जीव विज्ञान
Biology

कक्षा / Class XII

2025-26

विद्यार्थी सहायक सामग्री
Student Support Material

केन्द्रीय विद्यालय संगठन~Kendriya Vidyalaya Sangathan

संदेश

विद्यालयी शिक्षा में शैक्षिक उत्कृष्टता प्राप्त करना एवं नवाचार द्वारा उच्च - नवीन मानक स्थापित करना केन्द्रीय विद्यालय संगठन की नियमित कार्यप्रणाली का अविभाज्य अंग है। राष्ट्रीय शिक्षा नीति 2020 एवं पी. एम. श्री विद्यालयों के निर्देशों का पालन करते हुए गतिविधि आधारित पठन-पाठन, अनुभवजन्य शिक्षण एवं कौशल विकास को समाहित कर, अपने विद्यालयों को हमने ज्ञान एवं खोज की अद्भुत प्रयोगशाला बना दिया है। माध्यमिक स्तर तक पहुँच कर हमारे विद्यार्थी सैद्धांतिक समझ के साथ-साथ, रचनात्मक, विश्लेषणात्मक एवं आलोचनात्मक चिंतन भी विकसित कर लेते हैं। यही कारण है कि वह बोर्ड कक्षाओं के दौरान विभिन्न प्रकार के मूल्यांकनों के लिए सहजता से तैयार रहते हैं। उनकी इस यात्रा में हमारा सतत योगदान एवं सहयोग आवश्यक है - केन्द्रीय विद्यालय संगठन के पांचों आंचलिक शिक्षा एवं प्रशिक्षण संस्थान द्वारा संकलित यह विद्यार्थी सहायक-सामग्री इसी दिशा में एक आवश्यक कदम है । यह सहायक सामाग्री कक्षा 9 से 12 के विद्यार्थियों के लिए सभी महत्वपूर्ण विषयों पर तैयार की गयी है। केन्द्रीय विद्यालय संगठन की विद्यार्थी सहायक- सामग्री अपनी गुणवत्ता एवं परीक्षा संबंधी सामग्री संकलन की विशेषज्ञता के लिए जानी जाती है और शिक्षा से जुड़े विभिन्न मंचों पर इसकी सराहना होती रही है। मुझे विश्वास है कि यह सहायक सामग्री विद्यार्थियों की सहयोगी बनकर निरंतर मार्गदर्शन करते हुए उन्हें सफलता के लक्ष्य तक पहुँचाएगी।

शुभाकांक्षा सहित ।

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Student Support Material Class XII Biology

Unit	Title	Marks
VI	Reproduction	16
VII	Genetics and Evolution	20
VIII	Biology and Human Welfare	12
IX	Biotechnology and its Applications	12
X	Ecology and Environment	10
	TOTAL	70

COURSE STRUCTURE
CLASS XII (2025 - 26)
(THEORY)

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.

Chapter-12: Ecosystem

Ecosystems: Patterns, components; productivity and decomposition; energy flow; pyramids of number, biomass, energy.

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.

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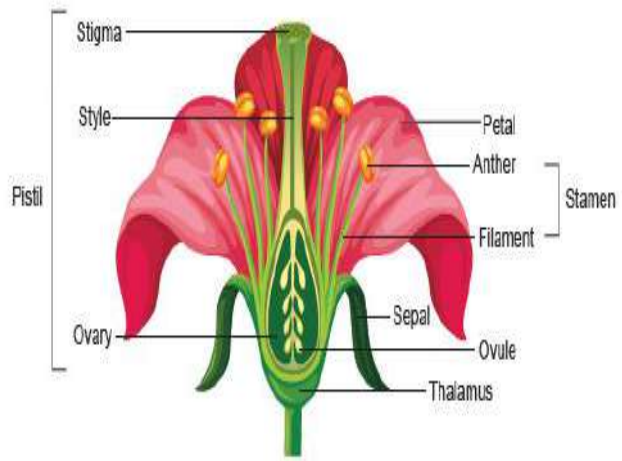
CHAPTER -1SEXUAL REPRODUCTION IN FLOWERING PLANTS.

Parts of flower



All flowering plants show sexual reproduction.
A complete flower consists of calyx, corolla, androecium and gynoecium.

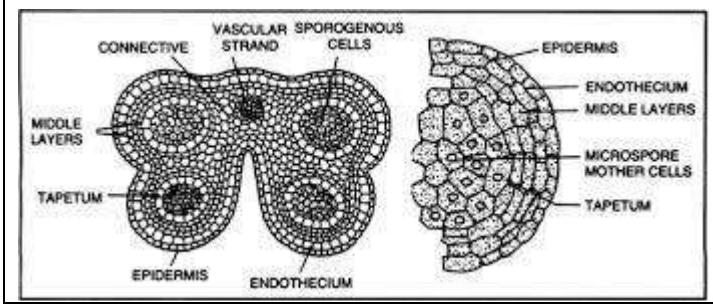
Androecium is the male reproductive structure that consists of a whorl of stamens.

