- It is represented as $p^2+ 2pq+ q^2 = 1$
- Disturbance in genetic equilibrium causes evolution

Let there be alleles A,a in a population.

Frequencies of alleles A and a are represented by p & q respectively.

Frequency of 'AA' individuals in a population= P^2

'aa ' individuals = q^2

'Aa' individuals = 2pq

$p^2+ 2pq+ q^2 = 1$ AA + 2Aa+ aa = 1

Factors affecting Hardy-Weinberg Equilibrium:

) Gene migration / Gene flow:

- When some individuals of a population migrate to another population, the gene frequency of that population change.
- That is some genes are lost from the first population and added to the second population.
- If this migration takes place a number of times, then gene flow occurs.

)Genetic drift :

- If the change in gene frequencies occurs by chance, it is called genetic drift.
- Sometimes the change in allelic frequency is too different in a new population, so it becomes a different species.
- The original drifted population becomes founders and the effect is called the **founder effect**

)Mutation :

- sudden inheritable changes in genetic material caused by chemicals and radiation
- When beneficial genetic variations are selected by nature, over a few generations it results in speciation.

)Genetic recombination:

- During gametogenesis meiosis occurs.
- In prophase I of meiosis , there is exchange of genetic material b/w non-sister chromatids of homologus chromosomes.
- This produces recombinants and results in a changed frequency of genes.

) Natural Selection:

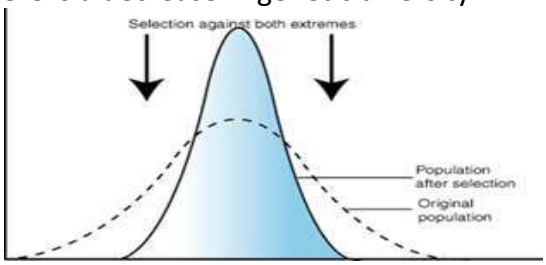
- Nature selects heritable variations that help the organism to survive better.
- These organisms are allowed to reproduce and leave a large-sized progeny.
- This results in a changed frequency of gene.

PERATION OF NATURAL SELECTION ON DIFFERENT TRAITS:

- Natural selection causes changes in the allele frequencies of a population.
- Depending upon which traits are favored by nature, it can produce three different results.

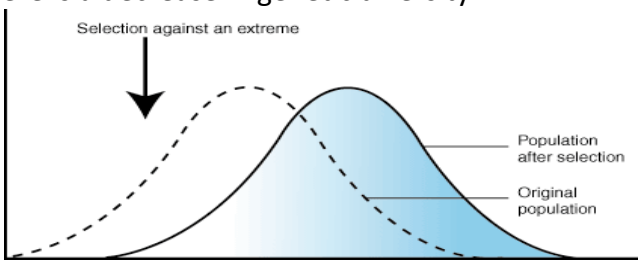
(a) Stabilizing selection

- Medium-sized individuals are favoured over the smallest and largest individuals. So they leave a large offspring.
- Therefore more individuals acquire mean character value
- The curve becomes narrow and higher
- There is a decrease in genetic diversity.



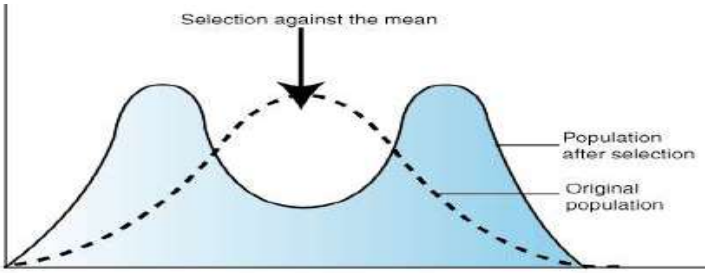
(b) Directional selection

- A single phenotype at either end is favoured over the medium-sized phenotype.
- This results in shifting of the curve in one direction.
- More individuals acquire character other than mean character value.
- There is a decrease in genetic diversity.



(c) Disruptive selection

- Extreme phenotypes of the population at both ends are favored.
- More individuals acquire peripheral character at both the ends of distribution curve.
- So we get two peaks
- the genetic diversity is high.



Account of Evolution

- Cellular forms of life first appeared on Earth around 2000 million years ago.
- Some of these cells could release O2 by splitting water with the help of solar energy.
- Slowly, single-celled organisms became multicellular life forms.

Evolution of plants

- Plants invaded land before animals
- Bryophytes originated earlier than vascular plants like pteridophytes and gymnosperms.
- The first vascular plants developed in the Silurian period.
- Seaweeds and a few plants existed around 320 mya.
- Herbaceous lycopods and arborescent lycopods evolved from the Zosterophyllum of the Paleozoic era.
- Psilophyton is the common ancestor for horsetails, ferns, and gymnosperms.

EON	ERA	PERIOD	MILLIONS OF YEARS AGO	
Phanerozoic	Cenozoic	Quaternary	1.6	
		Tertiary	66	Flowering Plants
	Mesozoic	Cretaceous	138	
		Jurassic	205	
		Triassic	240	
	Paleozoic	Permian	290	Gymnosperms
		Pennsylvanian	330	
		Mississippian	360	Pterophytes
		Devonian	410	
		Silurian	435	Lycophytes
		Ordovician	500	Liverworts and Mosses
		Cambrian	570	
Proterozoic	Late Proterozoic Middle Proterozoic Early Proterozoic		2500	
Archean	Late Archean Middle Archean Early Archean		3800?	
Pre-Archean				

Evolution of Animals

- The evolution of animals occurred around 500 mya.
- First animals were invertebrates.
- Jawless fish and amphibious fish with stout and strong fins originated around 350 mya.
- The first amphibians and ancestors of modern day frogs were **lobefins (Coelacanth)**

- Reptiles dominated the earth, around 200 mya. They lay thick-shelled eggs which do not dry up in sun,unlike those of amphibians.
- Some of the land reptiles went back into water to evolve into fish-like reptiles 200 mya (e.g Ichthyosaurs).
- Land reptikes were dinosaurs of which Tyrannosaurus rex was the biggest. They disappeared around 65mya.
- In the Jurassic period, the first mammal shrews were evolved.

Origin and Evolution of Man

Human Ancestors	Time of Origin	General Features
a) Dryopithecus b) Ramapithecus	15 mya	Ape-like, hairy, Walked like gorillas and Chimpanzees More man-like, and walked more erect.
Australopithecus	3-4 mya	Fossils found in Ethiopia and Tanzania,Man-like primates,4 feet tall,ate fruit, hunted with stone weapons, brain capacity was 400-600cc.
Homo habilis	2 mya	First human-like, did not eat meat, brain capacity -650-800cc.
Homo erectus (Java man)	1.5 mya	Fossils found in Java, brain capacity 900 cc, ate meat.
Neanderthal man	1,00,000 – 40,000 years back	Lived in Near East and central Asia, used hides to protect their body, buried their dead.
Homo sapiens (Modern Man)	75,000-10,000 years ago	Developed cave art, and agriculture, and started human civilization.
	18,000 years ago	Prehistoric cave art developed
	10,000 years ago	Agriculture started and human settlement

MULTIPLE CHOICE QUESTIONS	
1	The presence of homologous organs in different animals indicates…… a. Different ancestry b. common ancestry c. independent development d. dependant development
2	At which stage during evolution did human use hides to protect their bodies and buried their dead? (a) Homo habilis (b) Neanderthal man (c) Java man (d) Home erectus
3	In pigeons, one gene controls the appearance of a crest on the head. The allele C (smooth head) is dominant to allele C' (crested head). In a population of pigeons, the frequency of the allele responsible for a smooth head is 0.7 and for a crested head, it is 0.4. Which of the following conditions should be satisfied for the population to be in Hardy-Weinberg equilibrium? a. The sum total of the frequency of C and C' is equal to 1. b. The sum total of the frequency of C and C' is less than 1.

	c. The sum total of the frequency of C and C' is more than 1. d. (Can not be said without knowing the frequency of CC' individuals.)
4	  A B The diagram given here shows the skulls of two different mammals. Choose the most appropriate difference between A and B. a. Skull A has more teeth than skull B b. Skull A has more brain capacity than Skull B c. Skull A is of human and skull B is of ape d. Skull A is of an adult chimpanzee and skull B is of a human
5	Which of the following phenomena significantly contributes to speciation? P) Natural Selection Q) Genetic Drift R) Gene flow S) Geographic Isolation T) Stabilizing Selection a. only Q and S b. only R and T c. only P, Q and S d. only Q, R and T
6	The Hardy-Weinberg principle is a foundational principle for understanding population genetics with several assumptions. Which of the following is NOT an assumption of this principle? a. Random mating b. Emigration of species c. Large population size d. Non-occurrence of mutations
	Directions: In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as: (1) If both Assertion and Reason are true and Reason is the correct explanation of Assertion. (2) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion. (3) If Assertion is true but Reason is false. (4) If both Assertion and Reason are false.
7	Assertion (A): Lichens are used as indicators of pollution. Reason (R): A polluted environment accelerates the growth of lichens by providing them with more nutrition.
8	Assertion : The earliest organisms that appeared on the earth were non-green and presumably anaerobes. Reason : The first autotrophic organisms were the chemoautotrophs that never released oxygen.
9	Assertion: Thorns and tendrils of Bougainvillea and cucurbita represent homology. Reason: Homologous organs have similar functions but are different in their structural details and origin.
10	**Assertion:** Natural selection is the outcome of differences in survival and reproduction among individuals that show variation in one or more traits. **Reason**: Adaptive forms of a given trait tend to become more common; less adaptive ones become less common or disappear.
	<u>SOLUTIONS 1-10</u> 1(b) 2(b) 3(a) 4(d) 5(c) 6(c) 7(c) 8(b) 9(c) 10(a)
	VERY SHORT ANSWER QUESTIONS (2MARKS)

1

A group of paleontologists aim to characterize fossil samples based on their age amongst other parameters. They collected the samples from different depths in the ground. They have recorded the values of these samples from the ground level and compiled them in the following table:

Sample Name	Depth from the ground level (m)
A	4000
B	6000
C	1500

Arrange the sample names with respect to their age (oldest to youngest). Justify your answer.

- The age of the fossil samples in the order of oldest to youngest is - Sample B > Sample A > Sample C.
- The depth of a fossil sample can indicate its age because new sediment layers settle on top of existing ones, compressing and solidifying them. Older layers and fossils are found at greater depths than younger ones.

2

Genetic drift will lead to speciation in very large populations. Explain why this statement is false in TWO points.

- Genetic drift is the change in frequency of an existing gene variant in the population due to random chance.
- This effect is negligible when population sizes are very large and speciation may not occur.

3

Thalassemia is a disease caused by a specific gene mutation and it affects individuals who inherit two copies of the mutant allele. In a population, the frequency of homozygous recessive individuals is 1 in 100.
Calculate the frequencies of the following - (a) recessive allele (a) (b) dominant allele (A)

a) Since q^2 is 1 in 100,
   $q^2 = 1/100$ and $q = 0.1$
b) (b) $p + q = 1$ $p = 1 - q = 0.9$

4

In a population of birds, individuals with intermediate beak sizes can effectively feed on a range of available seeds while birds with either small or large beak sizes find it difficult to access certain seeds.
(a) Which birds are more likely to be naturally selected?
(b) Based on (a), which type of natural selection does this phenomenon exemplify?

(a) Birds with intermediate beak sizes have a feeding advantage, driving the population towards increased intermediate sizes due to their higher survival and reproductive success, reducing extremes.
(b) Stabilizing selection

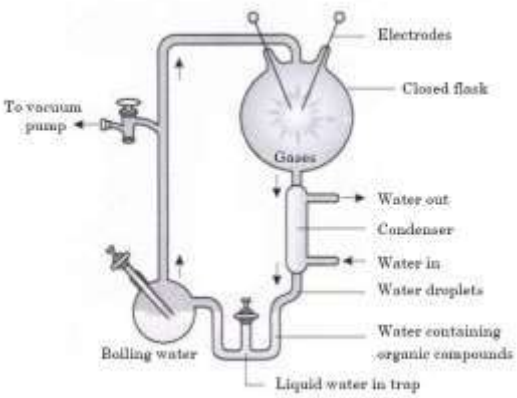
5

From an evolutionary point of view, predict the possible consequential events arising from the following situations:
(a) A population of mammals is split by a geographic barrier, leading to two isolated subpopulations. Over time, the environments on either side of the barrier changed, favouring different traits in each subpopulation.
(b) In a forest ecosystem, a species of herbivores consume plants that produce deterrent chemicals. A minority of herbivores possessing a genetic mutation can metabolize these compounds.

	(a) Isolated by a geographic barrier, two subpopulations adapt to their changing environments through distinct traits, possibly leading to the formation of separate species. (b) Over generations, the frequency of the herbivores with the mutation for metabolizing the compounds may increase as they can access a broader food source, potentially leading to a more specialized herbivore population
6	According to Darwinian theory of natural selection the rate of appearance of new forms is linked to the life-cycle or the life-span of an organism. Explain with the help of an example. • A colony of bacteria (say A) growing in a given medium has built-in variation in terms of ability to utilize a feed component, a change in the medium composition would bring out only that part of the population(say B) that can survive under the new conditions, In due is variant population outgrows the others and appears as new species thus organisms with shorter life-cycle or life-span will undergo evolution faster / for the same thing to happen in fish or fowl would take millions of years as life spans of these animals are in years.
7	Write the names of the following : (a) A 15 mya primate that was ape-like (b) A 2 mya primate that lived in East African grasslands. (a) Dryopithecus (b) Australopithecines/Australopithecus/Homo habilis
8	State two postulates of Oparin and Haldane with reference to the origin of life. (i) First form of life could have come from pre-existing non-living organic molecules/RNA & Protein. (ii) Formation of life was preceded by chemical evolution/formation of diverse organic molecules from inorganic constituents.
9	(a) Differentiate between analogous and homologous structures.

Homologous Organs	Analogous Organs
They differ morphologically.	They show superficial resemblance.
They have similar internal structure.	Their internal structure is quite different.
They develop in related organisms.	They develop in unrelated organisms.
Stages in the development are similar. They have similar developmental pattern.	Stages in the development are different. They have dissimilar developmental pattern.
They perform different functions.	They have similar functions.
Inherited from a common ancestor	Not inherited from a common ancestor
Examples would be: Wing of a bat, the lateral fin of a whale, and the human arm	Examples: Bat's wing & butterfly's wing- they both are used to help the creature fly, but they have diff patterns in bone structure

10	What is the frequency of heterozygous genotype (Aa) in a randomly mating population in which the frequency of all dominant phenotypes is 0.36? According to the Hardy-Weinberg equilibrium, p 2 + 2pq + q2 = 1 The dominant phenotype (AA and Aa) can be represented by p 2 + 2pq is equal to 0.36. q 2 = 1

	- (p2 + 2pq) = 1- 0.36 = 0.64 q = 0.8 p = 1- 0.8 = 0.2 2pq = 2*0.2*0.8 = 0.32 Therefore, the frequency of the heterozygous genotype is 0.32.
	SHORT ANSWER QUESTIONS (3MARKS)
1	List the different anthropogenic actions, and explain how have they led to evolution. • Industrial melanism: A shift from white-winged moths on trees to dim-winged or melanized moths was produced by smoke and sediment from man-made industries. Prior to the industrial revolution, white-shaded lichens protected tree bark, which was ideal for white-winged moths. • Excessive use of herbicides and pesticides has resulted in the evolution of resistant varieties of microbes in a much lesser time scale. • Microbes becoming resistant to antibiotics and drugs due to excessive use.
2	A group of students designed and executed an experiment similar to the Miller-Urey experiment, but missed a component. The experimental setup used by them is shown below.  They performed the experiment and analysed the sample after it. What compounds are they likely to find in the sample? Justify your answer. • CH4, H2O, H2, NH3 – • The experimental setup does not have a source of electric sparks/energy, that could provide the energy necessary to initiate chemical reactions among the gases and form various organic molecules.
3	Mention Darwin's observations made on finches during his visit to Galapagos Islands. Write the explanation given by Darwin on his observations. During his journey Darwin went to Galapagos Islands. • There he observed an amazing diversity of creatures of particular interest, small black birds later called Darwin's Finches amazed him. • He realised that there were many varieties of finches in the same island. • All the varieties, he conjectured, evolved on the island itself. From the original seed-eating features, many other forms with altered beaks arose, enabling them to become insectivorous and vegetarian finches . • This process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography (habitats) is called adaptive radiation.
4	Lake Tanganyika harbours a wide variety of cichlid fish. These fish have minor modifications in the jaw shape, number of teeth, and intestine length amongst various other features, and have evolved to feed on algae, plankton, plants, insects, and other fish of various sizes also residing in the lake.

	(a) Which of the following evolutionary phenomena does the above scenario describe? (b) Based on (a), mention any FOUR advantages of this phenomenon. (a) Adaptive radiation (b) This diversification allows the fish in the lake to - exploit different food sources - exploit different habitats - reduce competition - maximizing their chances of survival - increase beneficial traits and specialization - creates a more stable ecosystem.
5	Classify the following as examples of homology and analogy (i) Hearts of fish and crocodile (ii) Wings of butterfly and birds (iii) Eyes of Octopus and Mammals (iv) Tubers of potato and Sweet potato (v) Thorns of Bougainvillea and spines of Opuntia (vi) Thorn of Bougainvillea and tendrils of cucurbits. (i) Homology (ii) Analogy (iii) Analogy (iv) Analogy (v) Analogy (vi) Homology
	LONG ANSWER QUESTIONS (5MARKS)
1	Among plants, angiosperms, or flowering plants, stand out as the most diverse and numerous group of plants on Earth today, a reflection of their evolutionary triumph. Mark this statement as TRUE/FALSE and give any FOUR reasons for your answer using the characteristic features of angiosperms. • True • Angiosperms adapt widely, spanning deserts to rainforests, and high altitudes to aquatic habitats, driving global diversity and distribution. • Angiosperms' flower and fruit evolution enables efficient reproduction by luring diverse pollinators, promoting successful pollination and genetic variety. • Angiosperms use varied strategies — self and cross-pollination — to thrive in diverse conditions, leading to their evolutionary triumph. – • They co-evolve with pollinators, developing traits that attract specific species, and enhancing pollination efficiency. This symbiotic bond boosts both plant and pollinator success. - Many angiosperms have relatively short life cycles, allowing them to reproduce and spread rapidly. This quick turnaround time increases their evolutionary potential
2	A group of students perform the following experiment - Three plates of nutrient media were taken - A, B and C and studied for the extent of microbial growth in the plate post-incubation of 24 hours.

Plate	Incubation condition
A	The sterile plate was sealed and incubated
B	The sterile plate was not sealed and incubated
C	A microbial culture was spread on the plate and it was sealed and incubated.

(a) What would be the post-incubation results for the three plates?
(b) Which widely believed theory of the origin of life does this experiment disprove? Justify your answer.
(c) Based on (b), how was it originally disproved?

(a)

- A - No microbial growth would be observed since it was sterile and sealed.
- B - Microbial growth could potentially occur due to airborne contaminants reaching the nutrient media.
- C - Microbial growth from the initially spread culture would likely be observed, as the sealed environment would prevent external contaminants from entering.

(b)

- It disproves the theory of spontaneous generation.
- The lack of growth on the sterile, sealed plate (A) contradicts the idea of life spontaneously forming.

(c) Louis Pasteur's swan-necked flask experiment involved sealed and unsealed flasks containing broth to demonstrate that microorganisms do not spontaneously generate but come from external sources, supporting the concept of biogenesis.

CASE BASED QUESTIONS(4Marks)

1 Read the following and answer the questions given below:-

Comparative anatomy and morphology shows similarities and differences among organisms of
today and those that existed years ago. Such similarities can be interpreted to understand whether
common ancestors were shared or not. For example whales, bats, Cheetah and human (all mammals) share similarities in the pattern of bones of forelimbs. Though these forelimbs perform different functions in these animals, they have similar anatomical structure – all of them have humerus, radius, ulna, carpals, metacarpals and phalanges in their forelimbs. Hence, in these animals, the same structure developed along different directions due to adaptations to different needs. This is divergent evolution and these structures are homologous. Homology indicates common ancestry. Other examples are vertebrate hearts or brains. In plants also, the thorns and tendrils of Bougainvillea and Cucurbita represent homology. Homology is based on divergent evolution whereas analogy refers to a situation exactly opposite. Wings of butterfly and of birds look alike. They are not anatomically similar structures though they perform similar functions.Hence, analogous structures are a result of convergent evolution - different structures evolving for the same function and hence having similarity.

(i) Why are analogous structures, a result of convergent evolution ?
Ans. Analogous structures are a result of convergent evolution because they are not anatomically similar structures though they perform similar functions.
(ii) Identify the examples of convergent evolution from the following :
(a) Flippers of penguins and dolphins
(b) Eyes of octopus and mammals
(c) Vertebrate brains
Ans. Flippers of penguins and dolphins and Eyes of octopus and mammals.
(iii) “Sweet potato tubers and potato tubers are the result of convergent evolution.” Justify the statement.
Ans. Sweet potato tuber is a root modification and potato tuber is a stem modification but they show convergent evolution because both of them are unrelated and perform the functions similar like storage of food and vegetative reproduction.
(iv) Name the type of evolution that has resulted in the development of structures like wings of butterfly and birds. What are such structures called?

	Ans. Convergent evolution. Such structures are called analogous structures. (v) State the evolutionary relationship giving reasons between the thorn of Bougainvillea and tendril of cucurbit. Ans. Divergent evolution/Homologous organs. Similar in origin but perform different functions.
2	Read the following and answer the questions given below:- Consider a hypothetical situation: A species of butterflies exhibit a range of wing colours. Butterflies with extremely bright wing colours attract predators easily as compared to the ones with very dull wing colours. Butterflies with very dull wing colours fail to attract mates as compared to the ones with bright wing colours. Butterflies with intermediate wing colours have the best chance of both avoiding predators and finding mates. (a) Which type of natural selection does this phenomenon exemplify? Justify your answer. (b) A few years later, the rise in industries and pollution, causes the habitat to become darker. How would it affect the survival of the different kinds of butterflies belonging to this species? Which type of natural selection does this phenomenon exemplify? (c) In a specific region where this species is prevalent, a mutation in its population leads to butterflies with a shade of wing colours brighter than the existing shades. How would the long-term survivability of this variant be? Ans a) - Stabilizing selection. - Stabilizing selection occurs when the intermediate traits of a population, the intermediate wing colour in this case, are favoured over the extreme traits, such as wings with extremely bright or dull colours. b) - The darker environment aids camouflage for dull-winged butterflies, reducing predator visibility. Over time, the population could shift towards duller-winged individuals for increased survival and reproduction in the altered habitat. - Directional selection. (c) The brighter wing colour variant's long-term survivability would decrease due to heightened predator attraction.

Chapter 7: HUMAN HEALTH AND DISEASE

Health is a state of complete physical, mental & social well-being (1M)
Health is affected by (2M)
) genetic disorders-
) infections,

) life style (food, water, rest, exercise, habits etc.)

Mind influences immune system (through neural and endocrine systems).
Disease: When the functioning of organs or systems of the body is adversely affected, it is called a isease.
Diseases may be infectious (transmits from one person to another) e.g. STDs, COVID, Influenza or non-nfectious (do not transmit from one person to the other) e.g. Diabetes, Cancer, Genetic disorders
Pathogens: Organisms that cause diseases are called Pathogens.
Diseases 2M/3M

	Disease	**Causative Organism**	**Mode of transmission**	**Symptoms**	**Other information**
Bacterial	Typhoid	*Salmonella typhi*	Contaminated food and water	-Sustained high fever (39-40^{o} C) -Stomach ache -Loss of appetite, constipation, weakness -In severe cases, intestinal perforation and death might occur.	Confirmatory test: Widal Test
	Pneumonia	*Streptococcus pneumoniae* & *Haemophilus influenzae*	Inhaling droplets resulting from cough or sneezes. Through contaminated objects	-The alveoli get filled with fluid leading to severe problems in respiration. -Fever, Chills, Cough, Headache. In severe cases, lips and finger nails turn gray to bluish colour	

Protozoa	Malaria	Plasmodium species P. *vivax* P. *Ovale* P. *malariae* P. *falciparum*	Bite by the Female *Anopheles* mosquito (vector)	RBCs rupture releasing haemozoin, which is responsible for the chill and high fever recurring every three to four days	*P. falciparum* Caused malignant malaria, it is most serious and can even be fatal
	Amoebiasis (=Amoebic dysentery)	*Entamoeba histolytica*	Houseflies (mechanical carriers) transmit parasites from faeces to food & water	Constipation, abdominal pain and cramps, stools with excess mucous and blood clots.	
Helminth	Ascariasis	*Ascaris* (intestinal parasite)	Contaminated water, vegetables, fruits	Internal bleeding, muscular pain, fever, anemia and blockage of the intestinal passage	The eggs of the parasite are excreted along with the faeces of infected persons which contaminate soil, water, plants, etc.
	Elephantiasis or Filariasis	*Wuchereria (W. bancrofti* and *W. malayi)* Filarial worms	Bite by the female mosquito vectors	Chronic inflammation of Limbs and genital organs	-Usually, the lymphatic vessels of the lower limbs are affected

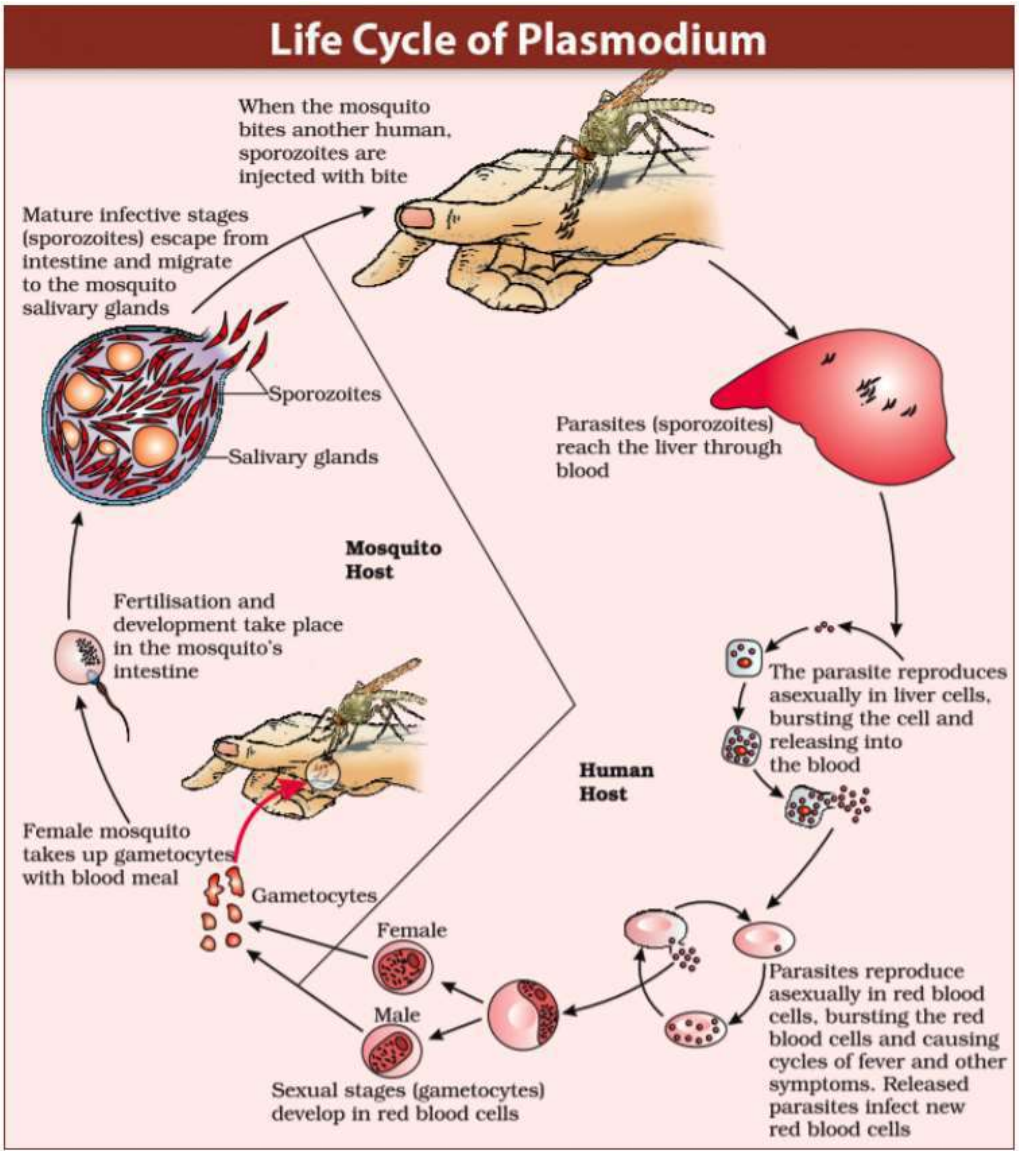
Fungi	Ringworm	*Microsporum*, *Trichophyton* & *Epidermophyton*	Acquired from soil or by using towels, clothes or even the comb of infected individuals	Dry, scaly lesions on various parts of the body (skin, nails and scalp) Lesions are accompanied by intense itching.	Heat and moisture help these fungi to grow, which makes them thrive in skin folds such as those in the groin or between the toes
Virus	Dengue	*Dengue virus* (Genus- *Flavivirus*)	Aedes mosquito	High fever, Muscle, bone or joint pain, Vomiting, Pain behind the eyes. In severe cases it causes serious bleeding and death	
	Chikungunya	*Chikungunya virus* (Genus- *Alphavirus*)	Aedes mosquito	Fever, joint pain, headache, muscle pain, joint swelling, rash	
	Common cold	Rhinoviruses	Inhaling droplets resulting from cough or sneezes. Through contaminated objects	Nasal congestion & discharge, sore throat, cough, hoarseness, headache, tiredness etc. Last for 3-7 days	It infects nose & respiratory passage but not lungs.

PREVENTION AND CONTROL OF DISEASES:

1. Personal hygiene: Keeping the body clean; consumption of clean drinking water, food, vegetables, fruits, etc.
2. Public hygiene:
   - Proper disposal of waste and excreta;
   - Periodic cleaning and disinfection of water reservoirs, pools, cesspools and tanks

- Observing standard practices of hygiene in public catering to avoid infectious agents are transmitted through food and water (to avoid typhoid, amoebiasis and ascariasis).
- Close contact with the infected persons or their belongings should be avoided.
- Control or eliminate the vectors (e.g. Mosquitoes) and their breeding places to avoid vector borne diseases like Malaria, Filariasis, Dengue & Chikungunya (1M)
    - Avoiding stagnation of water in and around residential areas,
    - Regular cleaning of household coolers
    - Use of mosquito nets,
    - Introducing fishes like Gambusia in ponds that feed on mosquito larvae
    - Spraying of insecticides in ditches, drainage areas and swamps, etc.
    - Doors and windows should be provided with wire mesh to prevent the entry of mosquitoes.

ife Cycle of Plasmodium 5M

- 

Malarial parasite requires two hosts – human and mosquito to complete its life cycle.

Plasmodium's life cycle can be divided into asexual stage occurring in humans and sexual stage that occurs in mosquitoes

<u>Asexual cycle:</u>

- Infected female mosquito transfers plasmodium as sporozoites into human body. Through blood stream the sporozoites enter liver cells and multiply in the hepatocytes asexually.
- The infected hepatocytic cells bursts and release the parasite (merosomes containing merozoites) into blood.

- The parasite reproduces asexually in RBCs and when the number of parasites increases, RBCs burst releasing haemozoin (toxic substance) which causes high fever and chills every 3-4 days. Released parasites infect new red blood cells
- Few merozoites (few parasites) develop into gametocytes (in RBCs). The female gametocyte is larger compared to male gametocyte

exual Cycle:

- Female Anopheles mosquito takes up gametocytes with blood meal when it bites an infected person.
- These parasites enter the gut of mosquito where fertilization occurs forming an ookinete.
- Ookinete being motile, escapes from the gut and migrates to the salivary gland.
- In Salivary gland, it matures to form the sporozoite (the infective stage)
- When mosquito bits another human sporozoites are injected with the bite.

mmunity 2M/3M

t is the ability of the immune system to fight the pathogens, conferred by the immune system.
mmunity is of two types: (i) Innate immunity and (ii) Acquired immunity.

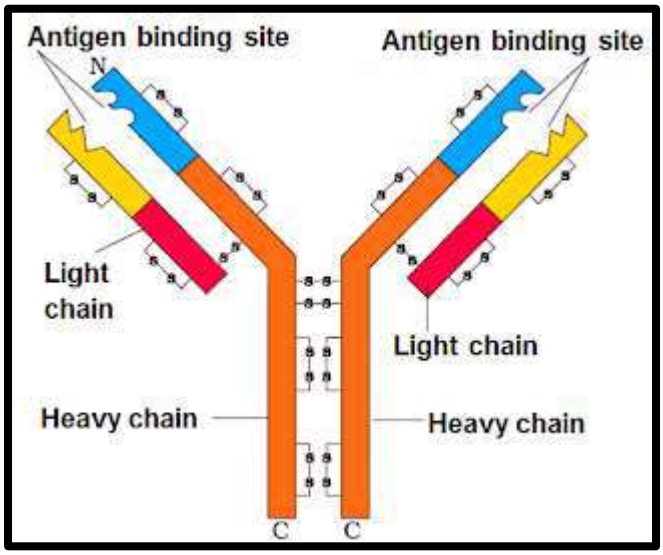
(i) Innate immunity

- It is the non-specific immunity present at the time of birth.
  It includes 4 types of Barriers:
- Physical barriers:
  - Skin - Prevent entry of microorganisms.
  - Mucus coating of the respiratory, gastro-intestinal and urino-genital tracts to trap microbes entering the body.
- Physiological barriers: Acid in the stomach, saliva in the mouth, tears from eyes– all prevent microbial growth
- Cellular barriers: Phagocytes like WBC (e.g. neutrophils or Polymorphonuclear leukocytes (PMNL), monocytes and natural killer lymphocytes, macrophages etc.) can phagocytose and destroy microbes.
- Cytokine barriers: Virus infected cells secrete proteins called interferon which protect non-infected cells from further viral infection.

(ii) Acquired immunity

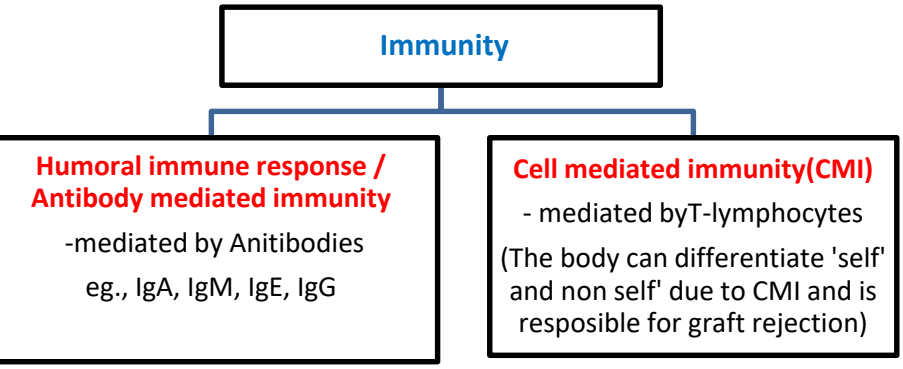
- It is pathogen specific immunity developed during lifetime.
- It is characterized by memory, i.e. during first encounter of a pathogen, body produces primary response in low intensity. Second encounter of the same pathogen causes a secondary (anamnestic) response in high intensity.
- Primary and secondary immune responses are carried out with B-lymphocytes (B-cells) and T-lymphocytes (T-cells).
- B-lymphocytes: Produce antibodies (proteins) & T-lymphocytes: Help B-cells to produce antibodies.

tructure of Antibody: 2M



- Each antibody molecule has **four peptide chains**, **two** small called **light chains** and **two** longer called **heavy chains**.
- Antibody is represented as H2 L2.

<u>Types of immunity</u> 2M



Types of acquired immunity

Acquired immunity is of 2 types: Active and passive. (2M)

Active immunity	Passive Immunity
Antibody production is induced by infection (when host is exposed to antigens)	Ready made antibodies are directly given to protect the body against foreign agents
Cell mediated immunity and humoral immunity is involved (the host body produces antibodies)	Antibodies are not produced by the body but are directly transferred into the body.
Natural Active immunity is by clinical infections	Natural Passive immunity is by transfer of antibodies through placenta (Colostrum, the first formed milk is rich in IgA & foetus receives some antibodies from the mother through placenta) Note: Artificial Passive immunity is b
It is long lasting	It is short lived

There is a lag period present (takes time for antibody production). E.g. Immunity developed by	Immediate action and lag period is absent

Vaccination: Is the process of administration of antigenic proteins of pathogen or inactivated weakened pathogen (vaccine) into the body. (1M)

Immunization: (2M)

- It is the process by which a person is made immune or resistant to a particular infection by administration of vaccine.
- The vaccine generates memory B and T cells that recognize the pathogen quickly on subsequent exposure to the pathogen and prevent the disease by producing antibodies in huge numbers
- The antibodies produced in the body in response to vaccines would help in neutralizing the pathogenic agents during actual infection.

Passive immunization: 2M

- Transfer of antibodies to an unprotected individual for the prevention or treatment of disease.
- If a person is infected with some deadly microbes to which quick immune response is required as in tetanus, we need to directly inject the preformed antibodies, or antitoxin (a preparation containing antibodies to the toxin).
- In cases of snakebites, the injection which is given to the patients, contain preformed antibodies against the snake venom.
- This type of immunization is called passive immunization

Vaccine produced using Recombinant DNA technology: 1M

- Allows large production and hence greater availability
- Antigenic polypeptides of pathogen can be produced in bacteria or yeast
  E.g. Hepatitis B vaccine is produced from yeast

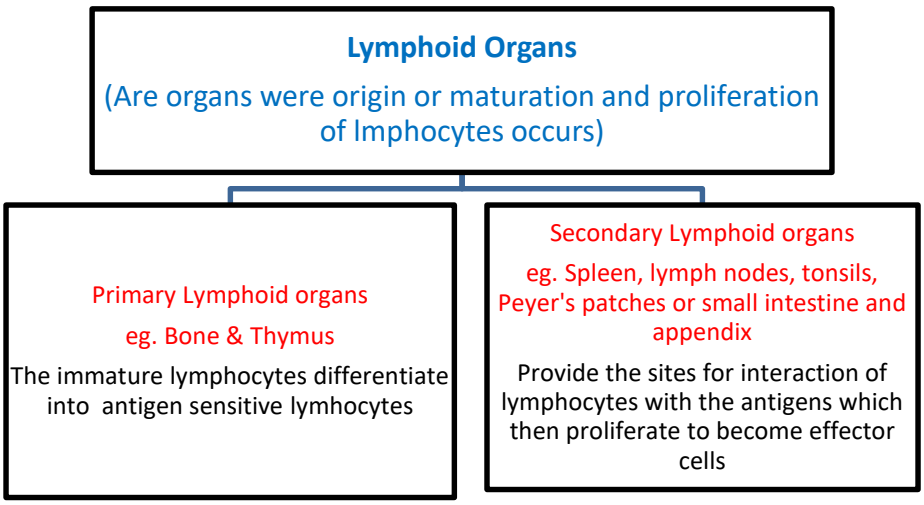
Allergies2M/3M

- It is the exaggerated response of the immune system to certain antigens present in the environment.
- Allergens: Substances causing allergy. E.g. mites in dust, pollens, animal dander, fur etc.
- Antibodies produced against the allergens are of IgE type.
- Allergy is due to the release of chemicals like histamine and serotonin from the mast cells.
- Symptoms: Sneezing, watery eyes, running nose, difficulty in breathing, skin rashes etc.
- Determination of cause of allergy: The patient is exposed to or injected with very small doses of possible allergens, and the reactions studied.
- Treatment: Anti-histamine, adrenaline and steroids quickly reduce the symptoms of allergy.

Auto immunity

- It is the condition in which the body attacks self-cells due to genetic and other unknown reasons.
- It leads to auto-immune disease. E.g. Rheumatoid arthritis.

Lymphoid Organs: 3M



Bone marrow:

- All blood cells including lymphocytes are produced.
- Bone marrow provides micro-environments for the development and maturation of T-lymphocytes.

Thymus:

- Is involved in development and differentiation of T cells.
- It is a lobed organ located near the heart and beneath the breastbone.
- The thymus is quite large at the time of birth but keeps reducing in size with age and by the time puberty is attained it reduces to a very small size. (Provides micro-environments for the development and maturation of T-lymphocytes.)

Spleen:

- It contains lymphocytes and phagocytes.
- It acts as a filter of the blood by trapping blood-borne micro-organisms.
- Spleen also has a large reservoir of erythrocytes.

Lymph nodes:

- Are small solid structures located at different points along the lymphatic system.
- Lymph nodes serve to trap the micro-organisms or other antigens, which happen to get into the lymph and tissue fluid.
- Antigens trapped in the lymph nodes are responsible for the activation of lymphocytes present there and cause the immune response.

Mucosa associated Lymphoid tissue (MALT):

- Is located within the lining of the major tracts – respiratory, digestive and urogenital.
- Is rich in B lymphocytes and T lymphocytes

AIDS (Acquired Immuno Deficiency Syndrome) 5M

- It is the deficiency of immune system.
- It is caused by HIV (Human Immunodeficiency Virus), a retrovirus having RNA genome.
- AIDS was first reported in America (1981).
- Transmission:
    - Sexual contact with infected person.
    - Transfusion of contaminated blood & blood products

- Sharing of infected needles.
- From infected mother to her child through placenta.
- HIV does not spread by touch or physical contact. It spreads only through body fluids
- There is a time-lag (from few months to 5-10 years) between the infection and appearance of symptoms.

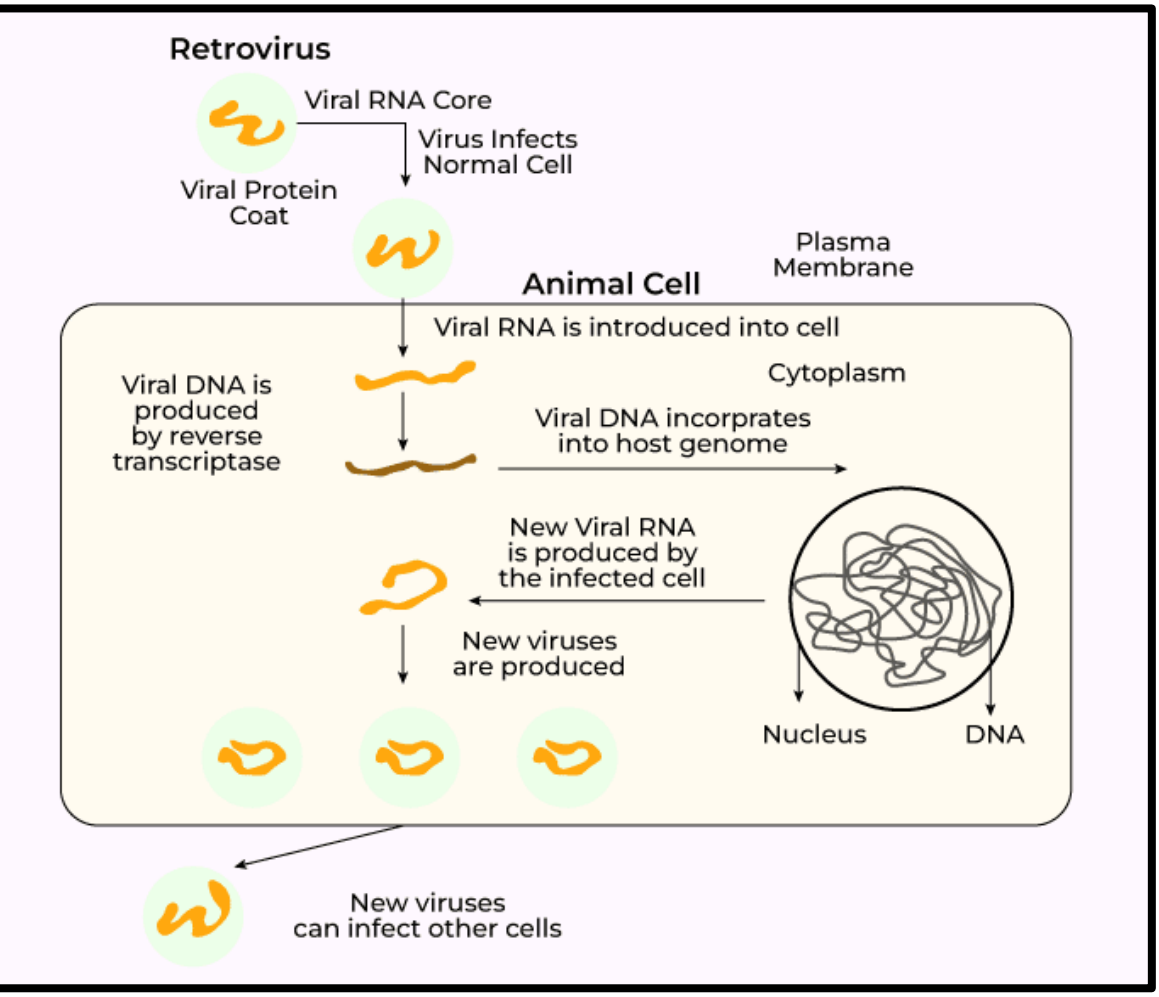
Who are at high risk of getting HIV?

- Individuals with multiple sexual partners.
- Drug addicts who take drugs intravenously
- Individuals who require repeated blood transfusion.
- Children born to an HIV infected mother.
    - .

Replication of HIV

HIV enters into body,

- Virus attacks the macrophages and Helper T cells.
- In macrophages
    - Virus replicates to form viral DNA with help of reverse transcriptase enzyme
    - Viral DNA gets incorporated into the macrophage's DNA and directs the macrophages to produce HIV
    - Macrophages now start producing virus particles and act as HIV factory
    - Macrophages release HIV which infects other immune cell.
    - Simultaneously HIV enters into Helper T lymphocytes, replicates and produce progeny viruses which further attack other helper T lymphocytes leading to decrease in number of helper T-lymphocytes leading to immune deficiency.

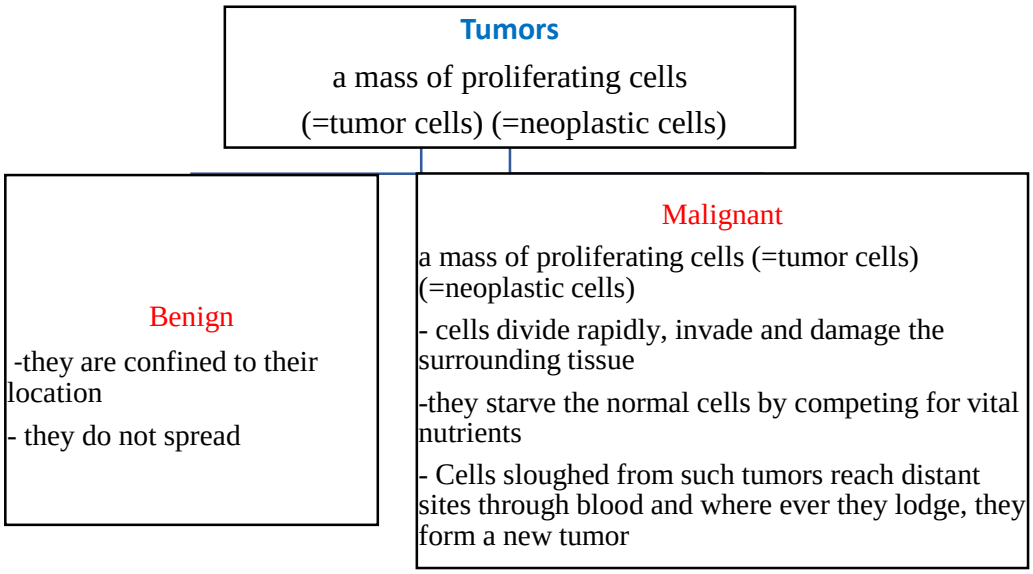


- HIV infected person may get infected with Mycobacterium, viruses, fungi and parasites like Toxoplasma. 1M
- Diagnosis: ELISA test (Enzyme-linked immuno-sorbent Assay). 1M
- Treatment: Anti-viral drugs partially effective. They can only prolong the life of the patient.
- Prevention of AIDS:
    - Educate peoples about AIDS.
    - Making blood (from blood banks) safe from HIV.
    - Use of disposable needles and syringes.
    - Advocating safe sex and free distribution of condoms.
    - Controlling drug abuse.
    - Regular check-ups for HIV in susceptible population.

NACO: National AIDS Control Organisation 1M
VHO: World health organization
NGO: Non-government organization

Cancer: 2M/3M

- Cancer is an abnormal and uncontrolled multiplication of cells resulting in the formation of tumor (masses of cells).
- Normal cells show contact inhibition (normal cells when they come in contact with the other cells inhibits their uncontrolled growth). Cancer cells do not have this property



Carcinogens

- Physical (cause DNA damage leading to neoplastic transformation)
  - Ionising – X rays and Gamma rays
  - Non Ionising – UV rays

- Chemical
  - Tobacco smoke – lung cancer
  - Asbestose
  - Benzene
  - Mustard gas
  - Vinyl chloride

- Biological
  - Oncogenic viruses (have viral oncogenes)
  - Normal cellshave cellular oncogenes or proto oncogenes when activated under certain conditions could lead to oncogenic transformation of cells.

Cancer detection and diagnosis 2M

- Biopsy: A piece of tissue is cut into thin sections and put on a slide and observed under microscope (histopathological study)
- Bone marrow test: For increase in cell count
- Computed tomography (CT): Uses X-rays to generate a three-dimensional image of the internals of an object.
- Magnetic resonance imaging (MRI): Uses strong magnetic fields and non-ionising radiations to accurately detect pathological and physiological changes in the living tissue.
- Radiography (use of X rays) ,
- CT, MRI and Radiography are used to detect cancer in internal organs
- Antibodies: Antibodies against cancer -specific antigens are used to detect cancers
- Molecular biology techniques: To detect genes in individuals with inherited susceptibility to cancers

Treatment of cancer 2M

- Radiotherapy: Tumor cells are irradiated lethally, without damaging surrounding normal tissues.

- Chemotherapy: Use of chemotherapeutic drugs. Many drugs have side effects like hair loss, anaemia etc.
- Immunotherapy: The patients are given biological response modifiers (e.g. α- interferon) which activates their immune system and helps in destroying the tumor.
- Surgery. Most cancers are treated by combination of surgery, radiotherapy and chemotherapy.

Opioids	**Cannabinoids**	**Coca alkaloid or Cocaine (=Coke) (=Crack)**
It binds to opioid receptor present in central nervous system and gastrointestinal tract	It interacts with receptors present in brain.	It affects central nervous system. It interferes with the transport of the neurotransmitter dopamine
It is extracted from latex of poppy plant (*Papaver somniferum)*	It is obtained from inflorescence of *Cannabis sativa*	It is obtained from E*rythoxylem coca Atropa belladonna and Datura also cause hallucination*
Smack (diacetylmorphine) or heroine is obtained by acetylation of morphine	The flower tops, leaves and the resin of cannabis plant are used in various combinations to produce marijuana, hashish, charas and ganja.	*(Atropa belladonna* and *Datura* also cause hallucination) Cocaine is made from leaves of coca plant
Heroin is a depressant and slows down the body functions	It has effect on cardiovascular system	Produces sense of euphoria and increased energy. Excess cause hallucination.
Taken through sorting or injections	Taken by inhalation and oral ingestion	Taken by snorting, smoking, injection or orally

Smoking

• Tobacco is smoked, chewed or used as a snuff.

• Tobacco contains nicotine (an alkaloid). It stimulates adrenal gland to release adrenaline and nor-adrenaline, causing high BP and heart rate.

• Smoking causes cancers of lung, urinary bladder and throat, bronchitis, emphysema, coronary heart disease, gastric ulcer etc. Tobacco chewing causes oral cancer.

• Smoking increases CO content in blood and reduces oxyhaemoglobin. This causes oxygen deficiency in the body 1M

Adolescence: 2M

- Adolescence is a bridge linking childhood and adulthood - period between12-18 years of age. Adolescence is accompanied by several biological and behavioral changes. It is very vulnerable phase of mental and psychological development.
- Causes of drug/alcohol use in Adolescence –
    - Curiosity and Experimentation.
    - Need for adventure and excitement.
    - To escape facing problems.

- Stress from pressure to excel in academics or examination.
- Television, movies, newspapers, internet etc.
- Unstable or unsupportive family structures & peer pressure.

Addiction and Dependence 2M

Addiction:

- It is a psychological attachment (euphoria and a temporary feeling of wellbeing) with drugs and alcohol.
- With repeated use of drugs, the tolerance level of the receptors increases. Thus, the receptors respond only to higher doses leading to greater intake and addiction.

Dependence:

- It is the tendency of the body to manifest a characteristic and unpleasant withdrawal syndrome if regular dose of drugs/alcohol is abruptly discontinued.
- This results in anxiety, shakiness, nausea and sweating.
- Dependence leads to social adjustment problems.

Effects of Drug/alcohol abuse 2M

- Reckless behavior, vandalism and violence.
- Coma and death due to respiratory failure, heart failure or cerebral haemorrhage.
- Drugs in combination with alcohol may lead to death.
- Damage of nervous system and liver cirrhosis.
- Mental and social distress to family and friends.
- Social problems like stealing and spread of infectious diseases (e.g. AIDS, hepatitis
- Use of drugs and alcohol by pregnant woman affect the foetus.
- Sportspersons misuse anabolic steroid, narcotic analgesics, diuretics and certain hormones to increase muscle strength and bulk and to promote aggressiveness and as a result increase athletic performance.

Warning signs of drug/alcohol abuse in Adolescence period: 2M

- Drop in academic performance and absence from school.
- Lack of interest in personal hygiene.
- Withdrawal and isolation.
- Depression, fatigue, aggressive and rebellious behaviour.
- Change in sleeping and eating habits.
- Fluctuations in weight, appetite etc.
- Loss of interest in hobbies.
- Deteriorating relationships with family and friends.

Side-effects of the use of anabolic steroids in males: 2M

- Acne
- Increased aggressiveness
- Mood swings & depression
- Reduction of size of the testicles & decreased sperm production
- Potential for kidney and liver dysfunction,
- Breast enlargement
- Premature baldness
- Enlargement of the prostate gland.
- In the adolescent male or female, severe facial and body acne, and premature closure of the growth centers of the long bones may result in stunted growth

Side-effects of the use of anabolic steroids in females 2M

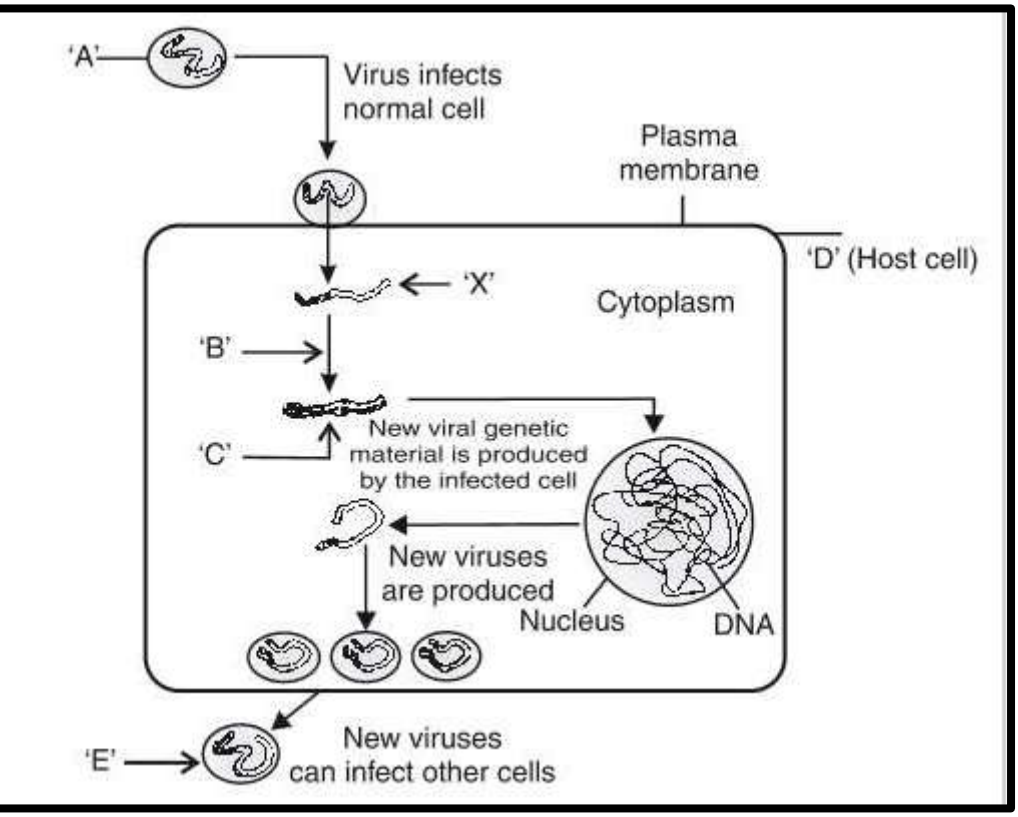
- Masculinisation (features like males)
- Increased aggressiveness
- Mood swings & depression
- Abnormal menstrual cycles
- Excessive hair growth on the face and body
- Enlargement of clitoris
- Deepening of voice

Prevention and Control 3M

- Avoid undue peer pressure.
- Education and counselling to accept disappointments, face problems and channelize child's energy into healthy pursuits
- Seeking help from parents and peers which will vent their feeling of anxiety and guilt
- Parents and teachers need to look for and identify the danger signs
- Seeking professional and medical help from psychologists, psychiatrists , Psychologists, deaddiction and rehabilitation programmes to help individuals who have unfortunately got in the quagmire of drug/alcohol abuse.