Gynoecium is the female reproductive structure that consists of a whorl of carpels (pistils)

Each carpel has three parts
Stigma: Landing platform for pollen grains.
Style: It is the elongated slender part beneath the stigma,
Ovary: Basal bulged part of pistil, has ovarian cavity (locule). Placenta is located inside ovarian cavity.

A typical stamen is composed of filament and anther. Filament: It is a long slenderstalk. The proximal end of the filament is attached to the thalamus or the petal of the flower. Anther is terminal and generally bilobed structure and each lobe having two theca ie., they are dithecous.

Antheris a four-sided (tetragonal) structure consisting of four microsporangia located at the corners, two in each lobe. The microsporangia develop further & become pollen sacs, They extend longitudinally all through the length of an anther and are packed with pollen grains.
Structure of Microsporangium : A typical microsporangium is generally surrounded by four wall layers. The outer three wall layers perform the function of protection and help in dehiscence of anther to release the pollen. The innermost wall layer tapetum nourishes the developing pollen grains.
Microsporogenesis is a process of formation of microspores from PMC (Pollen Mother Cell).
A typical microsporangium is generally surrounded by four wall layers.
The outer three wall layers perform the function of protection and help in dehiscence of anther to release the pollen. The innermost wall layer tapetum nourishes the developing pollen grains



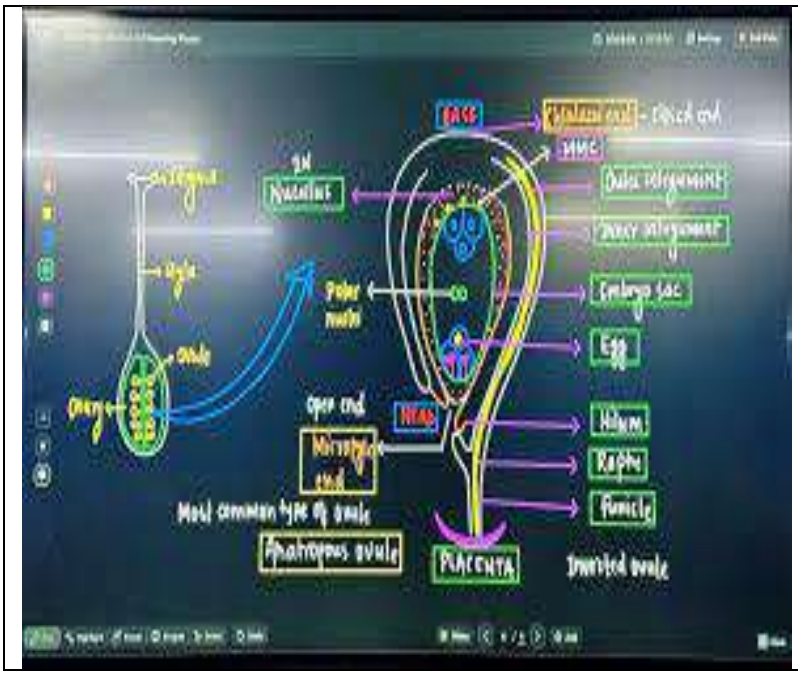
Pollen Grain

It represents the male gametophyte
It has prominent two layered wall: exine and intine.
* The outer layer exine is made up of **sporopollenin** and the intine is made up of pectin and cellulose.

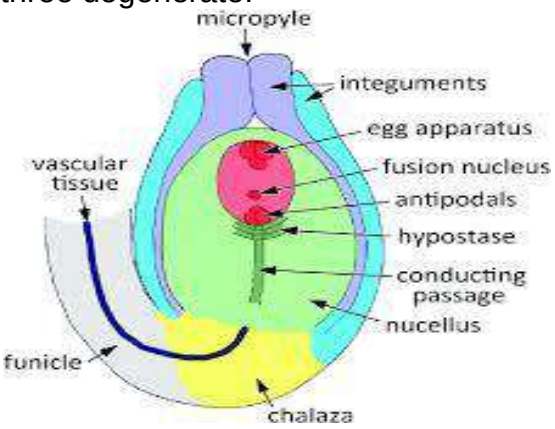
- Pollen grains of many species cause severe allergies.
- Pollen grains are rich in nutrients

- Pollen viability: depends on both temperature and humidity,
- Pollen of a large number of species can be stored for years in liquid nitrogen (-196°C) in pollen banks for crop breeding programmes.

Female Gametophyte

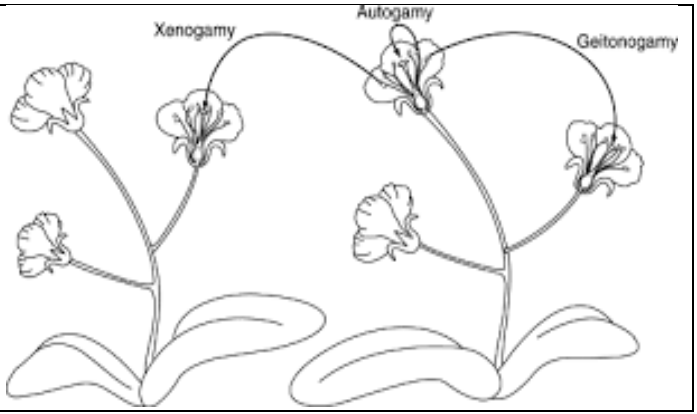


Ovules generally differentiate a single megaspore mother cell (MMC) in micropylar region of nucellus.
In majority of flowering plants, one megaspore remains functional and three degenerate.

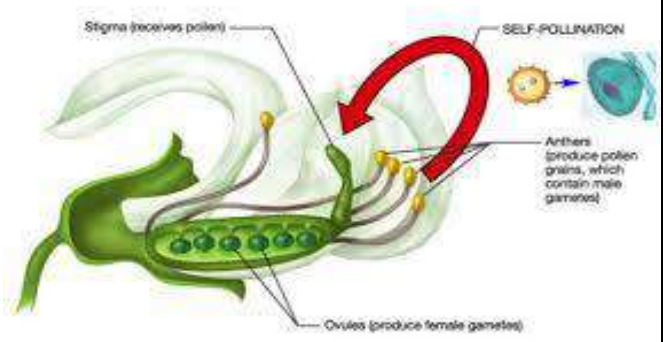


The functional megaspore develops in to the female gametophyte (embryo sac).The typical angiosperm embryo sac (female gametophyte) possess 8-nucleate and 7-celled condition at maturity.

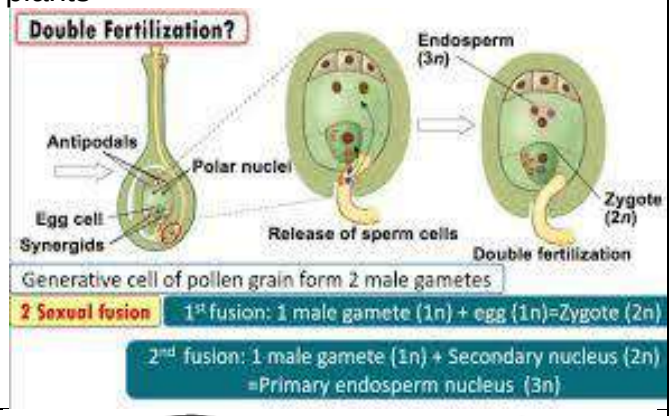
Pollination is the transfer of pollen grain from anther to the stigma of the same flower (self pollination) or of different flower (cross pollination) of the same species.
Self pollination is of two types ie, autogamy and geitonogomy. Autogamy can be promoted by cleistogamy.



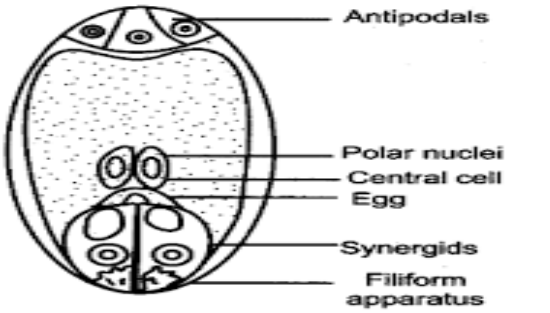
Pollen-pistil interaction is a chemical-mediated dynamic process. Following compatible pollination, pollen tube grows through the tissues of the stigma and style, the contents of pollen grain move into pollen tube. The growing pollen tube carrying two non-motile male gametes, reaches the ovary, enters the ovule through micropyle & then enters one of the synergids through the filiform apparatus, which guides the entry of pollen tube.
→ One male gamete fuses with egg cell and the other fuses with PEN. In artificial hybridization, desired pollen is used for pollination and stigma is protected from contamination from unwanted pollen by emasculation and bagging. If female flowers are unisexual, there is no need of emasculation.



Double Fertilization
Syngamy & triple fusion are called double fertilisation, an event unique to flowering plants



Double Fertilization
Syngamy & triple fusion together are called double fertilisation, an event unique to flowering plants. The central cell after triple fusion becomes primary endosperm cell (PEC) and develop into endosperm



Mature Embryo sac of an angiosperm

Endosperm
Endosperm development precedes embryo development, as it is filled with reserve food materials and used by developing embryo. Embryo develops at micropylar end of embryo sac where the zygote is situated.
Early stages of embryo development (**Embryogeny**) are similar in both monocotyledons and dicotyledons. In dicots, the zygote forms proembryo globular heart shaped mature embryo. Embryos of monocot have only one cotyledon called scutellum. Radicle or root cap is enclosed with undifferentiated sheath called coleorhizae. Epicotyl has shoot apex & a few leaf primordia enclosed in foliar structure coleoptile

Seed
In angiosperms, seed (fertilized ovule) is the final product of sexual reproduction, formed inside fruits. A seed typically consists of seed coats, cotyledon(s) & an embryo axis.
→ Mature seeds may be non-albuminous or ex-albuminous having no residual endosperm, which is consumed completely during embryo development (eg. Pea, groundnut), Albuminous seeds retain a part of endosperm (eg. Wheat, maize, barley, castor, coconut).
In black pepper & beet, remnants of nucellus are also persistent, called perisperm.