Questions

.Define the term 'health'. Mention any two ways of maintaining it. 2M
. Why does a doctor administer tetanus antitoxin and not a tetanus vaccine to a child njured in a roadside accident with a bleeding wound? Explain. 2M
. Name an opioid drug and its source plant. How does the drug affect the human body? 2M
. Mention the name of the causal organism, symptoms and the mode of transmission of ne disease Amoebiasis 2M.
. Differentiate between benign and malignant tumors. 2M
. (i) Write the scientific names of the two species of filarial worms causing filariasis. 1M
(ii) How do they affect the body of infected person(s)? 1M
(iii) How does the disease spread? 1M
. List the two types of immunity a human baby is born with. Explain the differences etween the two types. 3M
. (a) Name the causative agent of typhoid in humans. 1M
(b) Name the test administered to confirm the disease. 1M
c) How does the pathogen gain entry into the human body? Write the diagnostic ymptoms and mention the body organ that gets affected in severe cases. 2M
. Why is tobacco smoking associated with rise in blood pressure and emphysema (oxygen eficiency in the body)? Explain. 2M
0. Study the diagram showing replication of HIV in humans and answer the following uestions accordingly: 4M



i) Write the chemical nature of the coat 'A'. 1M
ii) Name the enzyme 'B' acting on 'X' to produce molecule 'C'. Name 'C'. 1M
iii) Mention the name of the host cell 'D' the HIV attacks first when it enters into the uman body. 1M
iv) Name the two different cells that the new viruses 'E' subsequently attacks. 1M
1. State two different roles of spleen in the human body. 2M
2. Name the plant source of ganja. How does it affect the body of the abuser? 2M
3. Name the two special types of lymphocytes in humans. How do they differ in their roles n immune response? 2M
4. Name the bacterium that causes typhoid. Mention two diagnostic symptoms. How is this isease transmitted to others? 3M
5. Trace the life-cycle of malarial parasite in the human body when bitten by an infected emale Anopheles. 3M
6. Name any two organisms that are responsible for ringworms in humans. Mention two iagnostic symptoms. Name the specific parts of the human body where these organisms nrive and explain why. 3M
7. How do interferons protect us?
8. Name the cells that act as HIV factory in humans when infected by HIV. Explain the vents that occur in the infected cell. 2M
9. For early detection of cancer, 3D images of tissues are essential. Name the technique and the basis n which it can generate three-dimensional image of changes in living tissues. 2M
0. When does a human body elicit an anamnestic response? 1M
1. Write the events that take place when a vaccine for any disease is introduced into the uman body. 2M
2. Why a person with cuts and bruises following an accident is administered tetanus ntitoxin? 1M
3. Why is secondary immune response more intense than the primary immune response in umans? 2M
4. List the symptoms of Ascariasis. How does a healthy person acquire this infection? 3M
5. What is an autoimmune disease? give an example. 2M
6. What is "withdrawal syndrome"? List any two symptoms it is characterised by. 2M
7. Name the form of Plasmodium that gains entry into the human body. Explain the

ifferent stages of its life-cycle in the human body. 2M
8. (a) Name and explain giving reasons, the type of immunity provided to the newborn by
ne colostrum and vaccinations. 1M
b) Name the type of antibody
i) present in colostrum 1M
ii) produced in response to allergens in human body. 1M
9. How does haemozoin affect the human body when released in blood during malarial
nfection? 1M
0. A heavily bleeding and bruised road accident victim was brought to a nursing home.
he doctor immediately gave him an injection to protect him against a deadly disease.
a) Write what did the doctor inject into the patient's body. 1M
b) How do you think this injection would protect the patient against the disease? 1M
c) Name the disease against which this injection was given and the kind of immunity it
rovides. 1M
1. (a) It is generally observed that the children who had suffered from chicken - pox in
heir childhood may not contract the same disease in their adulthood. Explain giving
easons the basis of such an immunity in an individual. Name this kind of immunity.2M
(b) What are interferons? Mention their role. 2M
2. Name the cells, HIV (Human Immunodeficiency Virus) gains entry into after infecting
he human body. Explain the events that occur in these cells. 3M
3. Mention one application for each of the following:
a) Passive immunization 1M
b) Antihistamine 1M
c) Colostrum 1M
d) Cytokinin-barrier 1M
4. Name a human disease, its causal organism, symptoms (any three) and vector that spread
y intake of water and food contaminated by human faecal- matter.
5. (a) Why is there a fear amongst the guardians that their adolescent wards may get
rapped in drug/alcohol abuse? 1M
b) Explain ‘addiction’ and ‘dependence’ in respect of drug/alcohol abuse in youth. 1M
6. Name the type of immunity the colostrum provides to a newborn baby. Write giving an
xample where this type of immunity should be provided to a person. 2M
3. (a) Name the source plant of heroin drug. How is it obtained from the plant? 1M
(b) Write the effects of heroin on the human body. 1M
4. How do cytokine barriers provide innate immunity in humans? 1M
5. Name two diseases whose spread can be controlled by the eradication of Aedes
nosquitoes. 1M
6. Differentiate between the roles of B-lymphocytes and T-lymphocytes in generating
mmune responses. 2M
7. Principle of vaccination is based on the property of “memory” of the immune system.
aking one suitable example, justify the statement. 2M
7. (a) Name the causative agents of pneumonia and common cold. 1M
b) How do these differ in their symptoms? 1M
c) Mention two symptoms common to both. 1M
8. (a) Write the scientific names of the causative agent and vector of malaria, and write its
ymptoms. 2M
b) Name any two diseases spread by Aedes sp. 1M
9. (a) Differentiate between active and passive immunity. 2M
b) Comment on the role of vaccination and immunization in keeping human population
ealthy. 2M
0. Name any two physiological barriers that provide innate immunity?
1. While on an excursion to a hill station, some of the children developed allergic
ymptoms.
a) List any two allergic symptoms. 1M

b) Name any two allergens. 1M
c) List any two antiallergens. 1M
2. The main barrier that prevents the entry of micro-organisms into our body is 1M
A) Antibodies (B) Macrophages (C) Monocytes (D) Skin
3. It is often observed that the chances of a person suffering from measles in his or her
fetime is low if he or she has suffered from the disease in their early childhood.
ustify the statement. 2M
4. The diagnostic test that confirms typhoid in humans is 1M
A) ELISA (B) Widal (C) MRI (D) Amniocentesis
5. Name the type of immunity the mother provides the newborn baby. How does it
appen? 1M
6. Name the two primary lymphoid organs. State the importance of T-lymphocytes. 1M
7. How are malignant tumors different from benign tumors? Why are some patients
eated with α – interferons? 2M
8. The principle of vaccination is based on the property of 1M
A) Specificity (B) Diversity (C) Memory
D) Discrimination between 'self' and 'non-self'
9.Opioids act as – 1M
A) Depressants (B) Pain killers (C) Euphoria providers (D) Stimulants
0. Mention the chemical nature of an antibody and name the type of cells they are
roduced by. Write the difference between active and passive immune responses on the
asis of antibodies. 3M
1. What are protooncogenes and why are they called so? 2M
2. Why is malignant tumor considered more dangerous than a benign tumor? Explain 2M
3. a. Explain the property of contact inhibition and its effect on normal cells and cancerous cells. 1.5M
b. Why are biological modifiers like α-interferons required for cancer treatment? How do they act to
eat the disease?
4. A HIV patient normally does not die of 'AIDS' but death is caused due to many other infections. Do
ou agree with the statement? Give explanatory reasons in support of your answer. 3M
5. A person suffering from AIDS dies of opportunistic infections (ARC) i.e., infections that could have
een otherwise overcome
. State one reason as to why a 'HIV' patient dies of opportunistic infections. 1M
. Give the scientific name of one bacterium and one parasite which attacks a person suffering from
IDS. 1M

Chapter-8 MICROBES IN HUMAN WELFARE

MICROBES IN HUMAN WELFARE - NOTES	
GIST	**CONTENT**
Microbiology	Branch of biology that deals with the study form, structure, reproduction, physiology and metabolism of microscopic organisms
Microbes	Microbes and microorganisms which includes bacteria, fungi, protozoa, some algae, viruses, viroid and also prions.
Role of Microbes in Human welfare	• In household products (Food batter formation, Cheese and bread making) • In Industrial products (Beverages, antibiotics , Organic acids, enzymes and bioactive molecules)

	• In sewage treatment (Aerobic and anaerobic treatment) • In Biogas production (Methanogens) • As bio control agents (Lady birds, *Bacillus thuringiensis*, *Trichoderma*, baculoviruses) • As bio fertilizers (*Rhizobium, Azospirillum, Azotobacter*, Mycorrhiza, Cyanobacteria)
Biochemical Oxygen Demand (BOD)	The amount of oxygen that would be consumed if all organic matter in one litre of water or sewage oxidized by microbes.
Sewage	Sewage is a type of waste water that is produced by a community of people. Sewage treatment –(i) Primary (ii) Secondary
Biogas	Biogas is a mixture of gases produced by microbial activity which may used as fuel
Save River - Government Initiatives	• Ganga Action Plan by The Ministry of Environment and Forests • Yamuna Action Plan by The Ministry of Environment and Forests • Technology of Biogas production developed in India by Indian Agricultural Research Institute (IARI) and Khadi and Village Industries Commission (KVIC)

KEY POINTS

TABLE 1 : MICROBES IN HOUSEHOLD PRODUCTS

SL.NO	NAME OF MICROBES	ROLE IN HOUSEHOLD PRODUCTS
1	*Lactobacillus acidophillus*	Formation of curd from milk
2	*Propionibacterium sharmanii*	Large holes in swiss cheese
3	*Saccharomyces cerevisiae* (Baker's yeast)	For making Idlie batter,bread and cake

TABLE 2 : MICROBES IN INDUSTRIAL PRODUCTS

SL.NO	NAME OF MICROBE	ANTIBIOTICS
1	*Penicillium notatum (Fungus)*	Penicillin

TABLE 3 : MICROBES IN ENZYMES AND BIOACTIVE PRODUCTS

SL.NO	NAME OF MICROBES	PRODUCTS
1	*Aspergillus niger*	Citric acid , Lipase
2	*Acetobacter aceti*	Acetic acid
3	*Clostridium butylicum*	Butyric acid
4	*Lactobacillus sp.*	Lactic acid
5	*Strptococcus sp.*	Strptokinase
6	*Trichoderma polysporum*	Cyclosporin A
7	*Monascus purpureus*	Statin

TABLE 4 : ROLES OF VARIOUS ENZYMES AND BIOACTIVE MOLECULES

SL.NO	PRODUCTS	FUNCTION

1	Lipase	In detergent formulations and are used to remove oil stains from the laundry
2	Streptokinase	Act as " CLOT BUSTER",to remove clots from blood vessels of patients who have myocardial infarction
3	Pectinase and Protease	For clarifying bottled juices
4	Cyclosporin A	Immunosuppressive agent in organ transplant patients
5	Statin	Blood cholesterol lowering agent

MICROBES IN SEWAGE TREATMENT

Primary Treatment	Secondary Treatment
Physical treatment	Biological Treatment
1. Sequential filtration 2. Grit removal by sedimentation 3. Removal of Primary sludge and supernatant is termed effluent	1. Primary effluent is taken to Large aeration tank 2.Continuous agitation and air supply 3.Reduction in BOD 4.Effluent transferred to Settling tanks for Sedimentation 5.Activated sludge pumped back to aeration tank to serve as inoculum Anaerobic Sludge digester 1.Biogas production 2.BOD is reduced to <1 3.Effluent is released into natural water bodies.

MICROBES IN BIOGAS PRODUCTION

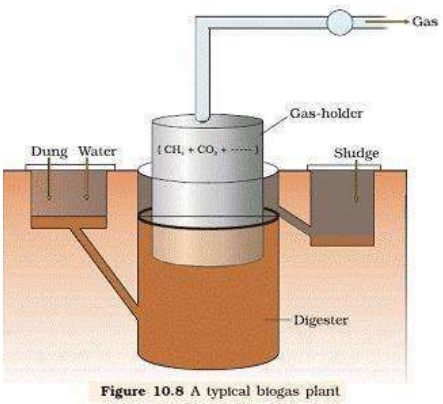


Figure 10.8 A typical biogas plant

Biogas contains Methane (60 %) and co_2 (40),Methanobacterium acting on cellulosic components produce biogas

Cattle dung contains cellulosic materials ans well as methanogens so it is used for the production of biogas

Indian Agricultural Research Institute (IARI) and Khadi and Village Industries Commission (KVIC) developed the technology of biogas production in India.

Bio gas plant:

1. A 10-15 deep concrete tank in which the slurry of dung is fed.

2. A metallic floating cover which keeps on rising as the gas is produced in the tank by microbial activity.

3. An outlet connected to a pipe is present for the removal of biogas

4. The slurry is removed through another outlet which can be used as manure.

MICROBES AS BIOCONTROL AGENTS

SL.NO	**BIOAGENTS**	**FUNCTION**
1	Lady bird	To control aphids
2	Dragon fly	To control mosquitoes
3	*Trichoderma* (Fungus)	Protects root system and control plant pathogens
4	Baculoviruses (Nucleopolyhedrovirus)	To control insects and other arthropods
5	*Bacillus thuringiensis*	To control cotton boll worms

MICROBES AS BIOFERTILIZERS

SL.NO	**BIOFERTILIZERS**	**FUNCTION**
1	R*hizobium* with roots of leguminous plants	Symbiosis - Fixes atmospheric nitrogen
2	*Azotobacter* and *Azospirillum*	Free living Nitrogen fixers
3	Mycorrhiza with root system of *Glomus*	Absorbs phosphorus and water from the soil for plant growth
4	Anabaena,Oscillatoria,Nostoc	Fix atmospheric nitrogen

<u>MULTIPLE CHOICE BASED QUESTIONS</u>

1. Microbes that causes diseases in human beings are commonly called

(a) Bacteriophage (b) Virus (c)Pathogen (d)Plankton

2. Expand IPM

a.Integrated Pest Management

b.Invested Pest Management

c.Inoculative Programme Management

d. Infective Pest Management

3. Ladybirds are useful in getting rid of

a.Mosquitoes (b) Aphids (c) Caterpillars (d) Housefly

4.Identify the genus of baculovirus from the given options

(a) Glomus (b) Nostoc

(c) Cyanobacteria (d) Nucleopolyhedrovirus

5. In Swiss cheese, big holes are formed by

(a) Methanogens
(b) Machine
(c) *Lactobacillus*
(d) Bacterium producing large quantities of carbon dioxe

6.Identify the microbial source of citric acid
(a)Aspergillus (b) Clostridium
(c)Saccharomyces (d) Pseudomonas

7.The immunosuppressive agent administered to organ transplant patients by medical practitioners
(a)Statin (b) Cyclosporin
(c)Lipase (d) Streptokinase

8. Government initiatives to save rivers
a. Ganga Action Plan
b.Yamuna Action Plan
c. Both (a) and (b
d.None of these

9. The most flammable gaseous component of biogas is
(a)Methane (b) CO_2,H_2,H_2S
(c)CO ,NH_2 (d) Methane and H2

10. The crop in which the presence of blue green algae helps in the fast growth of plants.
(a)Rice (b) Gram (c) Maize (d) Millet

SOLUTIONS 1-10

1(c)	2(b)	3(b)	4(d)	5(d)	6(a)	7(c)	8(c)	9(a)	10(a)

Questions(i) to (iv) contains two statements,Assertion (A) and Reason (R). Each of these questions have four alternative choices. Select the correct option from the following;

a.Both A and R are true and R is the correct explanation of A
b.Both A and R are true,but R is not the correct explanation of A
c.A is true, but R is false
d.A is false, but R is true

(i) Assertion : Yeast is used for the preparation of Idli –Dosa batter
Reason : Puffed appearance of batter is due to CO_2 released by Microbes
Solution : (a) Both A and R are true and R is the correct explanation of A

(ii) Assertion : Antibodies are chemical substances which are produced by some microbes.
Reason : Antibodies can kill or retard the growth of other Microbes.
Solution : (a) Both A and R are true and R is the correct explanation of A

(iii) Assertion :*Streptococcu*s improves the nutritional quality of Milk.
Reason : Milk has least nutritional quality when compare to Curd/Yogurt
Solution : (d) A is false, but R is true

(iv) Assertion :*Streptococcus* improves the nutritional quality of Milk.
Reason : Milk has least nutritional quality when compare to Curd/Yogurt
Solution : (d) A is false, but R is true

Direction: Read the following passage and answer the questions that follow.

In modern agriculture technique,farmers are depending chemical agents to control pests and to get good yield. This chemical treatment practice harms the soil organisms and affects soil fertility. It also causes bioaccumulation and biomagnification. Thus, it is better to use biological agents to conserve our crop plants and to get good yield. Bio control refers to the use of biological methods for controlling plant diseases and pests.

i. Which of the following can be used as a biocontrol agent against aphids?(a)Lady bird (b) Humming bird (c)Dragon fly (d) Mites

ii. Bacillus thuringiensis is used as a

(a)Biofertiliser (b) Biopesticide
(c)Bactericide (d) Fungicide

iii.Identify the organism that uses in vermicompost unit
. (a)Prawn (b) Lady bird (c) Earthworm (d) Neries

iv.Identify the symbiotic relationship among the following;
. Rhizobium and leguminous plants
a. Mycorrhiza
b. Lichen
c. All of these

SOLUTIONS: (i) a (ii) b (iii) c (iv) d

VERY SHORT ANSWER TYPE QUESTIONS

1. Which of the following is the baker's yeast used in fermentation?
   Saccharum barberi, Saccharomyces cerevisiae and Sonalika.
   Ans: Saccharomyces cerevisiae
2. Give the scientific name of the source organism from which the first antibiotic was produced
   Ans:PeniciIlium notatum
   Saccharomyces cerevisiae is the baker's yeast used in fermentation
3. Milk starts to coagulate when Lactic Acid Bacteria (LAB) is added to warm milk as a starter. Mention any other two benefits LAB provides.
   Ans : (i) They improve the nutrient quality of curd by increasing the vitamin-B12 content.
   (ii)LAB also check the growth of disease causing microbes in the stomach.
4. Mention the information that the health workers derive by measuring BOD of a waterbody.
   Ans:Higher the BOD of water body , more is its polluting potential and vice-versa. BOD indicates the presence of organic matter in the water.
5. Given below are a few impurities in urban wastewater. Select two colloidal impurities : ammonia, faecal matter, silt, bacteria, calcium.
   Ans:Faecal matter and silt are the colloidal impurities in urban wastewater.
6. Why is 'starter' added to set the milk into curd? Explain.
   Ans:When a small amount of curd as starter is added to fresh milk, millions of Lactic Acid Bacteria (LAB) present in the starter grow in milk and convert it to curd. During this process, acids are produced by LAB that coagulate and partially digest the milk proteins (casein). LAB increases vitamin-B12 content along with other vitamins in the curd

7. Name the bacterium responsible for the large holes seen in swiss cheese. What are these holes due to?
   Ans:Swiss cheese is produced by the bacterium Propionibacterium shermanii. The large holes in swiss cheese are due to the large amount of C02 production
8. Name the source of cyclosporin-A. How does this bioactive molecule function in our body?
   Ans:Cyclosporin-A is produced by the fungus Trichoderma polysporum. It is used as an immunosuppressive agent in organ-transplant patients.

9. Name some traditional Indian food made of wheat, rice and Bengal gram, which involve use of microbes.
   Ans:
   (a) Wheat – Bhature and Nan
   (b) Rice – Idli,Dosa,Aappam
   (c) Bengal gram-Dhokla and Khandvi
10. Why bioactive molecules called so? Cite any two examples.
    Ans :Bioactive molecules are produced from microbes that are useful to other living organisms in modifying their metabolism.
    Ex: Streptokinase, Cyclosporin A

SHORT ANSWER TYPE QUESTIONS

1. What is sewage? How it spreads epidemics in society?

   Ans:Sewage is a municipal waste water collected from city or town homes that contain toilet, bathroom and kitchen waste. It contains large amounts of organic matter and many pathogenic microbes which causes diseases in human beings and other living organisms thereby spreads diseases such as Cholera, typhoid, etc.

2. List the events that reduce the BOD of a primary effluent during Sewage Treatment.
   Ans: secondary treatment, aerobic and anaerobic treatment, BOD analysis

3. How is primary sludge different from activated sludge?
   Ans: Primary sludge is formed after the sedimentation in primary treatment,Activated sludge is the sediment formed from effluent after secondary treatment which contains bacterial flocs.A part of this is used as inoculum which is puped back into the aeration tanks.
4. Mention the role of flocs and anaerobic sludge digesters in sewage treatment.
   Ans: Flocs consume major part of the organic matter; anaerobic sludge digesters digest the organic mass as well as aerobic microbes and also produce bio gas.

5. Complete the Table

TYPE OF MICROBE	NAME	COMMERCIAL PRODUCT
	Lactobacillus	Lactic acid

Fungus	*Aspergillus niger*	
		Statins
Fungus		
Bacterium	*Trichoderma polysporum*	

6. Biofertilizers are used to increase soil fertility.
   (a) Name the water fern that is used as a biofertilizer for paddy cultivation
   Ans: : Azolla
   (b) Mention the function of the fern that helps in biofertility.
   Ans: : N_2 fixation

7. How do biofertilizers enrich the fertility of the soil?
   Ans: : N2 fixation , symbiotic assocication, play a significant role in biogeochemical cycle

LONG ANSWER TYPE QUESTIONS

1. The process of sewage water treatment before it can be discharged in to natural water is an essential process. Justify and describe about the different stages of Sewage treatment process.

Ans : The treatment involves two steps: Primary treatment and secondary treatment.

Primary treatment ; It is a physical treatment of removing small and large particles through filtration and sedimentation. The sewage is then kept in settling tanks, where the suspended materials settle down to form the primary sludge. The effluent is then taken for secondary treatment.

Secondary treatment:

The primary effluent is taken into large aeration tanks where it is constantly agitated and air is pumped. This causes rapid growth of aerobic microbes into flocs which consume the organic matter of sewage leading to the reduction in biochemical oxygen demand. After the significant reduction in BOD, the effluent is passed into settling tanks where flocs are sedimented leading to the formation of activated sludge. A part of this activated sludge is used a s inoculum which is pumped back into the aeration tanks. The major part of this sludge is pumped into anaerobic sludge digesters where digestion occurs by anaerobic bacteria producing methane, hydrogen sulphide and carbon dioxide. These gases form the bio gas. After secondary treatment the effluent is released into natural water bodies like rivers and streams.

2. Describe the ideology behind the biological control of pests and diseases.

   Ans : Organic farming aims to reduce the use of pesticides and chemical fertilisers in farming. In organic farming eradication of pests is undesirable because without them the beneficial organism that depends upon them for food also will suffer so these insects should be kept at manageable levels by a system of checks and balances within an ecosystem. This natural method of pest and pathogen control involving the use of viruses, bacteria and other insects is called biological control.

   For example 1. Lady bird feeds on aphids while Dragonflies prey upon mosquito .

2.The spores of *Bacillus thuringiensis* are toxic to certain insect larvae but not harmful to other insects.

3. The fungus Trichoderma is used in the control of plant pathogens.

4. Baculoviruses kill insects and other arthropods and are species specific so does not affect other beneficial insects.

CHAPTER 9: BIOTECHNOLOGY: PRINCIPLES AND PROCESSES

Biotechnology deals with techniques of using live organisms or their enzymes to produce products and processes useful to humans.

1. **Two core techniques that enabled birth of modern biotechnology: (2m)**

- Genetic engineering:
  It helped to alter the chemistry of genetic material (DNA and RNA).
  Then introduce it into host organisms,to change the phenotype of the host organism.

- Maintenance of sterile ambience (free from microbial contamination):
  This enables growth of only the desired microbe in large quantities, for the manufacture of products like antibiotics, vaccines, enzymes, etc.

2. a) Advantage of asexual reproduction over sexual reproduction: (1m)

Asexual reproduction:preserves genetic material

Sexual reproduction:produces variations by genetic recombination"s, which are useful to both organism and population

b) Disadvantage of traditional hybridisaton procedures used in plant and animal breeding: (1m)

It leads to inclusion and multiplication of undesirable genes along with the desired genes. This limitation can be overcome by genetic engineering. (1m)

c) Recombinant DNA technology:

A desirable gene is isolated from source organism, then it is inserted into a vector to form rDNA,

later this rDNA is allowed to multiply in a host

3. First artificial recombinant DNA molecule (2m)

- Constructed by Stanley Cohen and Herbert Boyer in 1972
- They isolated antibiotic resistance gene from a plasmid using restriction endonuclease
- Using DNA ligase, this gene was inserted into a plasmid of *Salmonella typhii* (vector) to form rDNA molecule
- Placed rDNA molecule into a host like E.Coli and cloned it.

4.	Three **Basic steps in genetically modifying an organism: (3m)** • Identification of DNA with desirable genes

	• Introduction of the identified desirable DNA into the host • Maintenance of introduced DNA in the host and transfer of the DNA to its progeny
5.	**Tools of Recombinant DNA Technology:(1m/2m)** **Enzymes –** restriction endonucleases, DNA ligase, DNA polymerase. **Vectors**- plasmids, bacteriophases, retrovirus, *Agrobacterium tumifaciens* **Host**- bacteria, plant cell, animal cell

6.	**Nucleases: (1m / 2m)**
	
	- **They cleave DNA or RNA molecule**
	
	- **They are two types-**
	  ○ **Exonucleases- remove nucleotides from the ends of the DNA**
	  ○ **Endonucleases -make cuts at specific positions within the DNA molecule.**

7.	**Restriction endonucleases/restriction enzymes /Molecular Scissors: (2m)** a) What are Restriction Enzymes and their action - They are a type of endonucleases. - They cleave DNA molecule at specific base sequence known as recognition sequence. - The recognition sequence possess palindromic nucleotide sequence. - (1m) Palindrome is a sequence of base pairs that reads same on the two strands in opposite direction i.e. 5‟ ->3‟ and 3‟ ->5‟ 3‟ GAATTC 5‟ 5‟ CTTAAG 3‟ - They cut the strand of DNA a little away from the centre of the palindrome sites, but between the same two bases on the opposite strands. This leaves single stranded portions at the ends called Sticky ends. These ends facilitate action of DNA ligase in joining foreign gene with vector DNA. - Hind II and ECoRI are the examples of R E b) Nomenclature of restriction endonucleases:(2m)

Eg: ECoRI is obtained from Escherichia coli RY 13 .

- The first letter comes „E“from the genus „Escherichia „
- and the second two letters „co“from the species „coli“of the prokaryotic cell.
- 4th letter „R“is derived from the name of the strain-RY 13
- Romen numbers indicate the order in which the enzymes were isolated from the strains of the bacteria

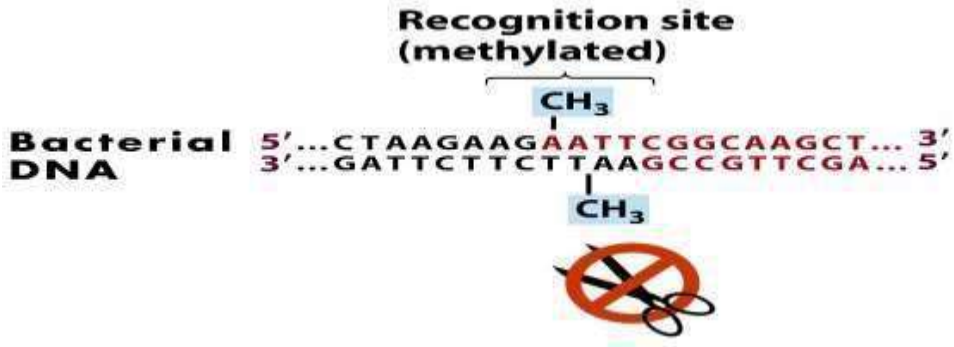
Note:The first restriction endonuclease was HIND II obtained from *Haemophilus influenza*. It cuts DNA molecule at the recognition sequence having 6bp (base pairs).

c) Discovery of restriction endonucleases:(2m)

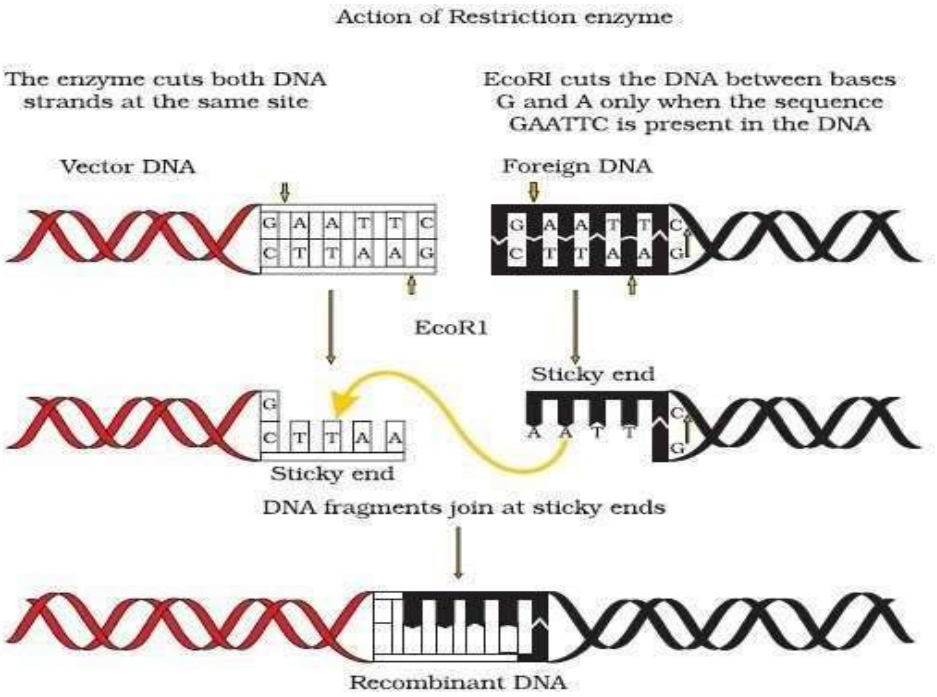
-E.Coli restricted the growth of bacteriophase in its body, by producing two enzymes.

- One enzyme added methyl groups to E. Coli DNA to protect from restriction enzyme action.
- The other enzyme cut the DNA molecule of virus.

This enzyme was Known as restriction endonuclease



8. Formation of Recombinant DNA: (2m)



9.

11) Recombinant DNA technology: (5m)

Steps:

Isolation of source DNA from the selected plant/animal/bacteria.