True fruits develop from ovary.
In apple, strawberry, cashew, etc., thalamus also contributes to form fruit called false fruit.
Parthenocarpic fruit develop without fertilisation eg. Banana.
Lupinus arcticus seed germinated and flowered after estimated record 10,000 years of dormancy. *Phoenix dactytifera* (date palm) seed remained viable for 2000 years.
Apomixis and Polyembryony
Some species of Asteraceae & grasses have evolved a special mechanism to produce seeds without fertilisation called apomixis.
In Citrus and mango, nucellar cells protrude into embryo sac & develops into embryos, so each ovule contains many embryos (polyembryony)

Question Bank
MCQs

1. The outermost and innermost wall layers of microsporangium in an anther respectively : are
(a) Endothecium and tapetum(b) Epidermis and endodermis
(c) Epidermis and middle layer(d) Epidermis and tapetum
2. The coconut water from tender coconut is
(a) Cellular endosperm(b) free nuclear endosperm
(c) bothcellular and nuclear endosperm(d) free nuclear embryo

3. Self-pollination is fully ensured if
(a) the flower is bisexual.(b) the style is longer than the filament.
(c) the flower is cleistogamous.(d) the time of pistil and another maturity is different.
4. The outermost and innermost wall layers of microsporangium in an anther respectively : are
(a) Endothecium and tapetum(b) Epidermis and endodermis
(c) Epidermis and middle layer(d) Epidermis and tapetum
5. The thalamus contributes to the fruit formation in
(a) banana (b) orange(c) strawberry(d) guava
Ans: 1d, 2b, 3c,4d, 5c

VERY SHORT ANSWER QUESIONS

1. Why does endosperm development precede embryo development ?
Ans. The cells of endosperm are filled with reserve food materials and are used for the nutrition of the developing embryo.
2. Some flowers, selected for artificial hybridization, do not require emasculation but bagging is essential for them. Give a reason.
Ans. If the female parent produces unisexual flowers, there is no need for emasculation. Instead, the female flower buds are bagged before the flowers open and the stigma gets contaminated with unwanted pollen grains.
3. Write any two ways by which apomictic seeds may be developed in angiosperms.
(i) In some species, the diploid egg cell is formed 1 without reductional division and develops into the embryo without fertilisation.
(ii) In Citrus and Mango varieties, some of the 1 nucellar cells surrounding the embryo sac start dividing, protrude into the embryo sac and develop into embryos.
4. Both nucellus and endosperm have abundant reserve food materials. How is their food reservoir utilised in angiosperms?
Ans. Both nucellus and endosperm have abundant 2 reserve food materials. The reserve food materials are used for the nutrition of the developing embryo.
5. Write one advantage and one disadvantage of cleistogamy to flowering plants.

ANS -Advantage: Assured seed set / maintain purelines.
Disadvantage: No variation / only parental characters are preserved / it can lead to inbreeding depression.

SHORT ANSWER QUESTIONS

1. Do you think apomixis can be compared with asexual reproduction? Support your Answer, giving one reason. How is apomixis beneficial to farmers? Explain.

Ans. Yes, Seeds are produced without fertilization . Production of hybrid seeds costly If hybrids with desirable characteristics can be made into apomicts .There is no segregation of characters in the hybrid progenyFarmer can continue using hybrid seeds year after year and not buy new seeds

2. How does a farmer use the dormancy of seeds to his advantage?

(b) What advantages a seed provides to a plant?

(a). For storage (dehydration) of seeds to be used as food.To raise the crop in the next season.
(b) Seed formation is more dependable.
Better adaptive strategy for dispersal to new habitat.
Hard seeds provide protection to the young embryo.Being a product of sexual reproduction they generate new genetic combinations / genetic variations / sufficient food reserve for the young seedling to be nourished.

3. Double fertilisation is reported in plants of both, castor and groundnut. However, the mature seeds of groundnut are non- albuminous and castor are albuminous. Explain the post fertilisation events that are responsible for it.

Ans.• Development of endosperm embryo) takes place in both. (preceding the
Developing embryo derives nutrition from endosperm.
Endosperm is retained / persists / not fully consumed in castor.
Endosperm is consumed in groundnut.

4. If the meiocyte of a maize plant contains 20 chromosomes, write the number of chromosomes in the endosperm and embryo of the maize grain and give reasons in support of your answer.

Ans. Endosperm = 30, Embryo = 20
1 Diploid meiocyte (20 chromosomes) form 1 haploid gametes (10 chromosomes). Two haploid gametes fuse to form diploid (20) zygote which develops into a (diploid = 20) embryo /syngamy of two haploid gametes to form a diploid zygote.
One haploid gamete (chromosome 10) fuses with two polar nuclei (chromosome 10 + 10) 1 to form (triploid - 30) endosperm nuclei (which divides to form endosperm) / Triple fusion of three haploid nuclei (1 gamete + 2 polar nuclei) to form a triploid endosperm.

4.How are parthenocarpic fruits produced by some plants and apomictic seeds by some others? Explain.

(b) When do farmers prefer using apomictic seeds?

ANS Ovary develops into fruit without fertilisation.
Formation of seeds without fertilisation / form without reductional division / develop 1 into embryo without fertilisation.
b) To maintain hybrid characters (year after year in a desired plant).
To avoid buying hybrid seeds every year 1 (expensive seeds).

ASSERTION REASON BASED QUESTIONS

For questions given below there are two statements marked as Assertion (A) and Reason (R). Choose the correct answer out of following choices.
Codes:
(a) If both Assertion (A) and Reason (R) are true and Reason is the correct explanation of assertion.
(b) If both Assertion (A) and Reason (R) are true, but reason is not the correct explanation of assertion.
(c) If Assertion (A) is true, reason (R) is false.

(d) If both assertion (A) and reason (R) are false

1. Assertion (A): Meiosis is the cell division which occurs in the sexually reproducing organisms.
Reason (R): Meiotic cell division results into two cells having exactly same genetic makeup
Ans (c) --(A) is true, but (R) is false

2. Assertion (A) : Insects visit flowers to gather honey.
Reason (R) : Attraction of flowers prevents the insects from damaging other parts of the plant.
Ans. (d) both assertion and reason are false.
Explanation: The insects visit flowers to get nectar (not honey). The attraction of flower in plants is not to diverge the insect from damaging other part but to bring about pollination.

CASE BASED QUESTION

Preeti during the lecture in the classroom felt surprised that how the pollen grains after reaching the stigma enters inside the ovule and sooner or later the seed and fruits starts developing. She started discussing this with her friend and they correlated the things with the reproductive process that takes place in all organisms. They then ask the teacher to explain the concept in class.

(i) The first step in pollen pistil interaction is :
(a) Recognition of anther
(b) Recognition of pollen grain
c) Growth of pollen tube
(d) Entry of pollen tube into ovule
Ans. (b) Recognition of pollen grain
Explanation: The first step in pollen pistilinteraction is recognition of pollen grain as the pistil has the ability to first recognize the compatible pollen and reject the incompatible one.

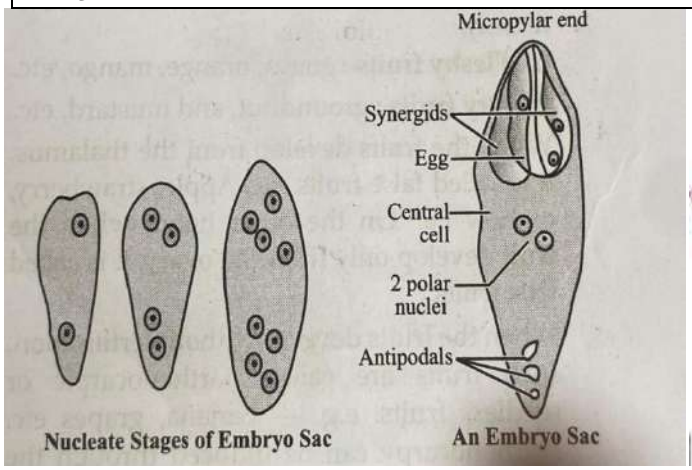
(**ii**) What happens to the plants that shed in the 3-celled condition? In the plants that shed pollen grains at 3-celled stage, the pollen carries the two male gametes from the beginning.

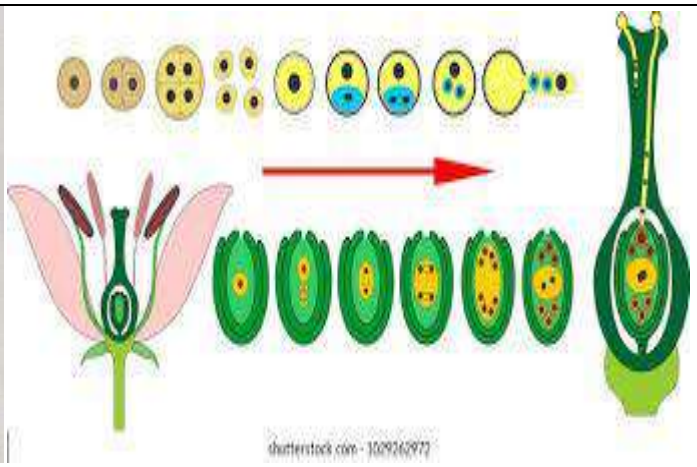
(iii) From what route does the pollen tube enters the ovule.
Ans. After reaching the ovary, the pollen tube can enter the ovule either through the micropylar end (porogamy), chalazal end (chalazogamy) or through funicle or (mesogamy).