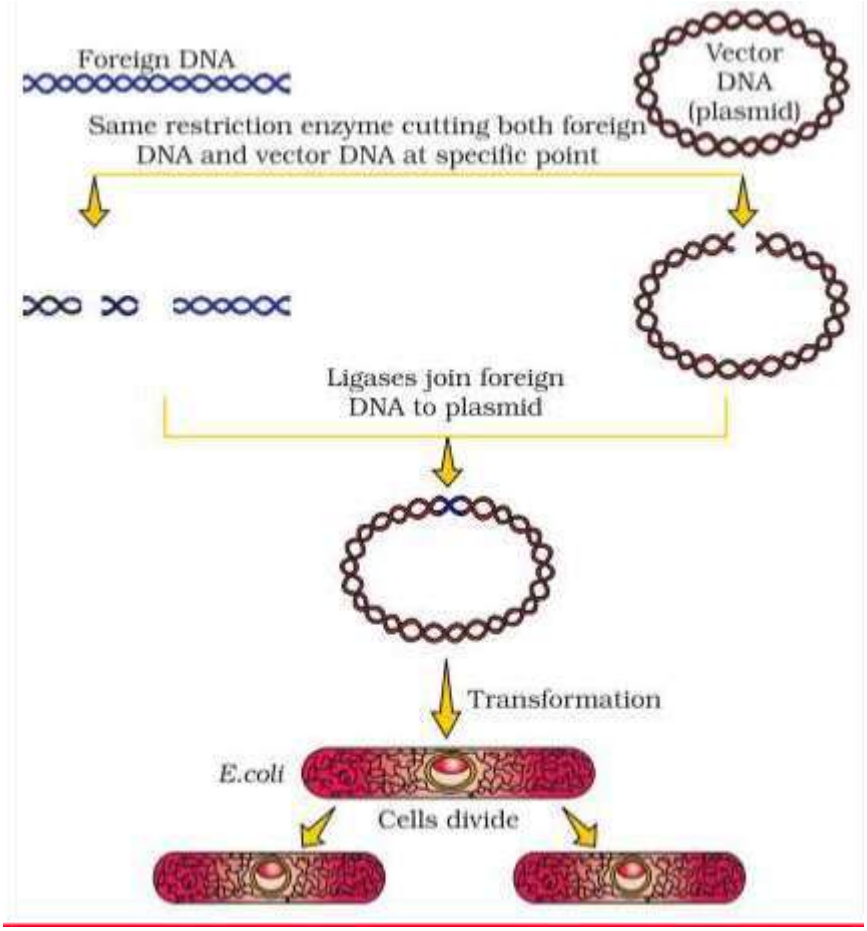
Isolation of desirable gene from the source DNA. Using specific R E the DNA is cut and the desirable gene is obtained. This gene has sticky ends

Cut and open vector DNA (plasmid DNA) using the same R E

Insertion of foreign gene into the plasmid with the help of DNA ligase to form recombinant DNA (rDNA) or hybrid plasmid

Insertion of rDNA into host cell: A suitable host cell like E. Coli is taken and into this hybrid DNA is inserted. The bacteria with plasmid DNA is known as transformant

a) **Multiplication of gene** :when the bacteria reproduces, the hybrid plasmid present in it also get

	replicated . So a large no. of copies of hybrid plasmid is raised. Later using the R E the gene is isolated from the plasmid and it is used for gene therapy **b) expression of gene:** In the bacteria the foreign gene is allowed to express by transcription and translation. The product is collected from the bacteria and used for therapeutic purposes.
10.	**Diagrams of rDNA technology** 
11.	**Separation and Isolation of DNA fragments by Gel electrophoresis: 3m** Technique of separating DNA fragments based on their lengths by Agarose Gel Electrophoresis, STEPS Cut DNA by restriction endonuclease. It results in formation of DNA fragments of varied lengths ⬇ Load the wells of agarose gel with DNA solution (containing DNA fragments) and apply electric field ⬇

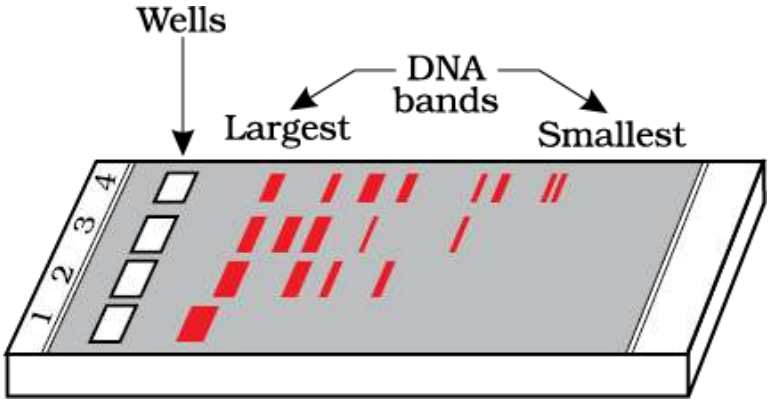
DNA being –vely charged moves towards positive electrode (anode).

During this movement the shorter fragments move faster through the pores of the gel and settle at the bottom. Whereas larger fragments settle at the top of the gel

Stain the gel with **Ethidium bromide**. Later expose it to **UV radiation**.

Now DNA fragments appear as bright orange coloured bands.

Cut and separate DNA fragments from the agarose gel. This step is known as ***Elution.***



12.

Cloning Vectors (Vehicles for Cloning):

Cloning Vector is DNA or RNA molecule, into which a foreign gene can be ligated and cloned in a suitable host .

Types of cloning vectors:

a) plasmid (2m)

-It is extra chromosomal, double stranded circular DNA molecule

- It provides antibiotic resistance to the bacteria

- *It can independently replicate

-* There can be several plasmids in a bacteria. Therefore they have high copy no. per cell

b) Bacteriophage (1m)

-Viruses that infect bacteria are called bacteriophases.

- *A bacteria may possess several bacteriophases. Therefore they have high copy No. per cell.

Both plasmids and bacteriophases are used to clone genes in E coli

c) *Agrobacteriumtumifaciens: (2m/3m)*

- It is a vector for cloning genes in **plants**
- Present in the soil and infects several **dicot plants** and causes a disease called crown gall tumor.
- Possess **Ti plasmid**(tumor inducing plasmid) which delivers a piece of DNA known as **T- DNA** into the plant cells when the bacteria infects them.
- T- DNA transforms plant cells into a **tumor**. So that more chemicals required for the growth of the pathogen can be synthesized.
- Ti plasmid can be **modified i**nto a cloning vector by disarming it(unabling it to cause disease). The disarmed bacteria is used for delivering desirable genes into plant cells

d) Retrovirus:

- They contain **RNA** as the genetic material
- They have the ability to transform normal cells into tumor cells.
- They can be **disarm**ed and used to deliver genes into animal cells.

Copy number: No of copies of vectors present in a cell

12. **Salient features of a Vector:**

-Ori
-Selectable markers
-cloning sites

a) origin of replication (*ori*).1m/2m

- It is a base sequence on vector from where replication starts.

So foreign gene linked to this sequence gets replicated.

- It also controls the copy No of linked DNA/ foreign gene

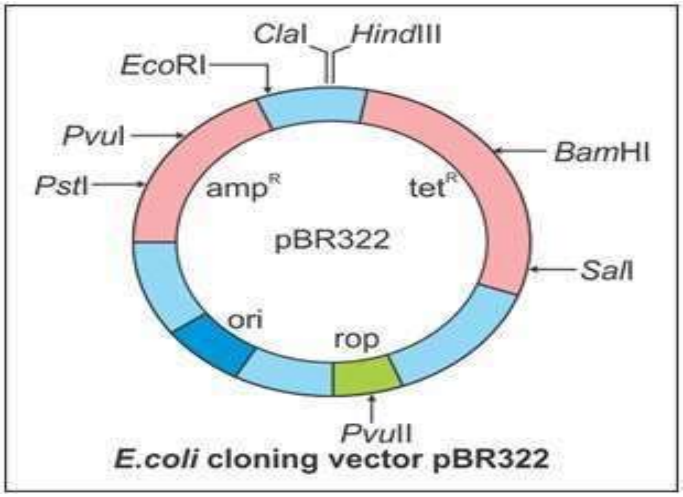
b) selectable marker : 2m

- Antibiotic resistance genes such as **tet^R and amp^R** act as selectable markers for E coli.
- These help in identifying and eliminating non-transformants and selectively permitting the growth of transformants.
- Transformation is a process by which rDNA is introduced into the host cells for cloning a foreign gene.
- Host cell with rDNA molecule is called transformant

c) Cloning sites: 2m

- It is a recognition site/ restriction site present on vector, at which a specific R E can cut open the plasmid for inserting a foreign gene
- Single recognition site is preferred. If there are more than one recognition sites, the RE will generate several fragments which will complicate the gene cloning.
- When foreign DNA is introduced into the coding sequence of the antibiotic resistant gene , there is **insertional inactivation** of the gene.So the transformed bacteria loses antibiotic resistance .This helps in selecting recombinants selected non-recombinants.

13. Structure of ***vector pBR322:*** ***(3m /5m)***



E.coli cloning vector pBR322

- It is a E coli cloning vector.It has ORI, selectable markers and cloning sites/restriction sites
- **Ori**– sequence from where replication starts . Any foreign gene linked to it can be made to replicate within the host (E coli).

  It also controls the copy No of foreign gene
- **Selectable markers- tet^R and amp^R** are the genes encoding for antibiotic resistance to tetracycline and ampicillin respectively . If a foreign gene is inserted at Bam HI site of tet^R , the plasmid will loose the tetracycline resistance. The markers help in identifying and eliminating non-transformants and selectively permitting the growth of transformants.
- **Rop-** codes for proteins involved in the replication of the plasmid
- **Restriction site:**. These are the sites on the plasmid at which a specific R E can cut open the plasmid for inserting a foreign gene.

  Hind III , Eco RI , Bam HI , Sal I, Pvu II , Cla I. are restriction enzymes, they can cut and open vector at specific sits

14. Selection of transformants using antibiotic resistance gene as cloning site3m

vector pBR322 has two antibiotic resistance genes- **tet^R and amp^R**. They provide resistance to antibiotics tetracycline and ampicillin respectively.

a) If a foreign gene is inserted at Bam HI site of tet^R, the plasmid will lose the tetracycline resistance due to insertional inactivation. But they still have ampicillin resistance

b) The bacteria possessing this recombinant plasmid are called transformants/ recombinants. They can grow in ampicillin containing medium but not on tetracycline containing medium .

c) Whereas Non-transformants will grow on the medium containing both the antibiotics

d) In this method one of the antibiotic resitance genes helped in identifying and eliminating non-transformants and selectively permitting the growth of transformants by a plating method.

Dis advantage of this method:

Selection of transformants from non-transformants using antibiotic resistance gene

	is**cumbersome procedure** because it requires **simultaneous** plating on two plates having different antibiotics
15.	Selection of recombinants from non-recombinants on the basis of colouring reaction. (Blue-White screening)3m In this method lac Z gene producing beta galactosidase is used as a marker, to select transformants from non-transformants. **a) In non- transformants: (blue in colour)** lac Z gene present in plasmid vector produces enzyme beta-galactosidase. ↓ This enzyme cleaves a chromogenic substrate into a blue coloured product, ↓ Blue colour bacterial colonies appear **b) In Transformants: (white in colour)** Insert a foreign DNA into the coding sequence of lac Z ↓ Insertional inactivation of the gene occurs . So, lac Z gene does not produce the enzyme beta-galactosidase . ↓ In the absence of the enzyme the bacteria do not produce blue colour ↓ They appear as white coloured colonies. c) By this way, we can differentiate transformants (white colour) from non-transformants (blue colour) colonies NOTE: Chromogenic substrate: **X-gal** is hydrolyzed to form 5-bromo-4-chloro-indoxyl, in presence of beta galactosidase .
16.	**Methods to introduce rDNA into host cells:** a) Chemical method in bacterial cells: 2m - DNA being a hydrophilic molecule, cannot pass through cell membranes. Hence the bacteria should be made competent to accept the DNA molecule. - Bacterial cell is treated with divalent cation such as calcium ions to increase pore size in the cell wall.

	- The bacterial cells are then incubated with rDNA on icefollowed by placing them briefly at 42°C and then putting them back on ice. This is called Heat Shock treatment. - This enables the bacteria to take up the recombinant DNA **b)** Physical methods- **for animal and plant cells** **i)** **microinjection method in animal cells:1m** rDNA is directly injected into the nucleus of the animal cell through micro pippetes ii) **Biolistics / Gene gun method in plants:**1m In this method, microscopic particles of gold / tungsten are coated with the DNA of interest and bombarded onto cells. **c)** *Disarmed Pathogen* Vectors: such as *Agrobacterium tumefaciens* , Retro virus, which when allowed to infect the cell, transfer the recombinant DNA into the host.
17.	**Isolation of genetic material (DNA):2m** DNA should be isolated in pure form, frombactrerial/fungal/plant cells. • Using the enzymesLysozyme (bacteria), cellulase (plant cells), chitinase (fungus), the cells are broken and nuclear contents are separated. • Later RNA and proteins are removed by ribonucleaseand proteases. • Using chilled ethanol the pure DNA is obtained
18.	**Amplification of Gene of Interest using PCR:** 3m/5m - PCR stands for Polymerase Chain Reaction. In this reaction, multiple copies of the gene of interest are synthesized in vitro using two sets of primers and the enzyme DNA polymerase. - There are 3 steps in PCRcycle a) **Denaturation:** Double stranded DNA is denatured by breaking H-bonds to get two DNA templates b) **Annealing:** - Primers are chemically synthesized oligo-nucleotides and they are complementary to DNA templates

- Primers are added on the templates in 5‟ → 3‟

c) Extension:

- To the primer deoxyribonucleotides are added at 3‟ end in presence of Taq polymerase
- In this way we get 2 DNA molecules .

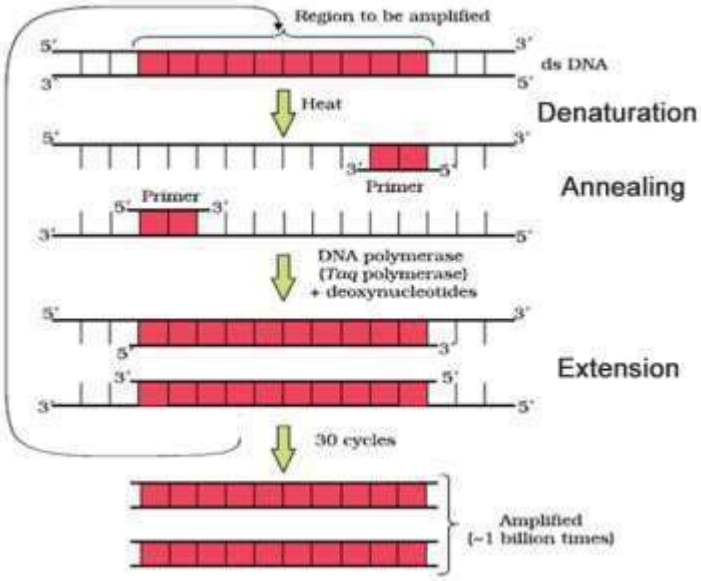
- All these steps are repeated many times to get several copies of the desired DNA segment.

- *Taq* DNA Polymerase : 2m

- The DNA polymerase used in PCR reaction is Taq polymerase.

- It is isolated from a bacterium, ***Thermus aquaticus***.

- *It is thermostable and can remain active at high temperature induced during denaturation of DNA.*



19.

a) simple stirred-tank bioreactor:

- **Bioreactor is a large** cylindrical **vessel in which raw materials are converted into useful products and enzymes, with the help of microbes.**

- **The reactor provides optimal growth conditions of pH, temp, substrate and other micronutrients.**

- Stirrer facilitates even mixing and oxygen availability throughout the bioreactor. Alternatively air can be bubbled through the reactor.

- It has an agitator system, an oxygen delivery system and a foam control system, as well as temperature and pH control systems

- Through the sampling ports, small volumes of the culture can be withdrawn periodically.

b) **Sparged stirred tank bioreactor:** sterile air bubbles are sparged , to increase the surface area for oxygen transfer

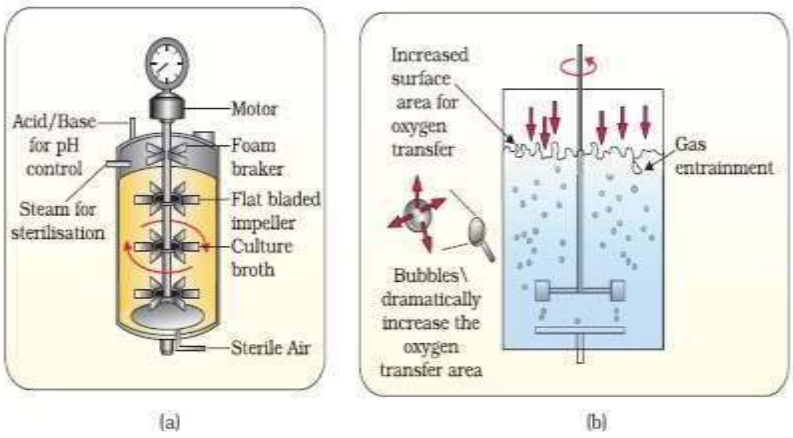


Figure 11.7 (a) Simple stirred-tank bioreactor; (b) Sparged stirred-tank bioreactor through which sterile air bubbles are sparged

20.

Downstream Processing: 1m

The raw product produced in the bioreactor is separated and purified first and thereafter, if required preservatives are added and marketed

Recombinant proteins:1m

Foreign gene present in rDNA molecule expresses in heterologous host (transgenic organism) to produce desired proteins. These proteins are known as recombinant proteins

Competency based questions:

1. Given below are two columns. In Column I is the list of four enzymes and in Column II is the list of functions of the given enzymes. Which one of the following options shows the enzymes matched with their respective functions correctly ?

Column I (Enzyme)	Column II (Function)
P. DNA Ligase	i. Removes nucleotides from ends of DNA
Q. Restriction exonuclease	ii. Extends primer on a DNA template
R. Taq polymerase	iii. Joins the DNA fragments
S. Restriction endonuclease	iv. Cuts DNA at a specific position

(a) P-i, Q-ii, R-iv, S-iii
(b) P-iv, Q-iii, R-ii, S-i
(c) P-i, Q-iv, R-iii, S-ii
(d) P-iii, Q-i, R-ii, S-iv

2. The organism used in construction of the first artificial recombinant DNA by Cohen and Boyer in 1972 was :
(a) E. coli
(b) Salmonella typhimurium
(c) Agrobacterium tumefaciens
(d) Bacillus thuringiensis

3. Given below are the steps carried out to construct a recombinant DNA. Which one of the following gives the correct sequence of these steps ?
(i) Isolation of genetic material
(ii) Insertion of recombinant DNA in the host cell / organism
(iii) Obtaining the foreign gene product
(iv) Amplification of gene of interest
(v) Downstream processing

(a) (i) (iii) (iv) (ii) (v)
(b) (i) (iv) (ii) (iii) (v)
(c) (ii) (i) (iii) (iv) (v)
(d) (ii) (iv) (v) (iii) (i)

4. After the completion of biosynthetic stage in a bioreactor, the product undergoes a series of processes before it is ready for marketing. List of the processes is given below. Identify the option that gives the correct sequence of the processes carried out :
(i) Purification of product
(ii) Formulation with suitable preservative
(iii) Separation of product
(iv) Clinical trial of product

(a) (ii) (iii) (i) (iv)
(b) (iii) (ii) (i) (iv)
(c) (iii) (i) (ii) (iv)
(d) (i) (iii) (iv) (ii)

5. Restriction enzymes cut the strand of DNA –
I -a little away from the centre of palindrome sites
II- closer to the centre of palindrome sites
III- between the same two bases on the opposite strands
IV - between the different bases on the same strands
V- leave single stranded portions at the ends
VI- do not leave the single stranded portions at the ends

a) I, III and VI
b) I, III and V
c) I, IV and VI
d) II, IV and V

6. Which restriction site is not present in pBR322 plasmid?

a) EcoRI b) Hind III
c) Hind II d) Sal I

For Questions number 7 to 10, two statements are given one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.
(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false, but Reason (R) is true.

7. Assertion (A): In order to cut the DNA with a restriction enzyme, it needs to be released from the membrane which encloses it.
Reason (R): A plant cell was treated with chitinase to achieve this.

8. Assertion (A): PCR is a powerful technique to identify genetic disorders.
Reason (R): PCR can detect mutations in low amounts of DNA.

9. Assertion (A): Plasmids and bacteriophages are used as cloning vectors in rDNA technology.
Reason (R): They have low copy number of their genome within the bacterial cell.

10. Assertion (A): The matrix used in gel electrophoresis should have controllable pore size.
Reason(R): Agarose concentration can be changed to change pore sizes.

ANS
1.(d) P-iii, Q-i, R-ii, S-iv
2. (b) Salmonella typhimurium
3. (b) (i) (iv) (ii) (iii) (v)
4. (c) (iii) (i) (ii) (iv)
5. b) I, III and V
6. c) Hind II
7. Assertion (A) is true, but Reason (R) is false.
8. (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
9. (c) Assertion (A) is true, but Reason (R) is false.
10. (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

2 mark questions:

1. Explain the process by which a bacterial cell can be made „competent" to take up foreign DNA from its surrounding, using divalent cations and temperature treatment .

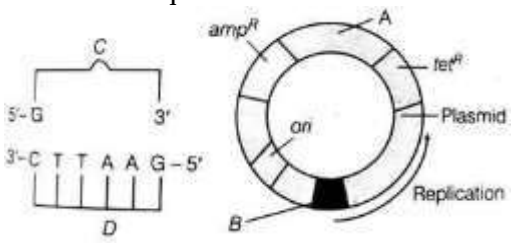
2. Vectors are DNA molecules that can carry a foreign DNA segment into the host cell.
   (i) Write the significance of ori in this vector
   (ii) Give one example each of vectors used for cloning genes in plants and animals.
3. What do you mean by "selectable markers"? Why are they necessary for genetic engineering?

4. „Insertional inactivation" is a method to detect recombinant DNA technology. Explain.

5. *Agrobacterium tumefaciens* is referred to as a natural plant genetic engineer by biotechnologists. Give arguments in favour of the claim.

6. How are DNA fragments visualized during gel electrophoresis? What is elution?

7. Study the figure and answer the questions that follow.



   (i) Identify the part B in the given illustration and give its function.
   (ii) What is the term given to C and D sequence on a DNA and explain why?

8. Restriction enzyme Y was used to extract gene of interest from a plant. This gene needs to be inserted in the given DNA segment which has been treated with restriction enzyme X. Will there be a successful recombination? Explain with a reason.

9. a. Why are restriction enzymes called molecular scissors?
   b. Write one point of difference between exonuclease and endonuclease.

10. How can retroviruses be used efficiently in biotechnology experiments inspite of them being disease causing?

ANS

1. In order to make the bacterial cells competent, they are first treated with a specific concentration of a divalent cation, such as calcium. It increases the efficiency with which DNA enters the bacterium through pores in its cell wall. This is followed by heat shock treatment

2. Origin of replication (ori) -This is a DNA sequence that is responsible for initiating replication. Any piece of DNA when linked to this sequence can replicate within the host cells. ori also controls the copy numbers of the linked DNA. For many copies of target DNA, it should be cloned in a

vector whose origin supports high copy number.
In plants, the tumour inducing plasmid (Ti) of Agrobacterium tumefaciens and Bacteriophages in animals.

3. A gene known as a genetic marker that causes the removal of the non-transformant can be used to choose the host cells which carry the vector. It is employed in genetic engineering, for instance, where the gene that codes for antibiotic resistance is proven to be a helpful selectable marker because when it inserts into a cell, it only allows transformants to develop.

4. Insertional inactivation: The gene which synthesizes the enzyme gets inactivated when a foreign DNA gets inserted into the gene that is coding for an enzyme. This process is known as insertional inactivation. Insertion of recombinant DNA within the coding sequence of ß -galactosidase results in colourless colonies.

5. Agrobacterium tumefaciens is known as a natural genetic engineer of a plant because it has the natural ability to integrates its plasmid genes into the plant genomes. It can deliver a piece of T-DNA in the plant genome.

6. The separated DNA fragments are visualized only after staining the DNA with the help of ethidium bromide followed by the exposure to UV radiation. The bright orange colour bands are shown. Then the elution is done, that is the separated bands of DNA are cut out from the agarose gel and extracted from the gel piece.

7. B- Rop- codes for proteins involved in the replication of the plasmid. Cand D - In molecular biology, palindromic sequences are referred to as the sequence of nucleotides in the DNA duplex or RNA, where the sequence in one strand is the same as the complementary sequence of the other strand when read from the same direction on both the strands, either 5‟ to 3‟ or 3‟ to 5‟.

8. They will not five successful recombinant as they are cut by different restriction enzymes hence they do not give sticky ends to join.

9. Restriction enzymes are also called "molecular scissors" as they cleave DNA at or near specific recognition sequences known as restriction sites. DNA exonucleases cleave the sequence from either end, whereas DNA endonucleases cleave the sequence within or adjacent to the sequence.

10. In biotechnology, they are used as natural vectors to deliver the desired gene in the host cell inspite of their disease causing ability. They are modified into a cloning vectors by removing the genes responsible for pathogenicity and inserting desired genes.

3 Mark questions:

1. With the help of a schematic diagram only, show in three steps, the formation of recombinant DNA by the action of restriction endonuclease EcoRI and DNA ligase.

2. (a) Simple stirred-tank bioreactors are used to produce large quantities of recombinant proteins, stirring the contents and mixing it with oxygen. Write any four other advantages of using stirred tank.
   (b) After downstream processing, the product of the biosynthetic stage cannot be marketed directly. Why? Give two reasons.

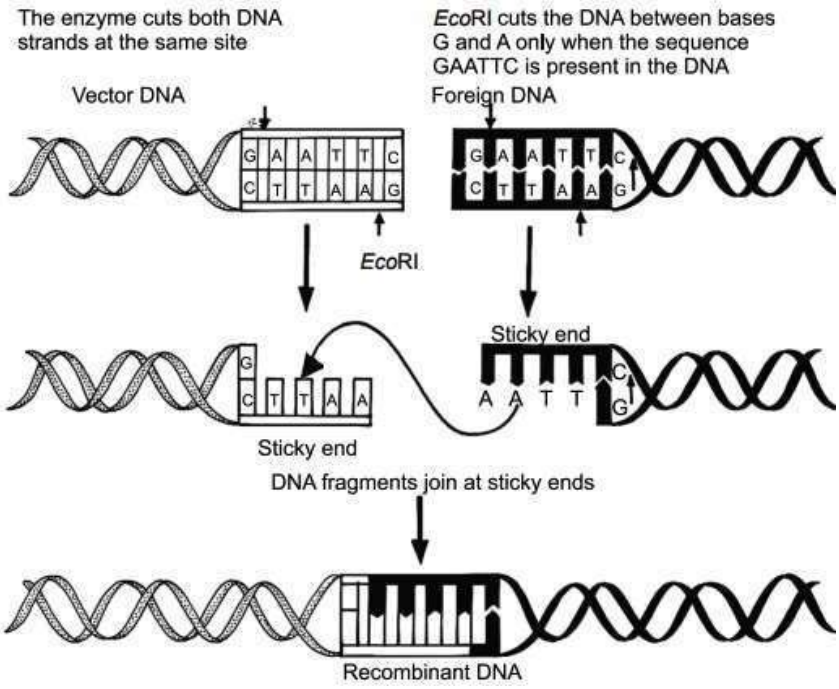
3. A researcher wants to amplify a desired fragment of DNA to be ligated with a vector for further cloning. Name the technique she would use. Explain the steps of the technique diagrammatically only.

4. Mention three vector-free techniques that can be utilised to transfer recombinant DNA into a ready host cell.

5. Expand "BAC" and "YAC". What are they, and why do they serve the purposes that they do?

ANS-

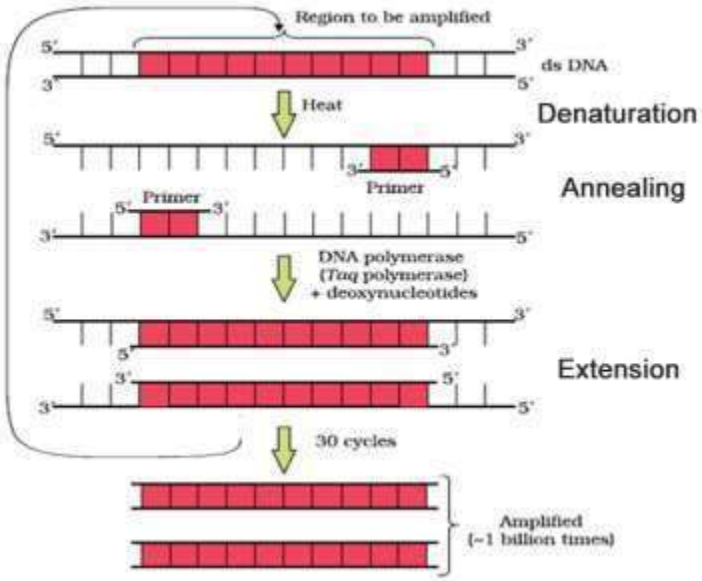
1.



2. a)The advantages of stirred tank bioreactors are,
   1. They provide better aeration and mixing properties
   2. They provide high temperature.

3. They don't allow entry of carbon dioxide
4, They are easy to operate.
b) After completion of the biosynthetic stage, the product is subjected through a series of processes before it is ready for marketing as a finished product. The processes include separation and purification, which are collectively referred to as downstream processing. The product has to be formulated with suitable preservatives. Strict quality control testing for each product is also required

3.