LONG ANSWER QUESTIONS

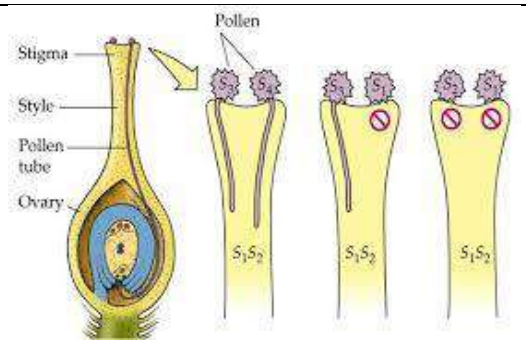
1. Explain the formation of embryo sac with a neat sketch.

Hint.





2. Explain pollen-pistil interaction with neat sketch.



Deposition of pollen grains on stigma → Recognition of right/wrong type of pollen → Germination/inhibition of pollen

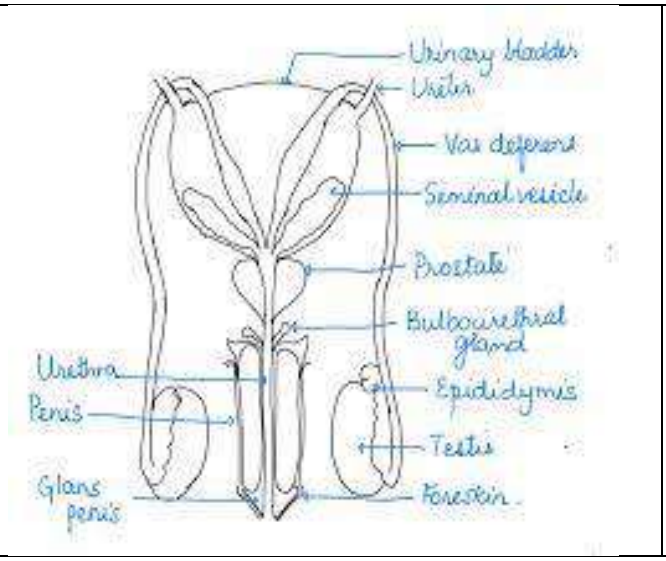
****

CHAPTER-2 HUMAN REPRODUCTION

Reproduction

The male and female reproductive organs work together to produce offspring.
Primary sex organs: Formation of the gametes (sperm and egg) and hormones.
Secondary Sex Organs: Do not produce gametes, but provide passage for the gametes.

Male Reproductive System

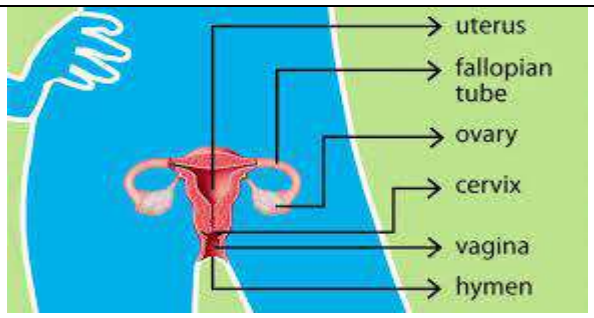


Male reproductive system consists of primary sex organ which are testes (one pair) and secondary sex organs which are male accessory ducts which include rete testis, vasa efferentia, epididymis, vas deferens, urethra.
Male accessory glands include seminal vesicles, prostate gland and Cowper's gland/Bulbourethral gland .Testes are situated outside the abdominal cavity within a pouch called scrotum, for the process of spermatogenesis, which provide 2-2.5°C less temperature than normal body temperature.

Each testis has 250 compartments called testicular lobules.
Each lobule contains one to three seminiferous tubules.
Each seminiferous tubules contain 2 types of cells- Sertoli cells (nurse cells) and Leydig cells (interstitial cells) which synthesise and secrete testosterone.
The pathway of sperm through the male body is:
Seminiferous tubule --Rete testis-- Vasa efferentia--- Epididymis--- Vas deferens--- Ejaculatory duct--- Urethra

Female Reproductive System

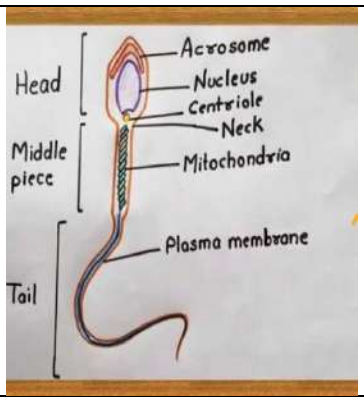
◆ It consists of primary sex organ which are pair of ovaries and secondary sex organs which are oviducts (fallopian tubes), uterus, vagina, female external genitalia and mammary glands
◆ Oviduct: Infundibulum (funnel-shaped), ampulla (fertilisation takes place) and isthmus (last part).
Uterus: Corpus/Body, fundus and cervix