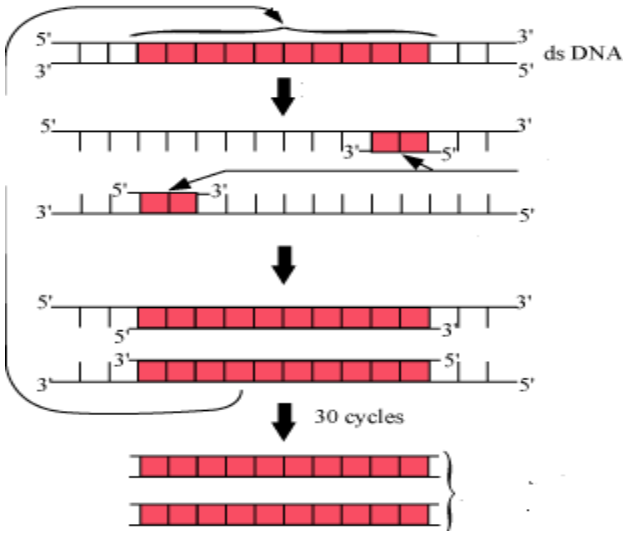
4. The three vector-free techniques are as follows.
Bacteria directly ingest environmental genetic material through a process known as transformation. For this, calcium chloride is applied to the bacterial cells. The cells are then heated to a very high temperature after being incubated in ice. As a result, the bacterial cell wall becomes porous, allowing the bacterial cell to absorb the foreign DNA.
Microinjection: Using a microneedle, recombinant DNA is directly injected into the animal cell‟s nucleus in this procedure.
Biolistics/Gene Gun Method: DNA-coated gold and tungsten microparticles are fired at the cells at extremely high speeds

5. Bacterial artificial chromosome and yeast artificial chromosome are both abbreviations for artificial chromosomes. These are the DNA cloning vectors. DNA from the cell is extracted and reduced to relatively smaller sizes called fragments before being used for sequencing. In an appropriate host, DNA fragments are cloned using specialised vectors like BAC and YAC. Automated DNA sequences are then used to sequence DNA fragments.

5 mark questions:

1. Draw a simple stirred-tank bioreactor.
   Highlight any one difference between a bacterial culture flask in a laboratory and a bioreactor that allows cells to grow in a continuous culture system.
   Explain the significance of downstream processing in obtaining the final gene product.

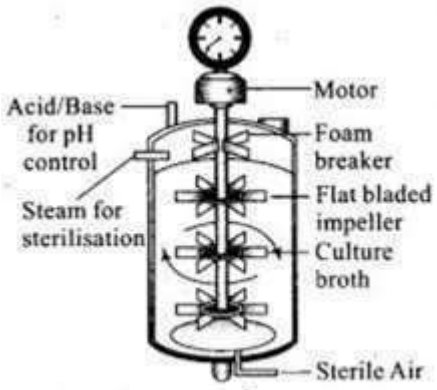
2.



a) Identify the process given in the diagram given above. What is the significance of this process in Biotechnology.
b) Name the enzyme used in this process. What is its special feature?
c) Explain the steps involved in the process.

Ans-

1.



Simple stirred-tank bioreactor

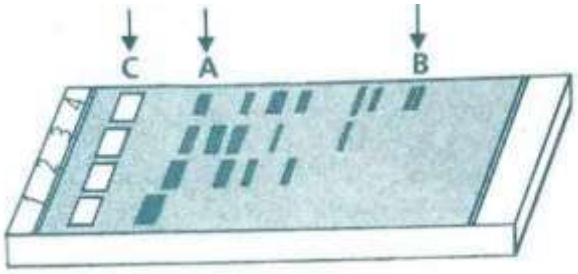
6 * ½=3

b) Small volume cultures cannot yield appreciable quantities of products.
bioreactors help to produce products in a very large scale. 1
c) The processes include separation and purification 1.

2. a.Polymerase chain reaction/ PCR
Used for gene amplification 1
b.Taq polymerase- It is thermostable- Thermus aquaticus 1
c.Denaturation - Double stranded DNA is denatured by breaking H-bonds to get two DNA templates, Annealing- - Primers are added on the templates in 5‟ 3‟
Extension - To the primer deoxyribonucleotides are added at 3‟ end in presence of Taq polymerase
(1mark each)

CASE STUDY BASED QUESTION

I-When cut by the same restriction enzyme, the resultant DNA fragments have the same kind of „sticky-ends‟ and these can be joined together (end-to-end) using DNA ligases The cutting of DNA by restriction endonucleases results in the fragments of DNA. These fragments can be separated by a technique depicted in the picture.



1. Name the material used as matrix in gel electrophoresis and mention its role. 1
2. Why do DNA fragments move towards the anode during gel electrophoresis? 1
3. How are the DNA fragments separated by gel electrophoresis visualised and separated for use in constructing recombinant DNA?

OR

Write any two ways the products obtained through this technique can be utilised. 2

II- Bioreactors are considered as vessels in which raw materials are biologically converted into specific products by microbes, plants and animal cells or their enzymes. They are used for large scale production as they provide optimum growth conditions such as temperature, pH, substrate, vitamins, oxygen and salts for obtaining desired product. Most commonly used bioreactors are of stirring type which include simple

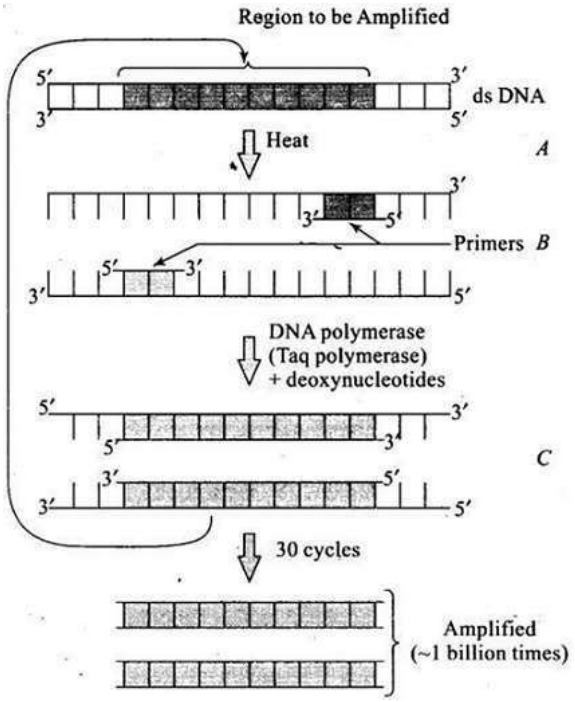
stirred tank bioreactor and sparged stirred tank bioreactor.

1. How does a simply stirred tank bioreactor to differ from sparged stirred – tank‟ bioreactor?
   OR
   List four growth conditions that a bioreactor provides for obtaining the desired product. 2
2. State the function of sampling ports. 1
3. The stirred-tank reactor is usually cylindrical or a curved base. Why? 1

III-. pBR322 is a plasmid and was one of the first widely used E. coli cloning vectors. Created in 1977 in the laboratory of Herbert Boyer at the University of California, San Francisco, it was named after Francisco Bolivar Zapata, the postdoctoral researcher and Raymond L. Rodriguez. The p stands for "plasmid," and BR for "Bolivar" and "Rodriguez."

1. State the significance of 'ampR' and 'tetR'. 1
2. Write the role of 'Ori' and 'restriction' site in a cloning vector pBR322.
   OR
   Name four recognition sites in pBR322. 2
3. What happens when an alien gene is ligated at Sal I site of pBR322 plasmid? 1

IV- Polymerase chain reaction (abbreviated PCR) is a laboratory technique for rapidly producing (amplifying) millions to billions of copies of a specific segment of DNA, which can then be studied in greater detail. PCR involves using short synthetic DNA fragments called primers to select a segment of the genome to be amplified, and then multiple rounds of DNA synthesis to amplify that segment.



1. Identify „A‟ and „C‟ 1
2. Name the source of the DNA polymerase used in PCR technique. Mention why it is used?
   OR

Mention the number of primers required in each cycle of Polymerase Chain Reaction (PCR). Write the role of primers PCR. 2

3. How many copies of DNA samples are produced in the PCR technique after 6-cycles? 1

ANS:

I- 1) The material used as matrix in gel electrophoresis is agarose. This agarose gel acts as a sieve to separate the DNA fragments according to their size.

2) DNA consist of a phosphate backbone which is a negatively charged, hence when the DNA is placed in gei-electrophoresis it always moves towards anode, as the anode is positively charged.

3) The separated DNA fragments by gel electrophoresis are stained with ethidium bromide. By the exposure to UV radiation, the separated DNA fragments become visible as orange-coloured bands.

The separated bands of DNA are cut out from the agarose gel and DNA is extracted from these gel pieces and this process is called elution

OR

Products obtained via gel electrophoresis can be utilised in following ways

(a) To construct a recombinant DNA molecule by joining them with cloning vector.

(b) For amplification of desired segment using Polymerase Chain Reaction (PCR).

II

1. In the simply stirred tank bioreactor the stirrer facilitates the even mixing and the oxygen availability throughout the process, whereas for proper mixing throughout the reactor in the case of sparged stirred-tank bioreactor the air is found to be bubbled.

OR

Growth conditions that a bioreactor provides for obtaining desired product are:

(i) Optimum temperature

(ii) Suitable pH

(iii) Salt

(iv) Vitamins

(v) Oxygen (any four)

2. Sampling ports to withdraw small volumes of culture periodically.
3. to facilitate the mixing of the reactor contents.

III

1. „ampR" and „tetR" are the selectable markers which help in identifying and eliminating non-transformants.
2. Ori - It is a genetic sequence that acts as the initiation site or the origin site for the replication of DNA. Any fragment of DNA, when linked to the ori region, can be initiated to replicate.Recognition sites are the genetic sequences where the restriction enzymes cut the DNA segments.

OR

EcoRI, Hind III, PvuI, BamHI, etc.

3. If an alien gene is ligated at Sal I site of tetracycline resistance gene in the vector pBR322, the recombinant plasmid will lose its tetracycline resistance.

IV

1. A- Denaturation C- Extention.
2. The DNA polymerase used in PCR is Tag polymerase extracted from *Thermus aquaticus*. It is a thermostable enzyme that can withstand high temperature used in the denaturation and separation of DNA strands. Hence, it can be used for a number of cycles in amplification.

OR

Two sets of primers are required. Primers are required for the addition of nucleotides to make multiple copies of the DNA of interest.

3. 64 copies.

CHAPTER 10 : BIOTECHNOLOGY AND ITS APPLICATIONS

❖ Biotechonology has varied applications. some of which include :

i) Therapaeutics

ii) Genetically modified crops for agriculture

iii) processed food

iv) waste treatment

v) Bioremediation

vi) energy production.

1. **Three critical research areas** of biotechnology: 3m

i) Providing best catalyst - in the form of improved microbe or pure enzyme.

ii) Creating optimal conditions by engineering, for a catalyst to act.

iii) Downstream processing technologies to purify the product (protein).

2. Food production can be increased by 3 ways :

a) Agrochemical-based agriculture (chemical fertilizers and pesticides) .

b) Or**ganic agriculture** (using biofertilizers and biopesticides).

c) **Genetically** engineered crop-based agriculture. (using Bt cotton)

Green Revolution succeeded in increasing food supply by using : 1m

- improved crop varieties.
- Agrochemicals (fertilisers and pesticides).
- better management practices

Agrochemicals are **expensive** for farmers in developing countries and also **have harmful effects on environment. Therefore, need for genetically modified crops arose.**

3.

GMO (Genetically modified organism) . It is a plant/ animal/ bacteria/ fungi whose **genes have been altered for desirable expression**.

uses of GMO: 2m/3m

a) increased tolerance against abiotic stresses (cold. drought, salt, heat).

(b) reduced reliance on chemical pesticides (by using pest-resistant crops).

(c) reduced post-harvest losses.

(d) increased efficiency of minerals usage by plants (this prevents early exhaustion of fertility of soil).

(e) enhanced nutritional value of food, *e.g.,* vitamin *A* enriched rice (golden rice).

f) creation of tailor-made plants to supply alternative resources such as starches, fuels and pharmaceuticals to industries.

5. **Examples of GMOs:** Bt cotton and nematode resistant tobacco plants

(i) Bt cotton

- ***Bacillus thuringiensis*** contains cry gene . It produces an insecticidal protein that kill some insects like lepidopterans ,coleopterans and dipterans.

To develop Bt cotton plant- 3m

Isolate cry gene from the bacteria

⇩

insert it into the cotton plants through a vector or gene gun.

⇩

The gene produces inactive **protoxins, in the plant. Hence plant is not affected by it.**

⇩

When the larva of insect feeds on the cotton plant, the protoxin enters its gut region.

⇩

The inactive toxin becomes **active due to the alkaline pH of the gut which solublise the crystals.**

⇩

The activated toxin binds to the surface of midgut epithelial cells and creates pores. This causes cell swelling and lysis of the gut region leading to the death of the insects.

- Proteins produced by the genes cry IAc and cry IIAb control the cotton bollworms and *cry IAb* ' control corn borer.

Note : lepidopterans - **tobacco bud worm, armyworm**

coleopterans- **beetles**

dipterans - **flies, mosquitoes**

6.

(ii) ***Pest resistant plants – Nematode resistant tobacco plants development by RNAi process*** ***3m.***

- A nematode ***Meloidegyne incognitia*** infects the roots of tobacco plants which **reduce the production of tobacco.**
- It can be prevented by using RNA interference **(RNAi)**.

  Here specific *mRNA which* is single stranded is converted into ds RNA using a complementary RNA strand.

  Formation of dsRNA prevents translation of the mRNA.

  This is called silencing of mRNA.

To develop nematode resistant plant

Isolate nematode specific genes

⇩

using *Agrobacterium* vectors, introduce nematode-specific genes into the host plants.

⇩

This foreign gene produces both sense and anti-sense RNA in the host cells.

⇩

These two RNAs are complementary to each other and form a double-stranded RNA *(dsRNA)* that initiates RNAi.

⇩

When the nematode infects the tobacco roots, it releases mRNA into root cells for synthesizing proteins required for the growth of the nematode.

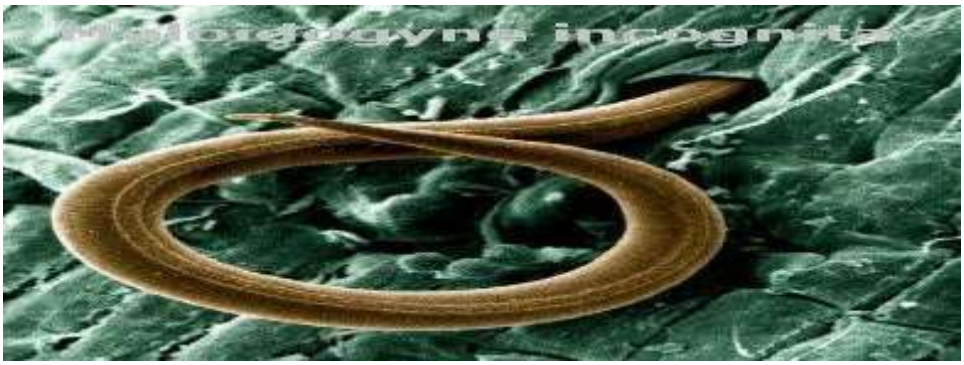
⇩

But this ss RNA is converted into dsRNA, when a complementary RNA strand (already present in root cells) attaches to it.

⇩

Hence mRNA gets silenced and the nematode fails to grow in transgenic

Source of complementary RNA:-**Retroviral infection** or mobile genetic (**transposons**) that replicate via an RNA intermediate. 1m



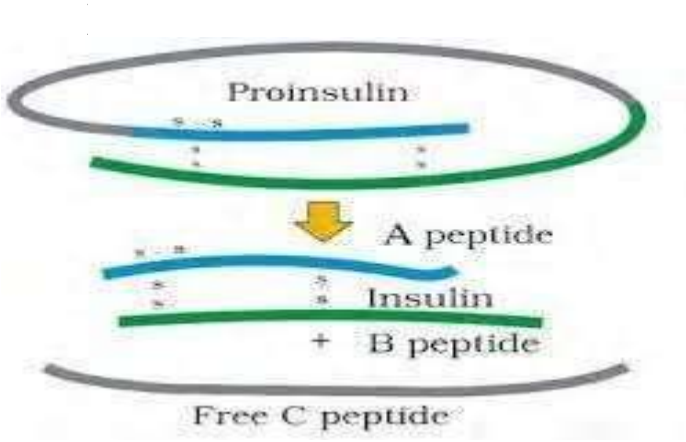
8. **Biotechnological Applications in Medicine**

Two advantages of medicines produced by rDNA technology

- They are safe and effective.
- It avoids unwanted allergic reactions commonly observed with similar products isolated

9. (i) Genetically engineered insulin to treat diabetes mellitus:

a) Insulin basic structure 2m



- Pro- insulin: In mammals, insulin is synthesized as a **pro-hormone and** it contains an extra C peptide chain. So, it is non-functional
- C peptide is removed during maturation of proinsulin into functional insulin.
  - Insulin : contains two short polypeptide chains- chain A and chain B linked by disulphide bridges. It is functional hormone

b) Source of insulin for diabetics

- Earlier, insulin was extracted from pancreas of slaughtered cattle and pigs but some patients began developing allergies. 1m

It prepared two DNA sequences (genes) corresponding to A and B peptide chains of of hum insulin.

⇩

These DNA sequences were inserted into separate plasmids (vectors).

⇩

the hybrid plasmids were placed into host cell (*E. coli).*

⇩

The genes expressed and produced A and B peptides in E.coli.

⇩

The A and B chains were separately extracted from E.coli. Later A and B peptide chains were combined by creating disulfide bonds to form human insulin.

9.

(ii) *Gene therapy for ADA deficiency or SCID*

a) gene therapy

- Gene therapy involves replacement of defective gene with a normal functional one in a child or embryo. The diseases corrected by gene therapy are : ADA deficiency, haemophilia, cancer.

b) adenosinede-aminase (ADA) deficiency/SCID

- Severe combined immune-deficiency disease (SCID) **genetic disorder that harms the child's immune system,** .
- ADA is caused due to deletion of gene that produces adenosine de-aminase.
- In the absence of this enzyme lymphocytes fail to mature into functional lymphocytes.

c) Treatment

- In some cases, it can be cured by bone marrow transplantation and enzyme replacement therapy. But it is not fully curative.

d) How is it cured by gene therapy?

- For the first time in 1990, M. Blease and W E Andresco of **National Institute of Health,** attempted gene therapy on a 4 year old girl with **adenosinede-aminase (ADA) deficiency.**

A functional ADA gene is isolated and inserted into dis-armed retrovirus (vector)

⇩

Lymphocytes from patient's blood were taken.

⇩

Both lymphocytes and vector were cultured together

⇩

ADA *cDNA was* introduced into lymphocytes.

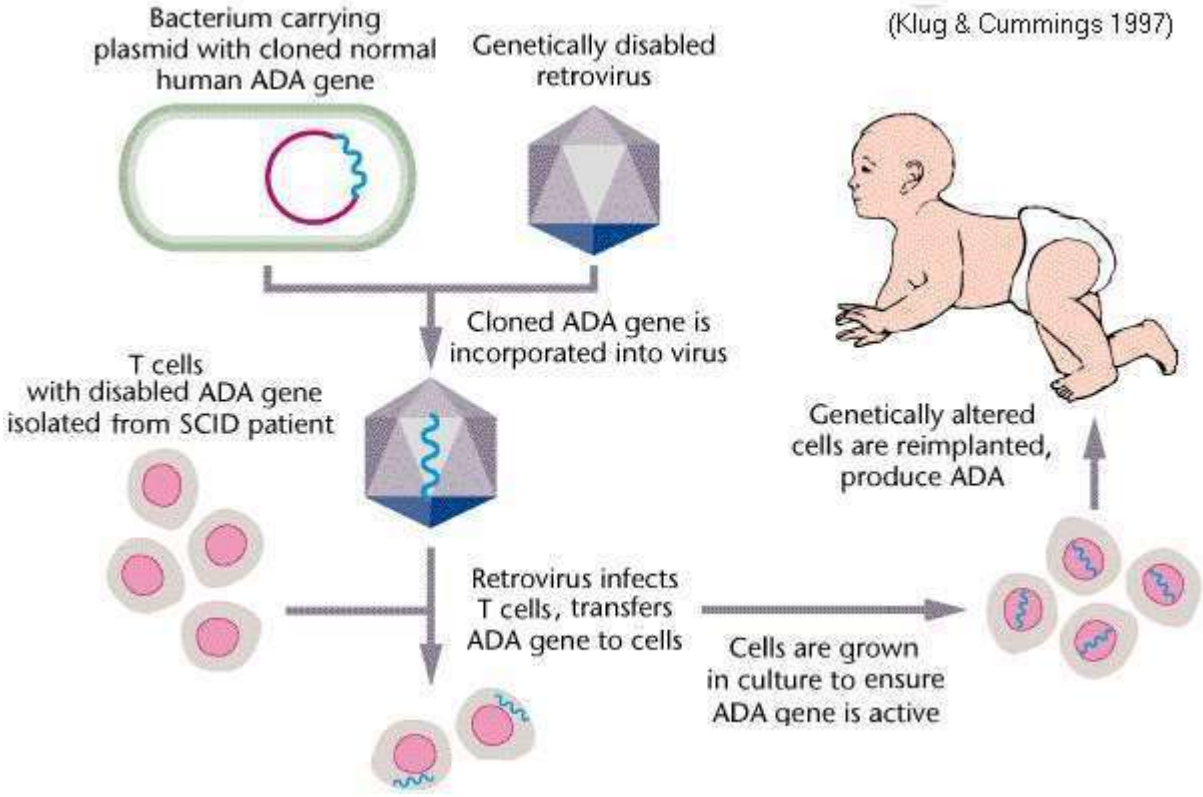
⇩

The transformed lymphocytes (functional lymphocytes) were placed back into the patient's body.

⇩

Periodic infusion of such genetically engineered lymphocytes is done because these cells are mortal.

- For permanent cure, insert gene isolated from the bone marrow cells producing ADA at early embryonic stage.



10. ***(iii) Molecular diagnosis 3m***

Early detection of a disease is not possible by conventional diagnosis methods.

Some techniques used for early diagnosis are:

(a) Polymerase chain reaction

- Low concentration of the pathogen (bacteria or virus) in the body does not allow its detection.
- So, the nucleic acid of the pathogen is amplified by PCR for its detection.
- It is being used for detection of HIV in suspected AIDS patients and genetic mutation in suspected cancer patients.

(b) Recombinant DNA technology

- **A single stranded DNA or RNA ta**gged with a radioactive molecule is called probe.
- In this method, a probe is allowed to hybridise to its complementary DNA in a clone of cells.
- The cells are then detected by autoradiography.
- The cell with **mutated gene** will not be observed on the photographic film because the probe was not complementary to the mutated gene.

(c) Enzyme linked immuno-sorbent assay (ELISA)

- It is based on the principle of antigen-antibody interaction.
- Either the presence of **antigens** (proteins, glycoprotein, etc.) or **the antibodies** produced against the pathogen are detected by the ELISA, to confirm the disease.
- Eg: HIV -AIDS

11. ***Transgenic Animals 2m/3m***

- Animals whose DNA is manipulated to **possess and express** an extra **(foreign)** gene are known as transgenic animals.
- Ex: Transgenic rats, rabbits, pigs, sheep and cows.

Need for developing transgenic animals:

(a) Study of normal physiology and development

- They are used to study a specific gene function, **gene regulation**, and its effect on the normal **functions and** development of the body.
- For example, study of complex growth factors –" insulin-like growth factor".

(b) Study of disease causing genes

- Create a transgenic animal by introducing a disease causing gene.
- Study how the **genes develops a disease and** possible treatment for it
- Eg: study of **cancer**, cystic fibrosis, **rheumatoid arthritis and Alzheimer's disease genes** .

(c) Biological products . 1m

- Useful biological products can be produced by introducing into transgenic animals, a **portion of DNA (genes) which codes for a particular product**.
- For example: --production of α I-antitrypsin to treat **emphysema**.

  -- In 1997, the first transgenic cow, Rosie produced human protein-enriched milk (2.4 g / L). The milk contained the human **alpha-lactalbumin** and was more nutritionally balanced for human babies than natural cow milk.

(d) Vaccine safety

- Transgenic mice are developed to test safety of vaccines before being used on humans. For example**, polio vaccine**.

(e) Chemical safety testing

- Transgenic animals are made to carry genes which make them more sensitive to the toxic substances than non-transgenic animals.
- Toxic substances effects are studied in less time by this way.

12. ***. Ethical Issues***

a) GMO's show **unpredictable results** when introduced into the ecosystem.
b) Gmos products may cause allergy/ side effects
c) GMOs may compete with native sps and eliminate them

GEAC (Genetic Engineering Approval Committee): 2m

set up by the Ministry of Environment and Forests

- It makes decision on validity of GM research
- Ensures the safety of releasing GM foods/crops for public sercices

Basmati rice patent : 2m

Patent: Exclusive royalty rights granted to a person/ organization for developing a novel product or process. Others cannot make use of this product without the permission of patented organisation.

- Basmati is unique for its aroma and flavor. Several varieties of basmati are cultivated in India.
- In 1997, an American company got patent rights for Basmati rice through the US Patent and Trademark Office, and was allowed to sell a 'new variety' in US and abroad.
- This new variety of Basmati was developed by crossing Indian Basmati with semi-dwarf variety of US.
- Angered public is questioning as to why certain companies are granted patents for products and technologies already known to Indian farmers/ indigenous people

13.

Biopiracy :

Biopiracy is defined as the use of bioresources by multinational companies and other organisations without proper authorization or compensatory payment from the concerned countries/ people.

a) Generally, **financially rich nations are poor** in biodiversity and traditional knowledge, while **developing and under-developed nations** are rich in

biodiversity and traditional knowledge
related to bioresources.

b) Traditional knowledge related to bioresources is exploited by developed Nations and the products manufactured with less expenditure are sold in developing countries to reep the benefits..

c) To check these problems, Indian Parliament has recently cleared the second amendment of the **Indian Patents** Bill, which takes such issues into consideration.

Questions

1. The illegal and unlawful development of biomaterials without payment to the inhabitants of their origin is called

a. Biopatent b. biopiracy c. biowar d. biotechnology

2. In ELISA, infection by the pathogen can be detected by the presence of

a. antigen b. antibody c. Both antigen and antibody d. DNA and RNA

3. Arrange in correct sequence the steps in synthesis of insulin by Eli Lilly company –

I. Extraction of chain A and B
II. Isolation of DNA sequences corresponding to chain A and B
III. Combining chain A and B by creating disulphide bonds.
IV. Introduction of the DNA sequence in plasmids of E coli.
V. Production of chain A and chain B in bioreactors separately.

a. I, II, III, IV, V b. II, IV, V, I , III c. I, IV, V ,II,III
d. V, III, I, II, IV

4. C- peptide of human insulin is-

a. a part of the mature insulin molecule
b. responsible for biological activity
c. removed during maturation of proinsulin to insulin
d. responsible for biological activity

5. Identify the vector used to transfer functional ADA cDNA to the lymphocytes

a. Micro injection b. Gene gun c. retrovirus d. bacteria

6. The organization which is involved in making decisions regarding validity of GM research and the safety of introducing GM crops for public services is-

a. Genetic Engineering Approval Committee
b. Genetic Engineering Assessment Committee
c. Genetic Engineering Assessment Council
d. Genetic Engineering Approval Council

Assertion and Reasoning Questions-

7. Assertion- Cellular defense mechanism in eukaryotes is RNAi.
   Reason – RNAi is silencing of specific m- RNA.

8. Assertion – Bt produces cry protein which is toxic to insect larvae.
   Reason – Bt is species specific.

9. Assertion – Patents are granted by the government to an inventor.
   Reason – Patents prevent others from commercial use of an invention.

10. Assertion- Conventional Insulin caused allergies.
    Reason – Earlier insulin was extracted from the pancreas of slaughtered cattle.

11. How does the insulin synthesized in the human body differ from the insulin produced by Eli Lilly Company? 2

12. Genetically modified plants are useful to us in many ways. Mention any 4 uses. 2

13. RNA i involves silencing of a specific mRNA due to a complementary dsRNA. What is the source of this complementary RNA? 2

14. Give reason - The Bt toxin does not kill the bacillus but kills the insect larvae. 2

15. Name some techniques of early diagnosis of diseases. 2

16. What is the cause for ADA deficiency? Explain briefly how it is treated? 3

17. Bt toxins are insect group specific. Explain giving examples. 3

18. List down the steps in development of pest resistant tobacco plants. 5

19. Case based question- 4

The gene therapy clinical trials underway in the U.S. are closely monitored by the Food and Drug Administration and the National Institutes of Health to ensure that patient safety issues are a top priority during research

.

Currently, the only way for you to receive gene therapy is to participate in a clinical trial. Clinical trials are research studies that help doctors determine whether a gene therapy approach is safe for people. They also help doctors understand the effects of gene therapy on the body. Your specific procedure will depend on the disease you have and the type of gene therapy being used.

The possibilities of gene therapy hold much promise. Clinical trials of gene therapy in people have shown some success in treating certain diseases. But several significant barriers stand in the way of gene therapy becoming a reliable form of treatment.

a. What is gene therapy?

b. What is ADA.?

c. .Gene therapy was successful in treatment of ADA deficiency.. Explain the steps in the treatment of ADA deficiency.

ANSWERS

1.b

2.c

3.b

4.c

5. c

6.a

7.a

8.b

9.a

10.a

11. Insulin produced in the human body is produced in the form of inactive proinsulin which has a C peptide(1) The insulin produced by Eli Lilly is in the active form and does not have C peptide(1)

12. GM crops are more tolerant to abiotic stress

-They have reduced reliance on chemical pesticides

-They helped to reduce post harvest losses

- They have increased efficiency of mineral usage preventing early exhaustion of fertility of soil.