The wall of the uterus has three layers of tissue: perimetrium, myometrium, endometrium.
Birth canal Cervical canal + vagina.
→ Female external genitalia consists of mons pubis, labia majora, labia minora, hymen, clitoris.
→ Accessory glands in female is of 2 types- greater vestibular or bartholin's gland and lesser vestibular glands or paraurethral or skene's glands.

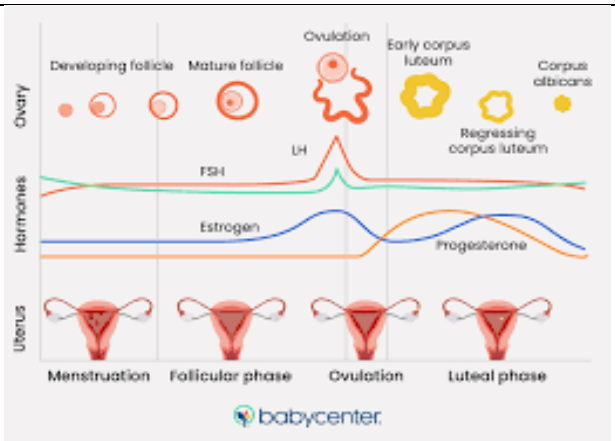
Gametogenesis The process of formationof gametes.
It is divided into three phases:
1. Multiplication phase 2. Growth phase 3. Maturation phase

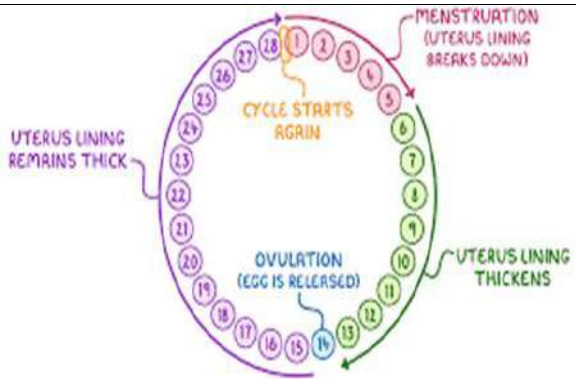
SPERM



Sperm is divided in head, neck, middle piece (production of energy due to presence of mitochondria) and tail that help in movement)
Human male ejaculates about 200-300 millions sperms during a coitus of which for normal fertility, at least 60 percent sperms must have normal shape and size, at least 40 percent of sperm among them must show vigorous motility.

MENSTRUAL CYCLE





The cycle of non-pregnant females in their ovaries and uterus, which involves the periodic shedding of the endometrium.It includes

1. Menstrual Phase Bleeding phase (3-5 days).
2. Pre-ovulatory phase Proliferative phase Follicular phase (6 to 13 days)
3. Post-ovulatory phase/Secretory phase Leuteal phase

Fertilisation

The process of fusion of a sperm with an ovum to form a diploid cell is called fertilisation. It involves:

1. Acrosomal reaction
2. Fast block to polyspermy
3. Slow block to polyspermy

Cleavage

The fertilised egg, undergoes repeated cell divisions which occur rapidly to produce a multicellular structure without changing its size. It involves following stages:

1. Morula2. Blastula3. Gastrula

Extra Embryonic Membranes

* There are 4 types of extra embryonic membranes

1. Chorion2. Yolksac3.Allantois4. Amnion

Lactation :The process of formation of milk at the end of pregnancy for bringing up a healthy baby.Prolactin helps in production of milk.Oxytocin causes ejection of milk.In initial few days of lactation colostrum (contains IgA) is released by lactating mother that helps to boost immunity of the child.

Questions

MCQs

1. Which of the following statements are correct with respect to hormones secreted by placenta?

(i) Placenta secretes relaxin during later stage of pregnancy.
(ii) Placenta secretes high amount of FSH during pregnancy.
(iii) Placenta secretes relaxin during intitial stage of pregnancy.
(iv) Placenta secretes hCG and hPL during pregnancy.