-They have enhanced nutritional value of food

13. Source of the complementary RNA -infection by viruses having RNA genomes(1) / mobile genetic elements (transposons)(1)

14. Bt toxin protein exists as inactive protoxin in the bacillus.It is converted to an actve toxin due to alkaline pH of the gut. The toxin binds to the surface of the midgut epithelial cells and create pores that cause swelling and lysis and eventually cause death of the insect.

15. Recombinant DNA technology, PCR and ELISA.

PCR is used to detect HIV in suspected AIDS patients,It is used to detect mutations in genes in cancer patients. It is used to identify genetic disorders.

16. Deletion of the gene for ADA.

Treatment for ADA deficiency-

Bone marrow transplantation

Enzyme replacement therapy

Gene Therapy

17. Bt toxin is coded by the gene cry. Proteins encoded by cryIAc and CryIIAb control cotton bollworm. cryIAb controls corn borer.

18. Nematode specific genes are introduced into host plants using Agrobacterium as vector.

The introduction of DNA is such that it produced both sense and antisense RNA in the host. The two RNA's being complementary to each pother form a double stranded RNA (dsRNA).

This initiates RNAi ,silencing the specific m-RNA of the nematode. Hence the parasite cannot survive in the transgenic hoist.

19. a.Gene therapy refers to collection of methods that help in correction of a faulty gene.

b. ADA stands for Adenosine deaminase.
c.Lymphocytes from the blood of the patient are grown in a culture medium.
A functional ADA cDNA is introduced into the lymphocyte using a retroviral vector.
The lymphocytes are subsequently returned to the patient.

Chapter 11: ORGANISMS AND POPULATION

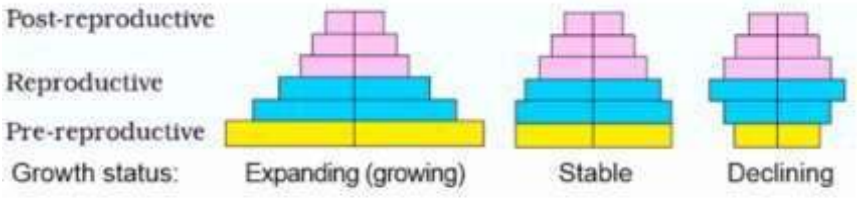
POPULATION

Population attributes

1. Birth rate: It is the number of births that has taken place in a population of 1000 individuals at a given area during a given period of time.
2. Death rate- It is the number of deaths that has taken place in a population of 1000 individuals at a given area during a given period of time.
3. **Sex Ratio**- It is the number of females per 1000 males
4. **Age pyramid**- Graphical representation of different age groups in a population gives the age pyramid.

Types:

(i) **Expanding –** Number of individuals are more in pre-reproductive age group
(ii) **Stable-** It has even distribution across all the 3 age groups
(iii) **Declining-** has more individuals in the post reproductive age group



Representation of age pyramids for human population

POPULATION DENSITY

Number of individuals of a particular species present per unit area at a given time.

a) *Ways of measuring population density:*

i) **Direct count:** Counting the total No of individuals of the species present in a particular habitat.
ii) **Percent cover/ biomass**: This method is adopted when we have to compare densities of small sized and large sized plants like parthenium and banyan tree.
iii) **Relative densities**: Used where total number is a difficult measure for a huge population. Eg:No. of fishes caught per trap .

iv) **Indirect method**: The pug marks or faecal pellets count is used to determine the density.

b) *Factors affecting population density:*

i) **Natality/ birth rate (B)**: No of births in a population during a given period

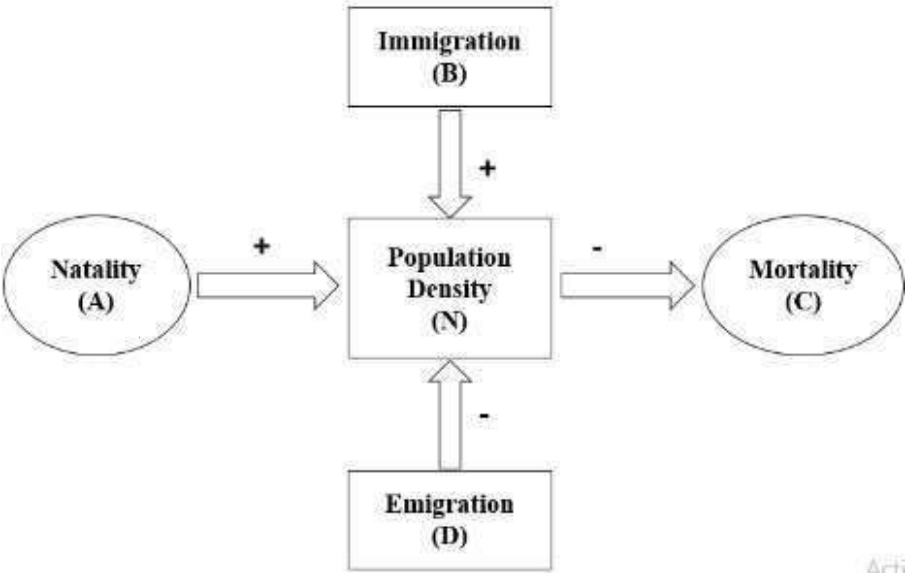
ii) **Mortality/ death rate (D)** : No of deaths in a population during a given period

iii) **Immigration(I)**: No of individuals of the same species that have come into the habitat from elsewhere during a given period. .

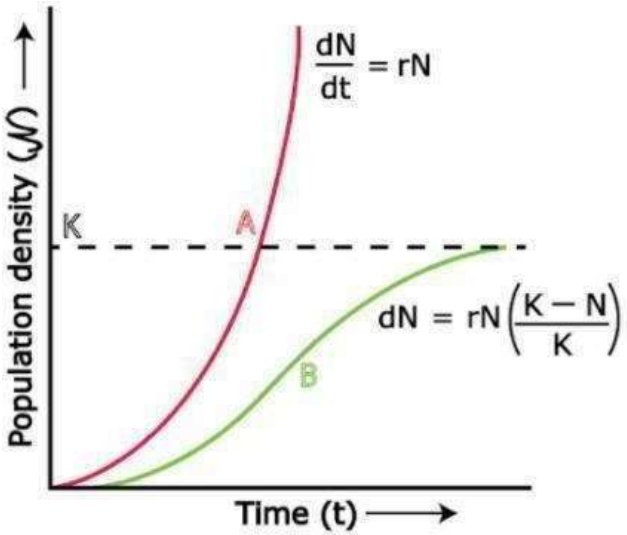
iv) **Emigration (E)** No of individuals of the same species that have left the habitat and gone elsewhere during a given period.

If **N** is the population density at time „**t**", then its density at time „**t+1**" is

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



POPULATION GROWTH MODELS/ CURVES:



Exponential Growth Curve/ J shaped curve

Obtained when the resources are unlimited and there is no competition for the resources.

If the population size is N , then increase or decrease in N at t (time period) is given by-
dN/ dt = rN (r is the "intrinsic rate of natural increase".)

Integral form :

$$N_t = N_0 e^{rt}$$

Where,
N_t − Population density at time t
N_0 − Population density at time 0
r − Intrinsic rate of natural increase
e − Base of natural logarithms (2.718)

Logistic growth curve/ sigmoid growth curve/ S shaped curve

Realistic growth curve - as resources are limited and there is competition among the individuals of the same species or with the different species.

- Comprises lag phase followed by acceleration , deceleration phases and finally asymptote at carrying capacity (K).
- Carrying capacity (K) - Maximum No of individuals of a species sustained by the available resources in a habitat.

It also called the Verhulst − Pearl Logistic growth curve and is expressed as

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

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

POPULATION INTERACTIONS: -

Name of interaction	Species A	Species B
Mutualism: Both species are benefitted (+)	+	+
Competition: Both species are harmed (-)	-	-
Predation: One (predator) is benefitted. Other (prey) is harmed	+	-
Parasitism: One (parasite) is benefitted. Other (host) is harmed	+	-
Commensalism: One is benefitted. Other is unaffected (0)	+	0
Amensalism: One is harmed. Other is unaffected	-	0

PREDATION

It is an Interspecific Interaction where predator is benefitted and the prey is harmed.
Ex: Deer and lion; cactus and moth.

Importance of predators

- They act as conduits of energy transfer.
- Control Prey population – Eg :- Prickly pear cactus controlled by introducing a moth that feeds on cactus.
- Maintain species diversity by reducing intensity of competition among competing prey. Eg Starfish-**Pisaster**

Defence mechanisms of prey to escape from predators

- **Camouflage**.
- **Distasteful** prey to its predator Eg Monarch butterfly to birds
- Presence of **thorns and spines- Eg** Acacia and cactus
- Calotropis produces **poisonous cardiac glycosides** to protect itself from cattle and goats

COMPETITION

It is a process in which the fitness of one species (r value) is significantly lower in the presence of another species.

- Competition occurs between closely related or unrelated species competing for the same resources which are limiting. Eg: **Flamingoes** and **fishes** present in South American lakes, compete for the same food i.e. Zooplanktons
- Competion can occur when resources are not limiting also. e.g : **Abington tortoise** became extinct within a decade, after **goats** were introduced on the island, due to greater browsing efficiency of goats.

Gause's competition exclusion principle

It states that two closely related species **competing for the same resources**, cannot co-exist indefinitely and the competitively **inferior will be eliminated** eventually.

e.g : Eg Barnacles (**Balanus**) dominates and eliminates smaller Barnacles(**cathamalus**).

Resource partitioning :It is the division of limited resources to avoid competition. Eg: 5 Different species of Warblers can coexist on a tree due to differences in foraging patterns.

PARASITISM

It is the interaction where parasite depends on the host for food and shelter and the host is harmed.

Ectoparasites (Live outside the host's body): Head lice on humans, ticks on dogs, Copepods on marine fish and cuscuta on hedge plants . Cuscuta lacks chlorophyll and leaves, so derives nutrition from host plant

Endoparasites(Live inside the host's body): Ascaris in human intestine; Wuchereria in the lymph vessels of human; Plasmodium in the liver and RBC of human: Liverfluke in the liver of human.

Adaptations of parasites

- Loss of unnecessary sense organs
- Presence of adhesive organs like hooks and suckers to cling to the host
- Loss of digestive system as they derive nutrients from host
- High Reproductive capacity.
- Complex life cycles involving more than one host.

Eg. Human liverfluke has two intermediary hosts- snail and fish; Plasmodium has human and female anophelus mosquito as hosts

Brood parasitism

Koel/ Cuckoo, a parasitic bird lays its eggs in the nest of its host-crow. The host takes care of them until they hatch

Koel eggs resemble crows eggs in size and crows eggs in size and colour. Therefore the crow fails to detect them as foreign eggs and throw them out of the nest

COMMENSALISM

Interaction between two species, where one is benefited while the other is neither benefited nor harmed.

Examples

- Clown fish living in the sea anemone tentacles
- Orchid growing as an epiphyte on the mango tree

- Egrets and cattle
- Barnacles growing on the back of a whale

MUTUALISM:

Interaction between 2 species where both are benefited.

Examples: **Lichen**s, **Mycorrhiza, Fig inflorescene and wasps**:

Sexual deceit by Mediterranean orchid (ophrys)

- Ophrys employs sexual deceit mechanism to get pollinated by Bumble bee
- One of the petals resemble **female bee** in colour, size and markings.
- Male bee, thinking it as a female bee and **psuedocopulates** with the flower leading to pollination

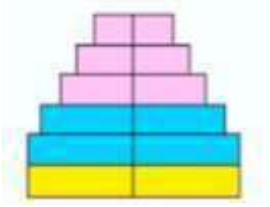
QUESTION BANK

Multiple Choice Questions:

1. Important attributes belonging to a population, but not to an individual are:
i) Birth rate and death rate (ii) Male and female (iii) Birth and death (iv) Sex ratio

Select the correct option from the given options.
(a) i only (b) ii only (c) (ii) and (iii) (d) (i) and (iv)

2 The status of the human population reflected in the human age pyramid given below is:



(a) declining population (b) stable population (c) expanding population (d) extinct population

3. A tight one-to-one relationship between many species of fig tree and certain wasps is an example of
(a) commensalism (b) parasitism (c) amensalism (d) mutualism

4. Interaction between clown fish living among the stinging tentacles of sea anemone is an example of
(a) amensalism(b) mutualism (c) parasitism(d) commensalism

5. Many copedods live on the body surface of marine fish. This is an example of
(a) commensalism (b) parasitism (c) amensalism (a) mutualism

6. Examples that show commensalism are
(i) An orchid growing on a mango tree (ii) Cuckoo bird and crow
(iii) Cuscuta growing on Nerium plant (iv) Barnacles growing on a whale

(a) (i) and (ii) (b) (i) and (iv) (c) (ii) and (iii) (d) (ii) and (iv)

7. Identifiy the option that does not exhibit a parasitic relationship.
(a) Head lice in humans (b) Cuscuta on a mango tree (c) Female Anopheles (d) Ticks on dogs

8. Exponential growth in plants can be expressed as:
(a) $L_t = L_0 + rt$ (b) $W_1 = W_0 e^{rt}$ (c) $W_1 = W_0 e^{rt}$ (d) $W_1 = W_0 + e^{rt}$

9, In asymptote state, population is:
(a) Increasing (b) Decreasing (c) Stabilized (d) Changing

10. The two intermediate hosts which the human liver fluke depends on to complete its parasitic mode of life cycle so as to facilitate its parasitisation of its primary host are:
(a) Snail and mosquito (b) Fish and human being (c) Snail and fish (d) Mosquito and fish

Assertion and Reason Questions

Answer these questions by selecting the appropriate option given below:

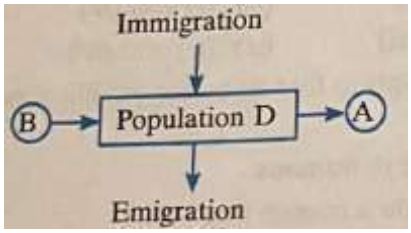
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true and reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is False but reason is true.

1. **Assertion**: Darwin showed how even a slow-growing animal like an elephant could reach enormous numbers.
Reason: When resources in the habitat are unlimited, each species has the ability to realise its innate potential fully.
2. **Assertion**: The Mediterranean Orchid, uses sexual deceit to get pollinated by a species of bee.
Reason: The female changes its colour depending on the temperature of that area.
3. **Assertion**: Cattle egret and grazing cattle in close association is a classic example of commensalism.
Reason: As grazing catle move through the field, they stir up and flush out the insects from the vegetation that otherwise might be difficult for egrets to find and catch.
4. **Assertion**: The Monarch butterfly is highly distasteful to the predators.
Reason: The butterfly has a very rough kin, which is not palatable.
5. **Assertion**: Cattle and goat are not seen browsing on Calotropis growing in abandoned fields.
Reason: Cattle and goats avoid grazing on Calotropis, because of the offensive smell of its flowers.

Very Short Answer Type Questions(2 marks)

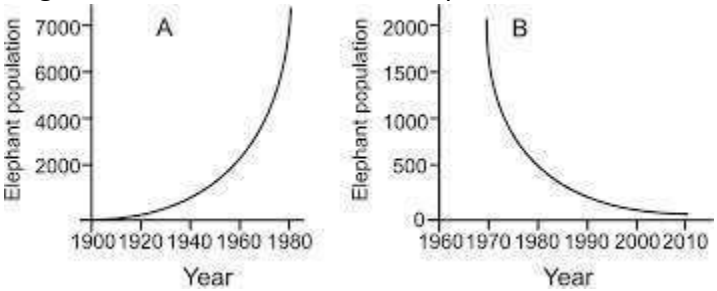
1. List and explain any two factors that lead to a decrease in the population density of an area. 2 Cattle and goats do not browse the Calotropis plant. Justify the statement giving reasons.
3. Abingdon tortoise in Galapagos islands became extinct within a decade on introduction of goats in the island. Explain giving reason.
4. 'Some species of insects and frogs have evolved specific features that help them from being detected"- Justify with examples
5. Write the best method to measure the population density of a single banyan tree in comparison to 20 Parthenium weeds in a forest by an ecologist. Explain and justify your answer.

6.



Observe the schematic representation given above and answer the following questions:
(a) Identify A and B
(b) Calculate the growth rate of bacteria in a curd sample, where 1 million bacteria increased to two million, within a period of one hour.

7. The graphs given below, A and B, represent populations of elephants in two different National Parks(a hypothetical situation) at different times. Study the graphs and comment upon the pattern of growth observed. Mention the possible reason for such patterns seen in nature.



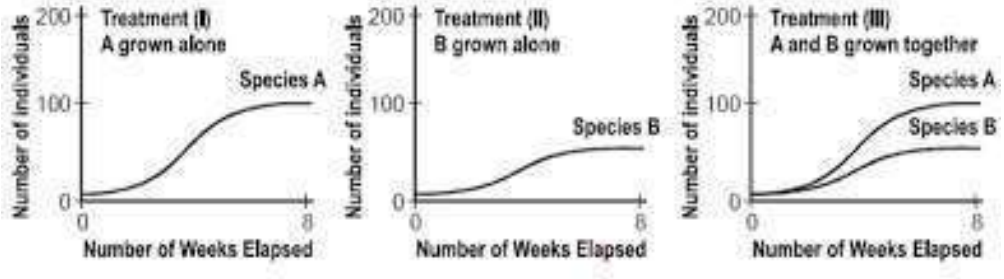
8. Why are predators considered to be 'prudent in nature?
9. (a) Write the observations made at the end of Connell's field experiment on barnacles on the rocky sea coasts of Scotland.

(b) Name any two categories of organisms that in general are adversely affected by competition.

10. The histogram given below representing the data for annual shark harvest in the great barrier reet/ coral reef located on the east coast of Queensland, Australia. Study the histogram and answer the questions that follow.
(a) Write your interpretation of the data given.
(b) Write the impact on the biodiversity of the area that you can interpret on the basis of given data.

11. (a) When prickly pear cactus was introduced into Australia in 1920s, it caused havoc and ecosystem instability by achieving very high population densities. Explain the reason for its rapid spread into millions of hectares of rangeland.
(b) State the importance of 'Prey-Predator' relationship in a habitat.

12. The figures given below show the results of a lab experiment in which two microbial species A and B belonging to same genus were grown in three petri dishes having same culture medium. In Petri dish-1, Species-A was grown alone for 8 weeks. In Petri dish-lI, Species-B was grown alone for 8 weeks. In Petri dish-III, both the species were grown together with the same number as Petri dish-I and Petri dish-ll for 8 weeks.



What conclusion will you draw from the graphs in terms of impact of interaction on growth? Explain, giving reason.

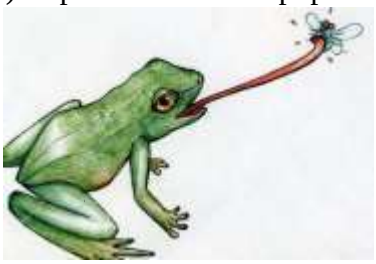
13. Explain the pollination mechanism involved in co-evolution of the two species, namely Ophrys (orchid) and its insect pollinator bees (and bumble bees).
14. Describe the two basic processes, which comtribute to an increase in population density of an area.
15. Explain commensalism with the help of an example from the animal world.
16. (a) How will you measure the population density of fish in a lake?
(b) In a pond, there are 100 frogs. 20 more were born in a year. Calculate the birth rate of this population.
17. Draw a 'stable' human age pyramid. Comment on the population growth rate that is depicted by it.
18. What is 'carrying capacity of a species in a habitat? Why is logistic growth model considered more realistic?
19. Substantiate with the help of one example that in an ecosystem mutualists (i) tend to co-evolve and (ii) are also one of the major causes of biodiversity loss.

20. What is mutualism? Mention any two examples, where the organisms involved are commercially exploited in agriculture.
21. Describe the mutual relationship between fig tree and wasp and comment on the phenomenon that operates in their relationship.
22. Differentiate between commensalism and mutualism by taking one example each from plants only.

Short Answer Type Questions (3marks)

1. (a) How does the Mediterranean orchid 'Ophyrs' ensure its pollination by bees without offering any floral reward?

(b) Explain the kind of population interaction observed in the following picture



2. State the various defence mechanisms the following organisms have evolved with, to protect themselves from predators:

(a) Frogs

(b) Monarch butterfly

(c) Plants (Morphological and chemical defence against herbivores)

3. (a) What does the equation dN/dt = rN express in terms of population growth?

(b) Write the significane of „r" in a population survey.

4. "The population of a metro city experiences fluctuations in its population density over a period of time"

(a) When does the population in a metro city tend to increase?

(b) When does the population in metro city tend to decline?

(c) If 'N' is the population density at the time „t" write the population density at the time „t + 1". 5.(a) Write how parasites have evolved with adaptations to co-exist with their hosts in an ecosystem.

(b) Parasites are host-specific and tend to co-evolve. How would the parasite respond if the host evolves a certain mechanism to reject the parasite?

6. Explain the differences between commensalism and mutualism types of interactions, with the help of a suitable example of each.

7. Study the table showing the population interaction between species 'Z' and 'Y', respectively. Assign the appropriate +'/'-' signs for A, 'B', 'D', 'E' and respective interactions for 'C' and F.

Species 'Z'	Species 'Y'	Name of Interaction
A	B	Mutualism
-	-	C
D	E	Parasitism
+	O	F

8. Differentiate between an 'expanding age pyramid and a 'stable age pyramid". Substantiate your answer with diagrams.

9. Explain brood parasitism with the help of a suitable example

10. Mention the special adaptations evolved in parasites and why?

11. State Gause's 'Competitive Exclusion Principle'. How have the recent studies modified this principle?

12. Explain with the help of an example each, any three ways the ecologists use to measure population density of different organisms rather than by calculating their absolute number.

13. It is observed that plant-animal interactions often involve co-evolution. Explain with the help of a suitable example.

14. When do you describe the relationship between two organisms as mutualistic, competitive and parasitic? Give one example of each type.

15 Highlight the differences and a similarity between the following population interactions: Competition, predation and commensalism.

16. Explain with the help of two examples, how certain plants have evolved morphological and

chemical defenses against primary consumers such as cows and goats.

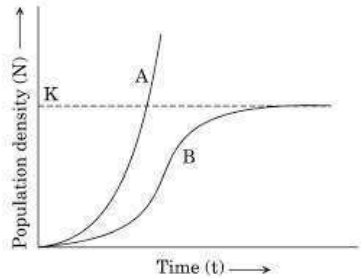
17. Name and explain the type of interaction that exists in mycorrhizae and between cattle egret and cattle.
18. Explain the defence mechanisms evolved in preys to avoid overpopulation of their predators.
19. (a) Write the importance of measuring the size of a population in a habitat or an ecosystem.
(b) Explain with the help of an example how the percentage cover is a more meaningful measure of population size than mere numbers.
20. Substantiate with the help of one example that in an ecosystem, mutualists (i) tend to co-evolve and
(ii) are also one of the major causes of biodiversity loss.

Case Study Based Questions

1 Predators are not always successful in their attacks. In fact the hit-rate usually is quite low when they are solitary predators.The hit-rate is higher when they hunt in packs like lions, but then they have to share the loot amongst the pack. They are dependent on the prey for their supply of energy, they have to conserve this, so only if there is a fair chance of a hit will they spend their energy on an attack. Apart from that, they cannot afford to be injured. Especially when they are solitary hunters, an injury will decrease or nullify their chance of success, probably leading to death.

a) How do predators control the species diversity in an ecosystem?
b) Name the predator that was used to control the prickly pear cactus in Australia
c) What are predators prudent in nature?
d) Name any two defences employed by the prey to protect themselves from the predator.

2. A population of 100 spotted deer was living without any carnivores in an enclosure of a few hectares of rich tropical forest land. Deer census was taken after a few years. Now study the graph given below and answer the questions that follow

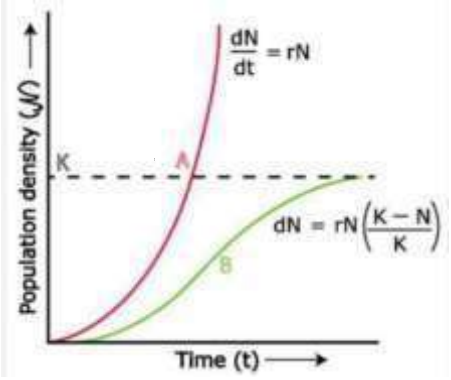


(a) Identify the curve that represents the deer population.
(b) Is it a realistic one? Justify.
(c) Write the equation for the
(c) What would have happened if the carnivores were also present in the ecosystem?

3. There is no natural habitat on earth, which is occupied by a single species. In nature, plants, animals and microbes do not and cannot live in isolation. Even in minimal communities many interactive linkages exist although all may not be readily apparent. Interspecific interactions arise from the interaction of populations of two different species. They could be beneficial, neutral or detrimental depending on the impact on the interacting species
a) An orchid plant is growing on the branch of mango tree- Name the interaction between the following organisms?
b) What is the ecological principle behind the biological control method of managing with pest insects?
c) Plants are capable of preparing their own food , yet they are dependent on other organisms for their survival . Justify
d) It is generally believed that competition occurs only when closely related species compete for the same resources that are limiting. Give two examples to show that the above statement is not always true

4. Populations evolve to maximise their reproductive fitness in the habitat in which they live. Ecologists suggest, the life history of organisms have evolved in relation to the constraints imposed by the biotic and abiotic components of the habitat in which they live. This gets reflected in the population growth pattern of all organisms including humans.

Study the population growth curves shown in the given graph and answer the questions that follow.



a) Identify growth curves A and B
b) Mention what does the dotted line in the graph indicate and state its importance also
c) Which one of the two curves is relevant in present days with respect to human population in our country and why?
d) Growth curve B shows a different pattern from that of growth curve A. Justify giving one reason

5. In many species of fig trees there is a tight one to one relationship with the pollinator species of wasp. It means that a given species can be pollinated only by its partner wasp species and no other species. The wasp pollinates the fig inflorescence while looking for suitable egg laying sites. In return for the favour of pollination the fig offers the wasp some of its developing seeds as its food for the developing wasp larvae.

i) The interaction between fig trees and wasp is an example of
a) Mutualism b) Competition c)ammensalism d)Parasitism

ii) All the given interactions are similar to the interaction between the fig and wasp except
a)Plant and animal relation for pollination
b)association between algae and fungi in
lichens c)Association of egret anjd grazing
cattle
d) Association between fungi and roots of higher plants in mycorrhiza

iii) In which of the following interactions are both the partners adversely affected
a) Parasitism b) Ammensalism c) Mutualism d) Competition

iv) Name the mechanism employed by Ophrys to get its flowers pollinated
a) Mutualism b) Commensalism c) Competition d) Predation

Chapter 12: ECOSYSTEM

An ecosystem is a functional unit of nature, where living organisms interact each other and with the physical environment.

Types of ecosystems

- Terrestrial ecosystem: Forest, grassland, desert etc.
- Aquatic ecosystem: Pond, lake, wetland, river & estuary.
- Man-made ecosystem: Crop fields and aquarium.

ECOSYSTEM – STRUCTURE & FUNCTION

*In an ecosystem, biotic and abiotic components interact with each other and function as a unit.

*Vertical distribution of different species occupying different levels is called stratification. E.g. in a forest, trees occupy top strata (layer), shrubs the second and herbs & grasses the bottom layers. (1m)

An Ecosystem consists of two components, BIOTIC and ABIOTIC.

BIOTIC COMPONENTS: Living components are the biotic components.

- Producers (Autotrophs)
- Consumers (Heterotrophs)
- Decomposers (Heterotrophs, reducers or microconsumers

Following are the aspects of ecosystem that help in functioning of different components of ecosystem as a unit.

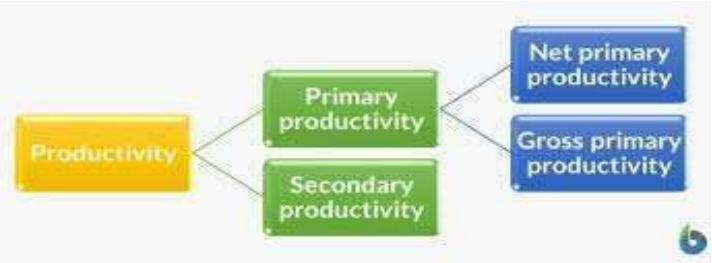
I. Productivity II. Decomposition III. Energy flow IV. Nutrient cycling

I. Productivity

The amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis is called **primary production**. 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} .

Primary productivity depends on

* The plant species inhabiting a particular area
* Environmental factors
* Availability of nutrients
* Photosynthetic capacity of plants



Gross primary productivity: It is the rate of production of organic matter during photosynthesis.

Net primary productivity: NPP is the available biomass for the consumption to heterotrophs


NPP
Net Primary Productivity
GPP
Gross Primary Productivity
R
Respiration Losses

(3m)

Secondary productivity: It is the rate of formation of new organic matter by consumers

II. Decomposition

It is the breakdown of complex organic matter by decomposers into inorganic substances like carbon dioxide, water and nutrients. It is largely an oxygen-requiring process. Raw material for decomposition is **Detritus** (dead plant remains such as leaves, bark, flowers and dead remains of animals, including faecal matter).

Steps of decomposition

a. Fragmentation: It is the breakdown of detritus into smaller particles by detritivores (e.g. earthworm).

b. Leaching: By this process, water soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts.

c. Catabolism: Degradation of detritus into simpler inorganic substances by bacterial and fungal enzymes. Fragmentation, leaching and catabolism operate simultaneously on the detritus.

d. Humification: Accumulation of humus (dark amorphous substance) in soil. Humus is resistant to microbial action and so decomposes very slowly. Being colloidal in nature it serves as a reservoir of nutrients.

e. Mineralization: It is the release of inorganic nutrients due to the degradation of humus some microbes. (3m)

Factors influencing decomposition

- **Chemical composition of detritus**: Decomposition rate is slower if detritus is rich in lignin & chitin, and quicker, if detritus is rich in nitrogen and water-soluble substances like sugars.
- **Climatic factors like temperature and soil moisture**: Warm and moist environment favour decomposition whereas low temperature and anaerobiosis inhibit decomposition resulting in build-up of organic materials.

III. Energy flow

*Sun is the only source of energy for all ecosystems (except deep sea hydro-thermal ecosystem).

*Of the incident solar radiation less than 50% of it is **photosynthetically active radiation (PAR).**

*Plants capture only 2-10% of the PAR and this small amount of energy sustains the entire living world.

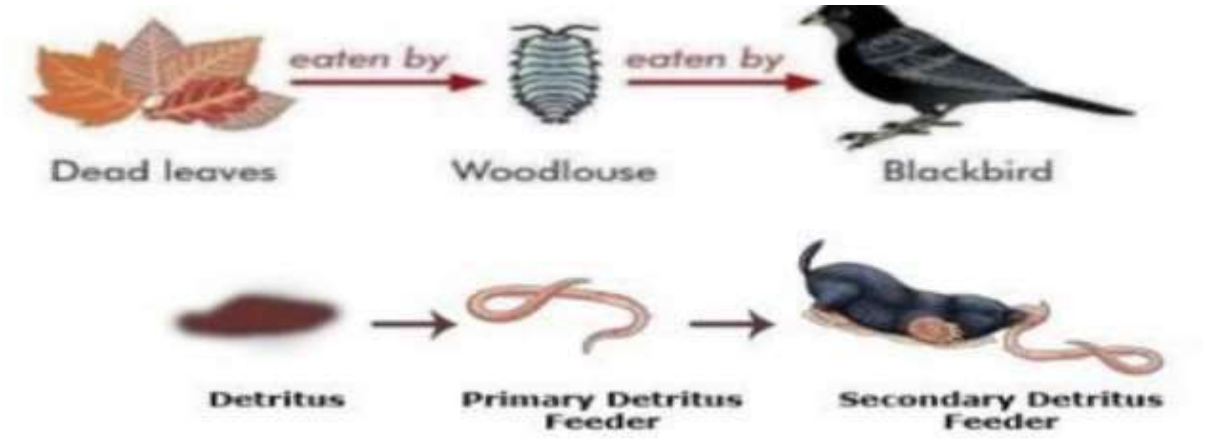
***Producers:** All organisms are dependent for their food on producers (green plants), either directly or indirectly. Primary producers in an aquatic ecosystem are phytoplankton, algae and higher plants.

***Consumers (heterotrophs):** These are all animals that depend on plants (directly or indirectly) for their food. They include:

- **Primary consumers (herbivores-** feed on plants). E.g. insects, birds and mammals in terrestrial ecosystem and molluscs in aquatic ecosystem.
- **Secondary consumers (primary carnivores**- feed on herbivores). E.g. frog, fox, man etc.
- **Tertiary consumers (secondary carnivores**- feed on primary carnivores).

A simple **grazing food chain (GFC)** is depicted below. In an aquatic ecosystem, GFC is the major conduit for energy flow.

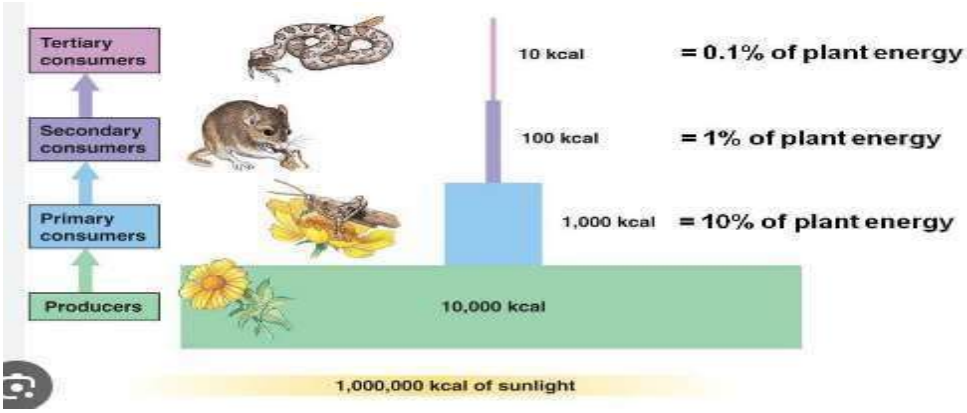
Detritus food chain (DFC) begins with dead organic matter. It is made up of **decomposers (saprotrophs**) which are heterotrophic organisms. E.g. fungi & bacteria. In a terrestrial ecosystem, a much larger fraction of energy flows through the DFC than through the GFC.



(2m)

- A specific place of organisms in the food chain is known as their **trophic level**.

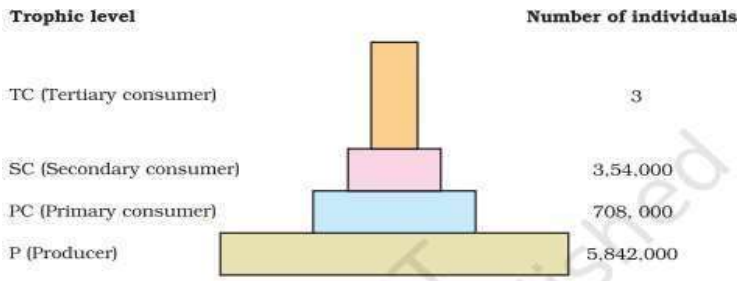
  Producers belong to the first trophic level, herbivores to the second and carnivores to the third.
- The amount of energy decreases at successive trophic levels.
- Standing crop is the mount of living matter present at a particular time in a tropic level or all the tropic levels of an ecosystem.
- The number of trophic levels in the grazing food chain is restricted as the transfer of energy follows 10 % law – only 10% of the energy is transferred to each trophic level from the lower trophic level.



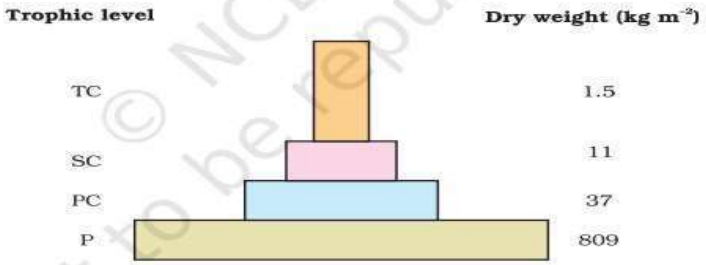
ECOLOGICAL PYRAMIDS **(3m)**

The representation of a food chain in the form of a pyramid is called ecological pyramid. The base of each pyramid represents the producers (first trophic level) while the apex represents tertiary or top-level consumer. Ecological pyramids are 3 types:

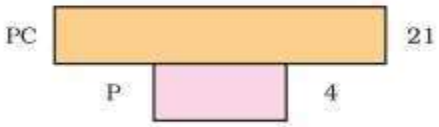
a) Pyramid of number: E.g. grassland ecosystem:



b) **Pyramid of biomass:** It shows a sharp decrease in biomass at higher trophic levels.

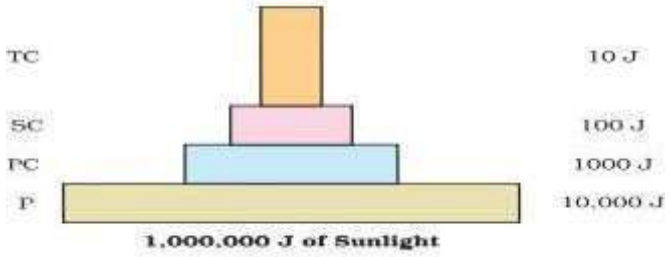


Inverted pyramid of biomass: Small standing crop of phytoplankton supports large standing crop of zooplankton.



(c) Inverted pyramid of biomass-small standing crop of phytoplankton supports large standing crop of zooplankton

c) ***Pyramid of energy:***



In most ecosystems, all the pyramids are upright, i.e., producers are more in number and biomass than the herbivores, and herbivores are more in number and biomass than the carnivores. Also energy at a lower trophic level is always more than at a higher level.

- ***Examples for inverted pyramids:***

- Insects feeding on a big tree
- Pyramid of biomass in sea is generally inverted because the biomass of fishes far exceeds that of phytoplankton.
- Pyramid of energy is always upright, because when energy flows from a trophic level to the next trophic level, some energy is always lost as heat at each step.

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. Each bar in the energy pyramid indicates the amount of energy present at each trophic level in a given time or annually per unit area.

Limitations of ecological pyramids:

- It does not take into account the same species belonging to two or more trophic levels.
- It assumes a simple food chain that almost never exists in nature; it does not accommodate a food web.
- Saprophytes are not included in ecological pyramids even though they play a vital role in the ecosystem.

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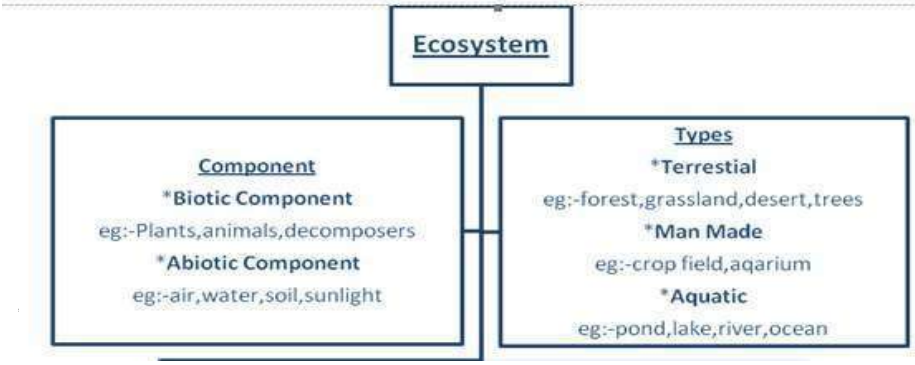
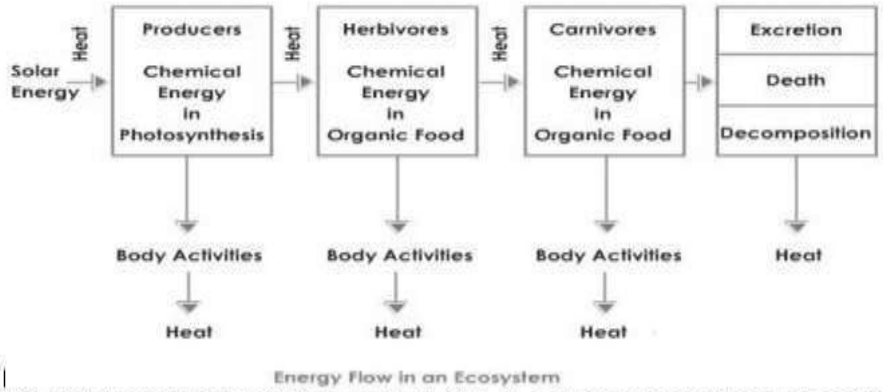
Concept map



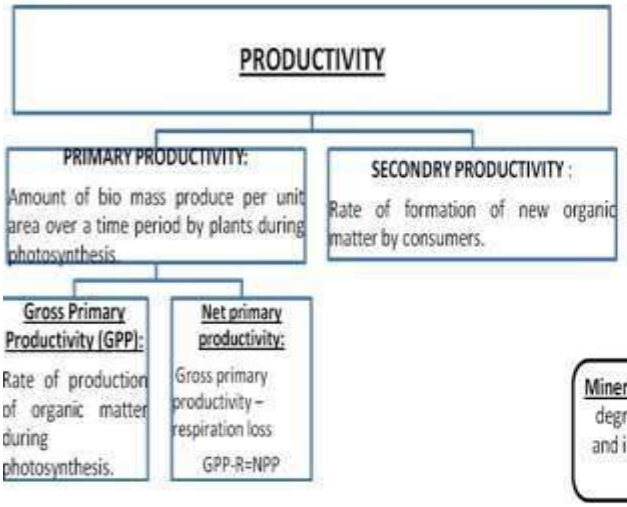
ENERGY FLOW THROUGH DIFFERENT TROPIC LEVELS



108-4

Energy Flow in an Ecosystem

Energy flow is governed by law of thermodynamics. In each trophic level there is loss of 10 % energy



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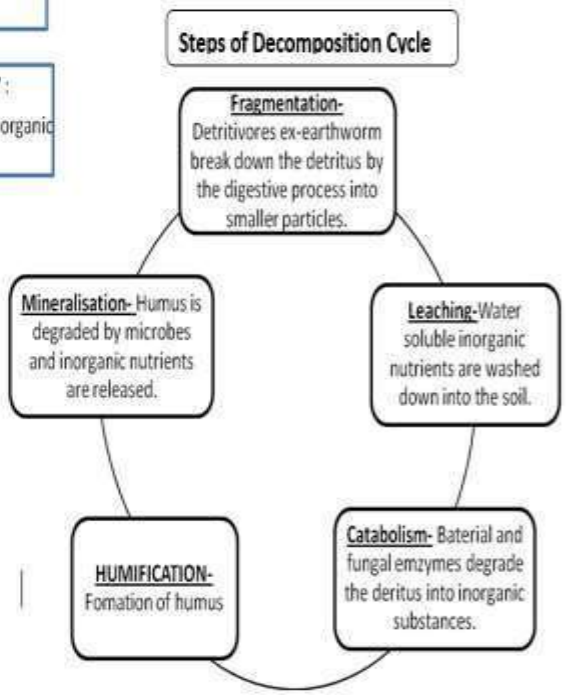
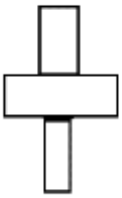


QUESTION BANK

ONE MARK QUESTIONS

1. The mass of living material at a trophic level at a particular time is called
   a) Standing rate b) Gross primary productivity
   c) Standing crop d) Net primary productivity
2. If we completely remove the decomposers from an ecosystem, their functioning will be adversely affected because
   a) Herbivores will not receive solar energy b) Energy flow will be blocked
   c) The rate of decomposition will be very high d) Mineral movement will be blocked



3. Given figure is one of the type of ecological pyramid. This type represents:
   a) Pyramid of number in a grassland b) Pyramid of biomass in a fellow land
   c) Pyramid of biomass in a lake d) Energy pyramid in a spring
4. If X is the amount of energy produced by the producers, which of the following is the correct amount of energy received by humans from the producers in a food web?
   a) Only 10% b). Either 10% or 1%
   c)Either 10%, 1% or 0.1% d). Humans are not part of a food web.
5. **Assertion**: The shorter food chains are advantageous than longer food chains in terms of energy.
   Reason: The main source of energy of biosphere is "SUN".
6. **Assertion**: The pyramid of biomass in a sea is generally inverted.
   Reason: The biomass of phytoplankton exceeds that of fishes.
7. **Assertion**: Removal of keystone species causes serious disruption in the functioning of the community.
   Reason: Key stone species are low in abundance (or biomass) than the dominant species.
8. **Assertion:** The energy utilised by an organism for growth is not transferred to the next trophic level.
   Reason: Growth causes an increase in biomass.
9. **Assertion:** Humus is organic in nature.
   Reason: Steps occurring before humification ensure the removal of most inorganic substances from the detritus.

TWO MARKS QUESTIONS

10. Why the rate of assimilation of energy at the herbivore level is called secondary productivity?
11. Cite an example of an inverted ecological pyramid. What kind of pyramid of energy would it have?
12. Why is the number of trophic levels in an ecosystem limited?
13. In the context of primary productivity, which ecosystem would be more productive? A natural old forest, a young forest, alpine meadow, a shallow polluted lake.

14. The Tundra desert's gross primary productivity (GPP) is 800 kilocalories/m2 and respiration losses are about 200 kilocalories.(a) What is the net primary productivity of the desert? Show calculations.(b) Why do deserts have the least NPP across most ecosystems?

THREE MARKS QUESTIONS

15. Discuss the role of healthy ecosystem services as a prerequisite for wide range of economic, environmental and aesthetic goods and services.
16. A farmer harvests his crop and expresses his harvest in three different ways:
    i) I have harvested 10 quintals of wheat.
    ii) I have harvested 10 quintals of wheat today in one acre of land.
    iii) I have harvested 10 quintals of wheat today in one acre of land, six months after sowing.

    Do the above statements mean one and the same thing? If your answer is "yes" give reason. And if your answer is "no" give the meaning of each expression.
17. What will happen to an ecosystem if
    a) All producers are removed?
    b) All organisms of herbivore level are eliminated?
    c) All top carnivore population if removed?
18. In the context of the transfer of energy in an ecosystem, what does "10kg of deer"s meat is equivalent to 1 kg of lion"s flesh" mean?

19. CASE STUDY BASED QUESTION

The consumers that feed on these herbivores are carnivores, or more correctly primary carnivores (though secondary consumers). Those animals that depend on the primary carnivores for food are labelled secondary carnivores. A simple grazing food chain (GFC) is depicted below:

Grass	Goat	Man
Producer	Primary consumer	Secondary consumer

The detritus food chain (DFC) begins with dead organic matter. It is made up of decomposers which are heterotrophic organisms, mainly fungi and bacteria. They meet their energy and nutrient requirements by degrading dead organic matter or detritus. These are also known as saprotrophs. Decomposers secrete digestive enzymes that breakdown dead and waste materials into simple, inorganic materials, which are subsequently absorbed by them. In an aquatic ecosystem, GFC is the major conduit for energy flow. As against this, in a terrestrial ecosystem, a much larger fraction of energy flows through the detritus food chain than through the GFC. Detritus food chain may be connected with the grazing food chain at some levels: some of the organisms of DFC are prey to the GFC animals, and in a natural ecosystem, some animals like cockroaches, crows, etc., are omnivores. These natural interconnection of food chains make it a food web. How would you classify human beings!

Que. 1).....is a beginning of Detritus food chain.

(a) Living organic matter (b) Producers (c) Dead organic matter (d) Consumers

Que. 2) The meaning of sapro word in the saprotrophs is …….

(a) To produce (b) To divide (c) To consume (d) To decompose

Que. 3) GFC is a ……..

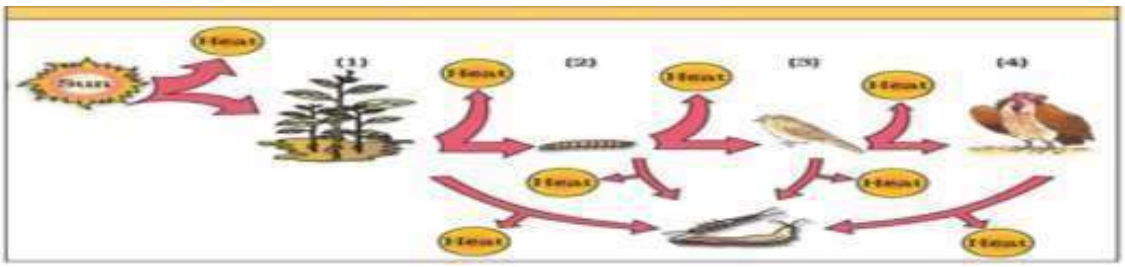
(a) Global food chain (b) Grazing food chain
(c) Global food consumers (d) Grazing form chain
Que 4) How grazing food chain is different from Detritus food chain.

20. Interaction of biotic and abiotic components result in a physical structure that is characteristic for each type of ecosystem. Identification and enumeration of plant and animal species of an ecosystem gives its species composition. 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 the ecosystem are seen to function as a unit when you consider the following aspects: (i) Productivity; (ii) Decomposition; (iii) Energy flow; and (iv) Nutrient cycling. To understand the ethos of an aquatic ecosystem let us take a small pond as an example. This is fairly a self-sustainable unit and rather simple example that explain even the complex interactions that exist in an aquatic ecosystem. A pond is a shallow water body in which all the above mentioned four basic components of an ecosystem are well exhibited.
The abiotic component is the water with all the dissolved inorganic and organic substances and the rich soil deposit at the bottom of the pond. The solar input, the cycle of temperature, day-length and other climatic conditions regulate the rate of function of the entire pond. The autotrophic components include the phytoplankton, some algae and the floating, submerged and marginal plants found at the edges.
The consumers are represented by the zooplankton, the free swimming and bottom dwelling forms. The decomposers are the fungi, bacteria and flagellates especially abundant in the bottom of the pond. This system performs all the functions of any ecosystem and of the biosphere as a whole, i.e., conversion of inorganic into organic material with the help of the radiant energy of the sun by the autotrophs; consumption of the autotrophs by heterotrophs; decomposition and mineralisation of the dead matter to release them back for reuse by the autotrophs, these event are repeated over and over again. There is unidirectional movement of energy towards the higher trophic levels and its dissipation and loss as heat to the environment.
Que. 1) Autotrophs consumption in the ecosystem occurs
by …….
(a) Decomposers (b) Autotrophs (c) Heterotrophs (d) Herbivores
Que. 2).....are represented as a consumer.
(a) Zooplanktons (b) Fungi (c) Flagellated (d) Algae
Que. 4) Write definition of „Stratification" and give one example of it.
Que. 5) Which decomposers are important to function ecosystem?

FIVE MARKS QUESTION

21. a)Name two examples of man-made ecosystems.
b) Write their salient features which distinguish them from natural ecosystems.
c) What is the importance of the ecosystem?

22. a) Fill up for the tropic levels, labelled 1,2,3,4 in the given figure.



b) Mention any two reasons, why the primary productivity varies in different types of ecosystems.

23. a) Describe how do oxygen and chemical composition of detritus control decomposition.
b) Why earthworm is considered a farmer‟s friend? Explain humification and mineralisation occurring in a decomposition cycle

ANSWERS

1. (c) Standing crop

2. d) Mineral movement will be blocked
3. c) Pyramid of biomass in lake
4. c) Either 10%, 1% or 0.1%
5. (b) Both assertion and reason are true and reason is not the correct explanation of the assertion.
6. (c) Assertion is true but reason is false
7. (b) Both assertion and reason are true and reason is not the correct explanation of the assertion
8. (d)
9. (a)

TWO MARKS QUESTIONS

10. The biomass available to the consumer for consumption is a resultant of the primary productivity from plants.
11. Example-Sea ,large tree Pyramid of energy- Upright
12. There are not more than 4-5 levels since the energy flow declines as we approach higher levels as only 10% of energy is passed from one to the next progressive trophic level. The remaining energy is lost during respiration and in other crucial activities to the sustenance of life. In case there are more levels, the remaining energy will be limited to an extent that it furthermore would not be able to sustain any trophic level through energy flow. Hence levels are limited.
13. An ecosystem which possesses more producers will be more productive. Young forests grow quicker than older and mature forests and hence are more productive in terms of primary productivity. The alpine meadows and shallow polluted lakes will be less productive since they have less number of producers and more dead matter.
14. (a) 0.5 marks for the correct formula and 0.5 marks for the correct answer:
    NPP = GPP - R
    NPP = 800 - 200 = 600 kilocalories/m2
    (b) The low water availability and other conditions are not

unfavourable for rapid photosynthesis.

THREE MARKS QUESTIONS

15. Health ecosystem is the base for a wide range of economic, environmental and aesthetic goods and services. The products of ecosystem processes are named as ecosystem services, as they are of help to the organisms living within an ecosystem. Health plants in the ecosystem purifies air and water. The plants in

the ecosystem release a lot of oxygen during photosynthesis and, thus, help in replenishing the gas consumed in respiration and combustion. It also mitigates droughts and floods as well as cycles nutrients. A number of pollinators present

in forests help in reproduction of various crop plants, fruit plants and others. Healthy ecosystem generates fertile soil and provides wildlife habitat. Maintenance of biodiversity is also an important aspect of health ecosystem. It also provides aesthetic, cultural and spiritual values.

16. i) The statement does not reveal land area and duration.
ii) This statement reveals about quantity and lane area but does not reflect the time.
iii) This statement is complete in all aspect and helpful in calculating the primary productivity of the crop.

17. (a) No biomass (food) remain available for higher tropic level. Thus decrease in primary productivity occurs.
(b) Carnivore population will decline due to shortage of food. However increase in primary productivity.
(c) Increase in herbivore population that led to overgrazing and desertification.

18. Only 10% of energy is passed from one to a higher trophic level. Hence if a lion hunts and eats a deer, 10kg of deer‟s meat will make up for 1kg of lion‟s meat.

19. CASE BASED QUESTION

Que. 1) (c) Dead organic matter
Que. 2) (d) To decompose
Que. 3) (d) Grazing form chain
Que. 4) A grazing food chain is a food chain that starts with green plants as the main source of energy. A detritus food chain is a food chain that starts with the dead remains of organisms as a main source of energy.

20. Que. 1) (c) Heterotrophs
Que. 2) (a) Zooplanktons
Que. 3) Answer: Different levels which are occupied by vertical distribution of different species, this is called as Stratification. In the forest, trees occupy top layer and grasses occupy bottom layer. This is an example of Stratification.
Que. 4) Answer: Decomposers such as flagellated, bacteria and fungi are import to function ecosystem.

21. a) Examples of man-made ecosystems are – farmhouse and aquarium.
b) In these ecosystems, maintenance of biotic and abiotic components occurs through measures such as – feeding, cleaning, adequate oxygen supply to fishes in aquarium and irrigation in crop or farmhouse. In a natural ecosystem, abiotic and biotic components are maintained naturally such as – the nutrient cycle, prevention of soil erosion, self- sustainability, reduction of threat due to global warming etc.
c) Ecosystem maintains a balance in the environment. It provides fresh air to breathe and sequesters carbon to regulate the climate. It cycles the nutrients through various biogeochemical cycles so that we have access to clean drinking water without any costly methods. It provides food and shelter to a number of living organisms. It also provides raw materials for different industrial and domestic purposes.

22.a) Producers (First Trophic level – Plants) 2 – Primary Consumers (Second Trophic level – Herbivores) 3 – Secondary Consumers (Third Trophic level – Carnivores) 4 – Tertiary Consumers (Fourth Trophic level – Top Carnivores)
b) i. It depends upon plant species (producers) of a given ecosystem and their photosynthetic capacity.
ii. It is dependent on various environmental factors, availability of nutrients.

23. a) Effect of oxygen The decomposition of detritus is largely an oxygen requiring process. Most of the decomposers (bacteria and fungi) are aerobic organisms. They require oxygen for their cellular activities while acting on dead organic matter.
Effect of chemical composition Decomposition rate is slower, if detritus is rich in lignin and chitin. It is quicker if detritus is rich in nitrogen and water soluble substances like sugars.
b) Earthworms are farmer‟s friend because these help in fragmentation of detritus and loosening of the soil. Both these processes are helpful for the decomposition of dead organic matter at a faster rate into inorganic substances like carbon dioxide, water and nutrients. These can be used by crop plants for their growth.
Humification and mineralisation occurring during decomposition cycle are as follows
Humification It is the process of accumulation of dark coloured amorphous substance called humus. Humus is highly resistant to microbial action and undergoes decomposition at very slow rate.
Mineralisation It is the process by which humus is degraded by some microbes to release inorganic substances.

Chapter 13: BIODIVERSITY AND ITS CONSERVATION

Ethical

Species area Relationship

log S= log C + Z log A

Latitudinal gradient

Least in poles, high at equator and

Narrowly Utilitarian

-Food, firewood, bio active substance, medicines

Reason for

patter

Species diversity

Broadly utilitarian

Ecosystem services

BIODIVERSITY

variety among living organisms

Types of diversity

Genetic diversity

Ecological diversity

Causes of biodiversity loss

1. Habitat loss
2. Habitat fragmentation
3. Overexploitation
4. Urbanisation
5. Co extinction
6. invasion of alien species
7. Pollution

1) In situ conservation

Within natural habitat

2) Ex situ conservation

Outside natural habitat

The Earth Summit

At Rio de jenario in 1992

The World summit

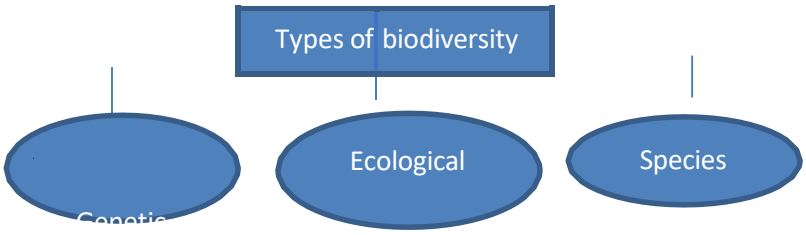
At Johannesburg in 2002

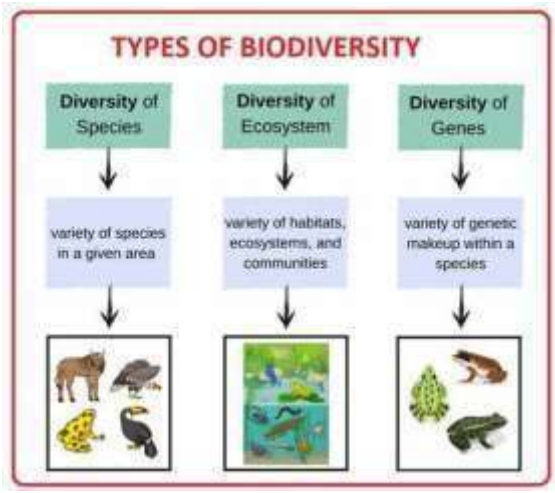
Ramsar Convention/ Wetland convention

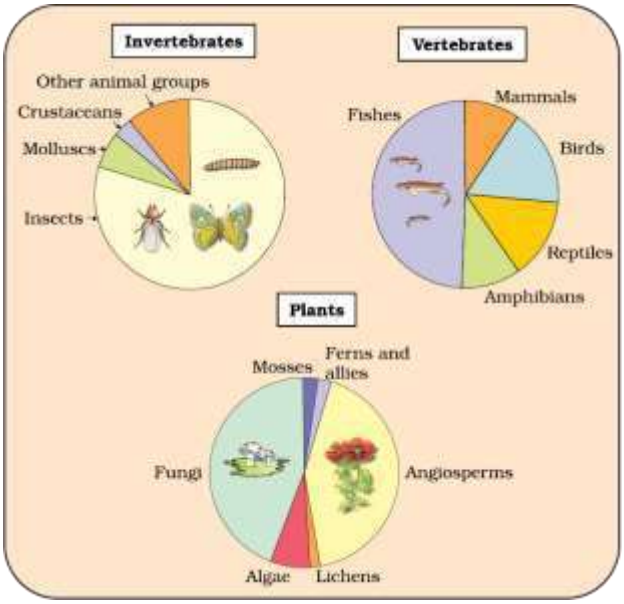
At Ramsar , Iran on 02/02/1971

Came into force on

Biodiversity: refers to the totality of genes, species, and ecosystems of a region.







Pattern of Biodiversity:

- **Latitudinal gradients**:

Species diversity decreases as we move away from the equator towards the pole.
Tropic harbors more species than temperate and pole

Reason-

Unlike temperate tropical latitudes have remained relatively undisturbed for millions of years.
Tropical environments. Unlike temperate ones, are less seasonal, relatively more constant and predictable, promotes niche specialization and lead to greater species diversity.
more solar energy available in the tropics, leads to higher productivity.

- ***Species area relationship:***

ALEXANDER VON HUMBOLDT observed within a region species richness increased with increasing area but only up to a limit.
The relation between species richness and area turns out to be a rectangular hyperbola.
On a logarithmic scale the relationship is a straight line describe by the equation LogS = logC +Z log A Where S= species richness, A = Area, Z = slope of the line (regression coefficient), C = Y-intercept. Regardless of the taxonomic group or region the slope of the regression line are

amazingly similar. However, for a very large area like the entire continent the slope of line is steeper.

Since the origin and diversification of life on earth there were five episodes of mass extinction of species. The sixth mass Extinctions in progress now. The Sixth Extinction is different from the previous five extinctions because the current extinction rate is 100 to 1000 times faster due to this one is anthropogenic influence

David Tillman's long-term field experiment finds that:

1. Plots with more species showed less year to year variation in biomass
2. Increased diversity contributed to higher productivity.

The rivet popper hypothesis: In an airplane (ecosystem) all parts are joined together by thousands of rivets (species). If every passenger starts popping a rivet (species extinct), it may affect flight safety as more and more rivets are removed, the plane becomes dangerously weak. The rivet is removed may also be critical. Loss of rivets on the wings (key species) is a more serious threat to flight safety than loss of a few other rivets.

Loss of Biodiversity: The IUCN Red List (2004) documents the extinction of 784 species. Recent extinction includes: Dodo (Mauritius), Quake (Africa), Thylacine (Australia), Stiller‟s cow (Russia),

Effects of biodiversity loss:

Decline in plant production.

Lowered resistance to environmental perturbations such as drought.

Increased variability in certain ecosystem processes such as plant productivity, water use, and pest and disease cycle.

Causes of biodiversity loss: The present loss is all due to human activity (anthropogenic) There are four major causes known as "**The Evil Quartet"** are as follows:

- ***Habitat loss** and **fragmentation**:*
- **Over-exploitation:**
- **Alien species invasion:** Eg. i) Nile perch introduced into Lake Victoria in east Africa led to extinction of 200 species of cichlid fish in the lake.

ii) Parthenium, (carrot grass), Lantana, and water hyacinth (Eichornia) posed a thread to indigenous species.

iii) African cat fish Clarias gariepinus for aquaculture purposed is posing a threat to indigenous catfishes in our rivers.

- **Co-extinction**: When a species becomes extinct, the plant and animal species associated

with it an obligatory way also become extinct. Extinction of Host species leads to extinction of the parasite also. Co-evolved plant pollinator mutualism where extinction of one invariably lead to the extinction of the other.

Conservation of Biodiversity: Reason for conservation biodiversity is grouped into three categories.

i) ***Narrowly utilitarian:***

Human derive countless direct economic benefits from nature- Food (cereals, pulses, fruits,firewood, fiber, construction material.

Industrial products (tannins, lubricants, dyes, resins, perfumes)

Products of medicinal importance.
Bioprospecting: exploring molecular genetic and species-level diversity for products economic importance.

ii) ***Broadly Utilitarian*** *:*

Amazonian forest along produce 20% of oxygen during photosynthesis.
Pollinators without which seed cannot be produced by plants.
Aesthetic pleasure.

Two types of conservation of biodiversity: In situ and Ex situ conservation.

In situ conservation: (On site)

When we conserve and protect the whole ecosystem, its biodiversity at all level is protected – we save the entire forest to save the tiger.

Biodiversity hot spot: regions with very high levels of species richness and high degree of endemism.(species confined to that region and not found anywhere else)

Hot spot in biodiversity is also regions of accelerated habitat loss.

Out of 34 hot spot in the world, three hot spot located in India: Western Ghats , Indo-Burma, Himalaya.

Other protected area under in situ conservations are: 14 biosphere reserve , 90 national park ,448 wild life sanctuary

Sacred groves: tract of forest were set aside, and all the trees and wildlife within were venerated and given total protection.

Ex situ conservation: threatened animals and plants are taken out from their natural habitat and placed in special setting where they can be protected and given special care.

Zoological Park.
Botanical garden
Wildlife safari.
Conservation of gamete by cryopreservation.
Genetic strains are preserved in seed bank.

Convention on Biodiversity:

"The earth Summit" held in Rio de Jeneiro in 1992 nations pledged to take appropriate measures for conservation of biodiversity and sustainable utilization of its benefits.

" 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 level.

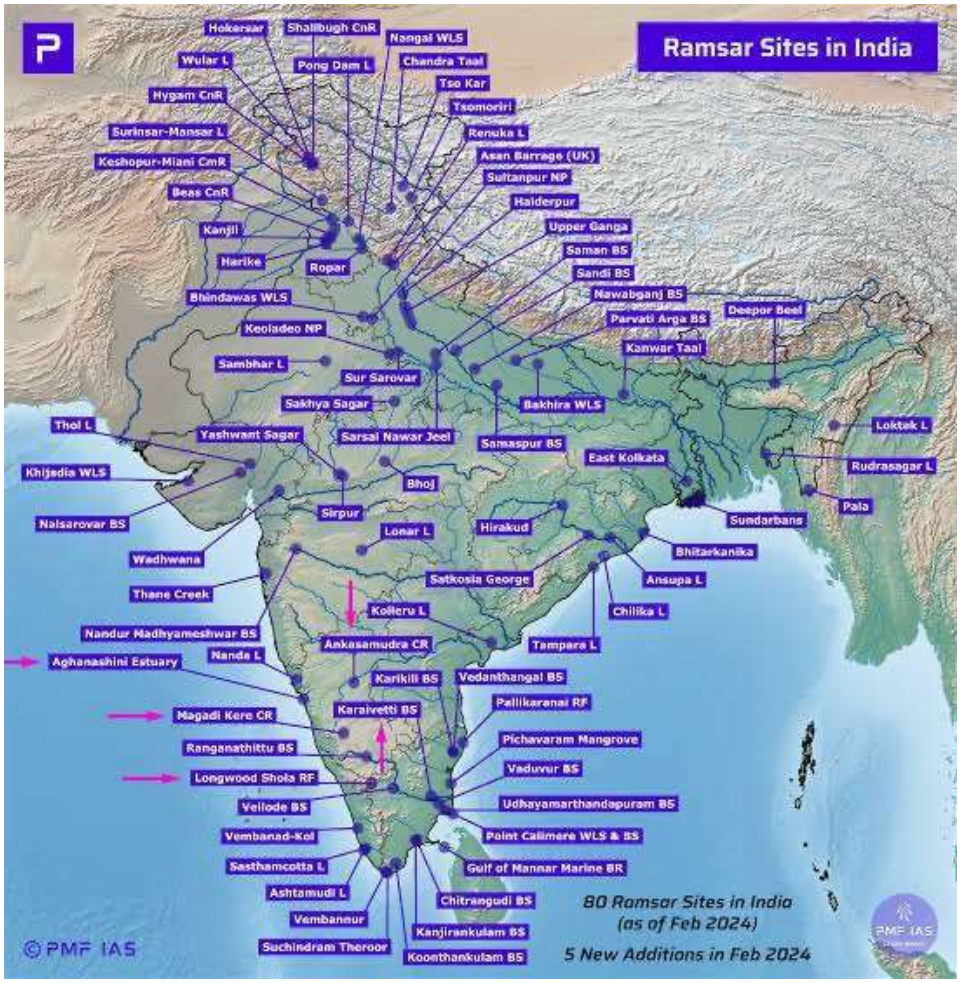
Ramsar sites- Ramsar site is a wetland site designated to be of international importance under the Ramsar Convention, also known as "The Convention on Wetlands", an international environmental treaty signed on 2 February 1971 in Ramsar, Iran, under the auspices of UNESCO. It came into force on 21 December 1975, when it was ratified by a sufficient number of nations. It provides for national action and international cooperation regarding the conservation of wetlands, and wise sustainable use of their resources. Ramsar identifies wetlands of international importance, especially those providing waterfowl habitat.

1st Ramsar sites in India - Chilika Lake (Orissa) , Keoladeo National Park (Rajasthan).

Total number of Ramsar siess in India - 86

Five new Ramsar sites (Wetlands of International Importance) announced in January 2024.

Ankasamudra Bird Conservation Reserve, Aghanashini Estuary, Magadi Kere Conservation Reserve (Karnataka) Karaivetti Bird Sanctuary, Longwood Shola Reserve Forest (Tamil Nadu).



MULTIPLE CHOICE QUESTIONS

1. Which of the following is an incorrect statement?

A. Biodiversity is moderate in temperate regions.

B. Diversity between two communities is called B- Diversity.

C. Species richness decreases with increasing explored area.

D. Diversity decrease from lower to higher altitudes on a mountain.

2. According to Alexander Von Humboldt within a region species richness increases with increasing explored area, but up to a limit. On a logarithmic scale the relationship is a

A. J shaped curve B. Sigmoid curve C. Straight line D. Rectangular Parabola

3. The Nile perch of Lake Victoria led eventually to the extinction of an ecologically unique assemblage of more than 200 species of cichlid fish in lake. This is due to:

A. Over-exploitation B. Alien species invasion

C. Fixed habitat D. Co-Extinction

4. Which of the following is not an ex-situ conservation.

A. Botanical Garden B. Seed banks

C. DNA banks D. National parks

5. The accelerated rates of species extinction that the world is facing now are largely due to:

A. Natural habitats B. Co-extinctions

C. Habitat loss D. Human activities

6. A specific area in which multiple use of the land is permitted by dividing it into zones, is called

a. Biosphere reserve b. Sacred groove

c. National park d. All the above

7. Inter governmental treaty on wetlands is called

a. Montreal protocol b. Helsinki declaration

c. Earth summit d. Ramsar convention

8. The „Evil Quartet" of biodiversity loss, does not include

a. Habitat loss b. Introduction of alien species

c. Over-exploitation d. Hunting

9. Saving the entire forest to save the tiger. This approach of conservation is

a. In situ b. Ex situ c. In vitro d. In vivo

10. Among the following which one is a hot-spot of biodiversity in India?

a. Indo-Gangetic plain b. Eastern Ghats

c. Aravalli Hills d. Western Ghats

11. Hotspots of biodiversity means

a. Areas of the earth that contain many endemic species

b. Species serves as proxy for entire communities in particular area.

c. Species in particular niche/area

d. Special diversity at particular area

12. The active chemical drug reserpine used for treatment of hypertension is obtained from

a. Datura b. Rauwolfia c. Atropa d. Papaver

13. Select the correct statement for biodiversity:

A. Large scale planting of Bt cotton has no adverse effects on biodiversity

B. Conservation of biodiversity is a fad pursued by developed countries

C. Desert areas of Sahara have very high level of desert animal species as well as others

D. Indo Burma regions have very high degree of species richness and endemism

14. Core, buffer and manipulation zone are found in:

A. National parks B. Biosphere reserves

C. Sanctuary D. Sacred groves

15. The category of species which requires maximum priority?

A. Rare B. Endangered

C. Extinct D. Vulnerable

16. . Loss of biodiversity may lead to all except:

A. Decline in Plant production.

B. Increased resistance to environmental perturbance

C. Increased variability of water use

D. Increased variability of pest and heir infestation

17. In India, we find mangoes with different flavors, color, fiber content, taste and shelf life. This large variation is on account of

A. Species diversity. B. Induced mutation

C. Genetic diversity. D. Ecosystem diversity

18.Destruction of species would be unethical because

A. It is a product of long evolutionary history

B. It forms a part of rich biological diversity.

C. It may still have certain unknown values

D. All of the above

19. Cryopreservation of gametes of threatened species in viable and fertile condition can be referred to as:

a. In situ conservation of biodiversity

b. In situ conservation by sacred groves

c. In situ cryo-conservation of biodiversity

d. Advanced ex situ conservation of biodiversity

20. Which of the following statements is not true about biodiversity? (a) The biodiversity decreases with the increasing altitude.

(b) species diversity decreases as we move away from the equator towards the poles

(c) The fishes show greatest biodiversity among vertebrates.

(d) The biodiversity of bryophytes is greater than that of angiosperms

ANSWERS

1- , 2-D ,3- B, 4- D, 5-D, 6-A, 7-D, 8-D , 9- A, 10-D , 11-A , 12- B, 13-D , 14- B, 15- B, 16- C, 17- C ,18- D, 19- , 20- .

ASSERTION AND REASONSING QUESTIONS

Assertion & Reason Type questions consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:

A. Both A and R are true and R is the correct explanation of A

B. Both A and R are true and R is not the correct explanation of A

C. A is true but R is false

D. A is False but R is true

1. Assertion: India is one of the 12 mega diversity countries of the world.

Reason: With only 4.2% of the land area India,already accounts for 5-6% of the recorded species of the world.

2. Assertion: Habitat loss and fragmentation is the most important cause driving animals and plants to extinction.

Reason: Habitat loss and fragmentation causes alien species invasion

3. Assertion : The diversity of plants and animals is uniform throughout the world Reason: Tropical environments are more constant unlike temperate ones.

4. Assertion (A): Sacred groves are highly protected.

Reason (R): They are of religious importance to the communities.

5. Assertion: Species with low genetic variability are generally greater risk of extinction than species with more genetic variability.

Reason: Species with low genetic variability are more venerable to disease, predators and other environmental challenges.

6. Assertion - When a species become extinct , the plants and animals the plants and animals associated in an obligatory ways also become extinct.

Reason -overexploitation can lead to loss of biodiversity.

7. Assertion -Decrease in species diversity occurs as we ascend a high mountain

Reason -Decrease in species diversity occurs with increase in altitude due to rise in temperature.

8- Assertion - India is more rich in biodiversity than Norway

Reason - India has more ecosystems than Norway.

9. Assertion - The Earth Summit was organised at Johannesburg.

Reason - It emphasized to reduce the rate of biodiversity loss by the year 2010.

10- Assertion - Biodiversity is very important and worthy to protection.

Reason - Because it provides sustainable benefits for the present as well as future generations.

11. Assertion- Process of extinction is random and fast.

Reason - Any species, not adapted to environment conditions cannot survive.

12. Assertion - Hotspots are protected areas covered under In situ conservation.

Reason- Hotspots are areas with a high variety of species and endemism.

13-Assertion - Conservationists have identified the biodiversity hotspots for maximum protection.

Reason- The species that are found in these areas have less significance than the ones in other parts of the world.

14. Assertion-If the species-area relationships are analyzed among very large areas like the entire continents, the value of Z i.e., slope of line lies in the range of 0.1 to 0.2.

Reason - The value of Z i.e., slope of line of species area relationships lies in the range of 0.6 to 1.2 when analysis is done among small areas.

15. Assertion -biosphere reserve is a specified area.

Reason- No restriction on human activities has been imposed in biosphere reserve.

16. Assertion -Alexander Von Humboldt experiment find that plots with more species showed less year to year variation in biomass.

Reason -He observed within a area species richness increased with increasing area.

17-Assertion- India has a great biodiversity.

Reason -India has ecological biodiversity including deserts, coral reefs. rainforest, mangroves etc.

18. Assertion - Temperate regions have lower productivity as compared to tropical regions.

Reason -Their is more solar energy available in temperate regions contributing to higher productivity

19. Assertion - Current extinction rate is 10 times faster than fifth extinction

Reason - Present day extinction is going through due to anthropogenic

influence.

20. Assertion - By photosynthesis, Amazonia forest produces 20% of oxygen

Reason - This can be considered as narrowly utilitarian method of biodiversity conservation.

Answers

1- C, 2- C, 3- D, 4- A, 5- A, 6- B, 7- C, 8- A,9- D, 10- A, 11- 12-A 13- C 14- D 15 - C, 16- D17- A 18-C 19- D,20- C

CASE STUDY-1

Read the passage given below and answer the following que

In India, ecologically unique and biodiversity rich regions are legally protected as biosphere reserves, national parks and sanctuaries. India has 14 biosphere reserves, 90 National parks and 448 wildlife sanctuaries. India has also a history of religious and cultural traditions that emphasized protection of nature. In many cultures‟ tracts of forest and all the trees and wildlife within were venerated and given total protection.

1. Periyar wildlife sanctuary in Kerala is famous for:

A. Elephant. B. Tigers. C. Lion D. Migratory birds

2. Protected areas are example of:

A. In-situ conservation B. Ex-situ conservation

C. Cryopreservation D. Green House

3. Which is not the different zone in biosphere reserves.

(a) A core zone. (b) A buffer zone.

(c) A protective zone. (d) A transition zone.

4. Biosphere reserves differ from National Parks and Wildlife sanctuaries because in the former

(a) Human beings are not allowed to enter.

(b) People are an integral part of the system.

(c) Plants are paid greater attention than the animals.

(d) Living organisms are brought from all over the world

5. Assertion – Biosphere reserves are included under the ex – situ conservation strategies. Reason – Cropping and Grazing are allowed in the transition zone of biosphere reserves.

(a) Assertion and the Reason are true and the Reason is a correct explanation of the Assertion.

(b) Assertion and Reason are true but the Reason is not a correct explanation of the Assertion.

(c) Assertion is true but the Reason is false.

(d) Assertion and Reason are false.

answer

1- A, 2- A, 3 - C, 4 ,5-D

CASE STUDY-2

Read the following and answer any four questions from (i) to(v) given below.

Excessive exploitation of species ,whether a plant or animal reduces the size of its population so it becomes vulnerable to extinction .Such as Dodo and passenger pigeon have become extinct due to over exploitation by humans.Thus the world is facing accelerated rates of species extinctions, largely due to human interference.

1. Which of the following causes of biodiversity loss is not included in the evil quartet?

a) coextinction. b) pollution.

c) Alien species invasion. d)Habitat loss and fragmentation

2.. Identify the species that have become extinct due to over exploitation

a) Stellar sea cow. b) Yucca moth. c) Blattaorientalis. d) Nile perch

3. Factors which make species susceptible to extinction are

a) large population size. b) lack of genetic variability

c) lower status of trophic level. d) ability to switch over to alternate foods

4. Assertion:Pollution reduces species biodiversity

Reason:Spill over of oil in sea causes death of several marine animals.

a) Both assertion and Reason are true and Reason is the correct explanation of assertion

b) Both assertion and Reason are true but Reason is not the correct explanation of assertion

c) Assertion is true but reason is false

d) Both assertion and Reason are false

5. _____is the first major cause of species

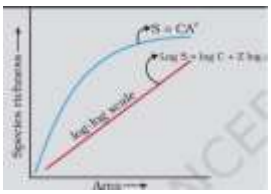
extinction a)Coextinction. b) Over exploitation

c) Habitat destruction d) Alien species invasion

answers

1- B, 2- A,3- B, 4- A

2 marks

1. Shown below is a figure 

a) Identify the curve.

b) How is it that when a very large area is considered the slope is steeper than

that for smaller areas?

Answer a) Species area relationship

2. What is the mission of Ramsar Convention?

Name the invasive fish introduced into Lake Victoria that caused extinction of a unique

assemblage of another fish species. Name the fish species that became extinct.

3. Explain the defense mechanisms evolved in preys to avoid overpopulation of

their predators

Ans defence either by camouflage or by mimicking the sounds of other aggressive organisms in order to create threat or by living underground.

4. In a species area graph what is value of „Z" regardless of the taxonomic group or the region and give one example

Ans The species-area relationships among very large areas (continents), will give a much

steeper slope and Z values in the range of 0.6 to 1.2. For example, for frugivorous (fruiteating) birds and mammals in the tropical forests of different continents, the slope is found to be 1.15.

5. What is the reason behind the vast diversity in Indian ecology?

Ans It can be attributed to the geographical diversity in terms of differing topography such as rain forests, deserts, coral reefs etc, thereby resulting in different varieties of ecosystems with diversity.

6. Write notes on the „rivet popper hypothesis" by Paul Ehrlich.

Ans. He suggested the hypothesis to understand the benefaction of species richness which he arrived at by comparing each species with rivet seen in the aeroplane body. It demonstrates that the ecosystem is an aeroplane and the species, the rivets holding together all the parts. If each passenger began to take rivets home (depicting species extinction), it may hardly affect the safety of the flight initially (representing stable functioning of the ecosystem), eventually, the plane becomes fragile and crash, implying species become endangered and ultimately extinct.

7. What IA cryopreservation?

Ans reservation is a technique of preserving viable and fertile commit for a long period under freezing temperature. These gametes can be later on used for producing offspring, to create seed bank et cetera.

8. Explain co extinction with example.

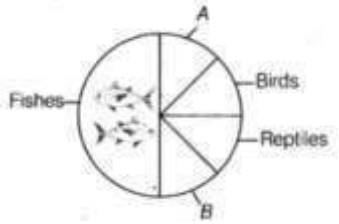
Ans when a species become extinct, then plants and animals which were obliquely dependent on it also become extinct in due course of time. This phenomenon is called co extinction.

Any one example

9. An alien hydrophyte called Eichhornia crassipes was introduced to India. Mention the issue this plant poses.

Due to its rapid clogging of stagnant water bodies, the water hyacinth (Eichhornia) introduced to India is endangering native species of aquatic life in ponds, lakes, etc.

10. Identify A and B in the figure given below representing proportionate number of major taxa.



A. mammals, B amphibians

3 marks

1. List the different anthropogenic actions, and explain how have they led to evolution.

Ans Excessive use of herbicides / pesticides / antibiotics, have resulted in the selection of pest resistant / antibiotic resistant varieties, in much lesser time / time scale of months or years and not centuries (example from industrial melanism / effect on DDT on mosquito / any other to be accepted) [1 + 1 + 1 = 3 Marks]

2. Since the origin of life on earth, there were five episodes of mass extinction of species.

(i) How is the „Sixth extinction", presently in progress, different from the previous episodes?

(ii) Who is mainly responsible for „Sixth Extinction"?

(iii) List any two points that can help to overcome this disaster outside.

Ans

i) The current species extinction rate is estimated to be 100-1000 time faster than in the pre-human era.(1)

(ii) All activities performed by human beings for survival and maintenance of their lifestyle.(1)

(iii) Point that can help to overcome this disaster are as follows Preventing habitat loss and fragmentation.

Checking overexploiting.

Preventing alien species invasion.

Preventing coextinction.

Conservation/protection of species.(any two points)(1/2+1/2)

3. The graph given below shows species area relationship.Study the graph & answer the following-

(a) Name the scientist who proposed it.

(b) what was his observation?

(c) What does„Z"represent? Give a case where the slope of the line will be much steeper

Answer (a) Alexander von Humboldt

(b) He observed that within a region species richness increased with increasing explored area, but only up to a limit

(c) Z= Regression co-efficient

very large areas like the entire continents / or

for frugivorous (fruit-eating) birds and mammals in the tropical forests of different continents.(any one)

4.a. What kind of biodiversity loss is exhibited by the given graph?

b. Give another example of this kind of biodiversity loss seen in plants.

c. What be done to prevent it?

AnsAlien species invasion

Carrot grass (Parthenium), Lantana and water hyacinth (Eicchornia).

Any logical reason

5. Name the type of biodiversity represented by the following

(i) 50000 different strains of rice in India,

(ii) Estuaries and alpine meadows in India

(Iii) variety of roses in your school garden

Ans I) Genetic diversity
(ii) Ecological diversity.

(iii) Genetic diversity

6. Sometimes alien species affect the indigenous organisms leading to their extinction. Substantiate this statement with the help of any two examples.
Answer:
Alien species become invasive, compete with the native species and cause extinction of indigenous species.

Introduction of Nile perch into Lake Victoria leads to extinction of more than 200 species of cichlid fish in that lake.

Carrot grass (Parthenium) and Lantana introduced in our country have become invasive and cause environmental damage. They pose a threat to the native species of plants in our forests

7. How does overexploitation of beneficial species affect biodiversity? Explain with the help of one example.
Answer:
Human beings when overexploite any plant/animal species, it affects their population size. The marine fish population around the world are declining due to overharvesting. It results in endangering the continued existence of some commercially important species. In the last 500 years, extinction of Stellar‟s sea cow and passenger pigeon were due to the overexploitation of these animals by humans.

8. India has greater ecosystem diversity than Norway. Do you agree with the statement? Give reasons in support of your answer.
(ii) Write the difference between genetic biodiversity and species biodiversity that exists at all the levels of biological organisation. (2018)
Answer:
(i) India is one of the twelve megadiversity regions of the world with 8.1% of genetic resources of the world. Since, India is placed in the tropical part of the world it exhibits more species diversity than the regions of temperate zones.
India, with much of its land area in the . tropical latitudes, has more than 1200 species of.birds. Greenland, Norway is away from tropics, so it exhibits less biodiversity.

5 marks

1. How can the loss of biodiversity be prevented?

Ans The occurrence of different types of habitat, species, ecosystem, gene pool, and a gene in a particular area in biodiversity. It can be conserved with various conservational strategies and management of abiotic and biotic resources. Listed below are a few conservational strategies:

Natural conservation or protection of useful plants and animals in their natural habitats.

Conserving crucial habitats like breeding and feeding areas, facilitating the growth and multiplication of endangered species

Regulation or banning hunting activities

Through bilateral or multilateral agreements, habitats of migratory entities should be conserved

Spreading awareness of the significance of conservation of biodiversity

Avoiding over-exploitation of natural resources.

2. Explain the ecosystem service. Write any four ecosystem services rendered by the natural ecosystem. Are you in support of or against imposing a charge on the service given by the ecosystem?

AnsEcosystem services are the products of ecosystem processes. The major services of ecological services are forests. Some of their services are:

Water and air purification

Droughts and flood alleviation

Cycling nutrients

Fertile soil generation

Rendering wildlife habitat

Promoting biodiversity

Crop pollination

Provisions of a storage site for carbon

Facilitating cultural, aesthetic and spiritual values

Students own view with justification

3. a) what are threatened and endangered species?

b)Suggest two practices giving one example of each, that help to protect rare or threatened species.

Answer. endangered species are those that will become extinct if certain protection measures are not taken. For example a panther threatened species species whose population is declining and if not protected they will become endangered. For example a cougar

b. Practices that help to protect rare threatened species are as follows

In situ (on-site) conservation involves protection of species in their natural habitat. In involves biosphere reserves, national parks, wildlife sanctuaries, sacred groves, etc,

Ex situ (off-site) conservation involves placing threatened animals and plants in special care units for their protection. Zoological parks, botanical gardens and wildlife safari parks serve this purpose.

4. a)State a difference between endemic and exotic species.

b) How can the prevailing rate of species extinction be declined by 30% solely through the protection of biodiversity hotspots?

Answer a) Exotic species are derived into a geographical area from another geographical area whereas endemic species are native species restricted to a particular geographical area.

b) Hotspots are species-rich, precisely those under human threat hence protecting them can significantly decrease the rate of extinction. They can be preserved as sanctuaries and national parks.

5. Give reason

A) Project Tiger is an In situ conservation.
B) Wildlife is not just , ' a game to be hunted' rather ' it's a gift of nature '

Answer – A) Project Tiger was launched in Jim Corbett National Park, Uttarakhand. The objectives of the Project Tiger was saving Royal Bengal Tigers from getting extinct. The major cause of their depletion is humans, and so all the conservation areas are made human free. By saving the forest as a whole, by conserving trees and by decreasing urbanization, we cam save the natural habitats of the tiger. This approach is known as in situ conservation.

6. Comment upon Indian biodiversity with special reference as a mega diversity nation

Answer Megadiversity, a term used by international organization . Biogeographically, India is situated at the tri-junction of three realms Afro-tropical, Indo-Malayan and Paleo-Arctic realms, and therefore, has characteristic elements from each of them. This assemblage of three distinct realms makes the country rich and unique in biological diversity. The Indian landmass is bounded by Himalayas in the north, the Bay of Bengal in east, the Arabian Sea in the west, and Indian Ocean in the south. Two areas in India have been identified as megadiversity hot spot areas, which are western ghat forests and eastern Himalayan forests, but India as a whole country as megadiversity nation.

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