(a) (i) and (iv) (b) (i), (ii) and (iv) (c) (iii) and (iv) (d) (ii), (iii) and (iv)
Ans. (a) (i) and (iv)
2. During human embryonic development the external gential organs are well developed in the foetus by the end of :
(a) 6 weeks of pregnancy(b) 12 weeks of pregnancy (c) 18 weeks of pregnancy(d) 24 weeks of pregnancy
Ans. (b) 12 weeks of pregnancy

3. The source of gonadotropin LH and its corresponding function is :
(a) Anterior pituitary, ovulation(b) Anterior pituitary, Graafian follicle formation
(c) Hypothalamus, Ovulation(d) Hypothalamus, Graafian follicle formation
Ans. (a) Anterior pituitary, ovulation.
4. Spermiation is the process of the release of sperms from:
(a) Seminiferous tubules(b) Vas deferens(c) Epididymis(d) Prostate gland
Ans.(a) Seminiferous tubules.
5. Mature Graffian follicle is generally present in the ovary of a healthy human female around :
(a) 5-8 day of menstrual cycle(b) 11-17 day of menstrual cycle
(c) 18-23 day of menstrual cycle(d) 24-28 day of menstrual cycle
Ans. (b) 11-17 day of menstrual cycle.
6.Which of the following hormones is not secreted by human placenta?
(a) Hcg(b) Oestrogens(c) Progesterone(d) LH
Ans. (d) LH.

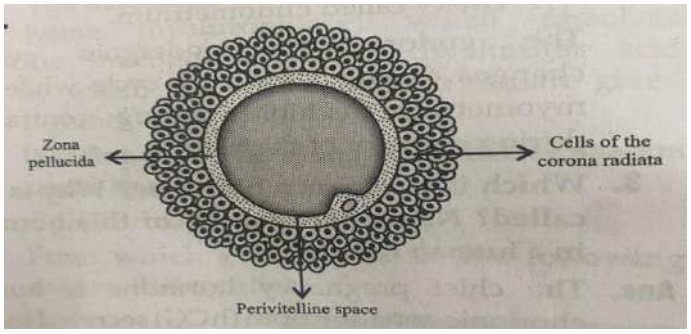
VERY SHORT ANSWER QUESTONS

1.Why are menstrual cycles absent during pregnancy?
Ans. The high levels of progesterone and oestrogen during pregnancy suppresses the gonadotropins which are required for the development of new follicles. Therefore, a new cycle cannot be initiated.
2.State the role of Oxytocin in parturition. What triggers its release from the pituitary?
Oxytocin acts on uterine muscle.and cause stronger uterine contraction.leading expulsion of the foetus / baby out of UTERUS
The signals from fully formed foetus and the placenta which induce mild uterine contraction / foetal ejection reflex triggers release of oxytocin.
3.List the three hormones produced in women only during pregnancy. What happens to the levels of oestrogen and progesterone during pregnancy
Ans. Human chorionic gonadotropin (hCG)
Human placental lactogen (hPL)
Relaxin
The level of progesterone & estrogen increases
4.During reproduction, the chromosome number (2n) reduces to half (n) in the gametes and again the original number (2n) is restored in the offspring, what are the processes through which these events take place?
Halving of chromosomal number takes place during gametogenesis and regaining the 2n number occurs due to fertilisation.
1.The corona radiata of an ovum acts as a barrier for the penetration of sperms. How do sperms overcome this barrier?

Ans. The acrosome of the sperm contains sperm lysine (hyaluronidase) which dissolves the mucopolysaccharide, hyaluronic acid by which the cells of corona radiate glued together.
2. Which part in the male reproductive system stores sperms?what is the importance of tail in sperms while they are absent in eggs
Ans. Epididymis.
sperms have a tail, whereas, eggs do not because eggs are non-motile (stationary) and sperms have to travel up to eggs.

SHORT ANSWER QUESTIONS

1.What is colostrum? How the milk production hormonally regulated?
Ans. The first milk comes from the mammary glands of the mother just after parturition for few days is called colostrum. It contains several antibodies (mainly IgA), that provide passive immunity to the new-born baby. The secretion and storage of milk generally begins after birth of young one, usually within 24 hours under the influence of hormone prolactin secreted by anterior lobe of the pituitary gland. The ejection of milk is stimulated by the hormone oxytocin released from the posterior lobe of the pituitary gland.
2.Give a short note on the walls of uterus.
Ans. The wall of the uterus has three layers of tissue namely,(i) The external perimetrium. thin membranous(ii) The middle thick layer of smooth muscle, myometrium.(iii) The inner glandular layer lining uterine cavity called endometrium.The endometrium undergoes cyclical changes during menstrual cycle while, the myometrium exhibits strong contraction during delivery of the baby.
3.Mention the functions of any three parts of human sperm.
Ans.Please see the text given above
4.Explain the role of gonadotropins in the development of oocytes?
Ans. The gonadotropins (Follicle Stimulating Hormone and the Luteinising Hormone) are released by the anterior portion of the pituitary gland. The maturation of the primary follicles into the Graffian follicles occurs during the follicular phase. The secretion of gonadotropins increases during this phase and cause follicular growth and the growing follicles produce oestrogen. The LH and FSH are at their peak in the middle of the cycle (14th day), and cause the rupture of the Graffian follicles to release ovum. This phase is called the ovulatory phase.
5.Draw a labelled sketch of the structure of human ovum prior to fertilization



Assertion reasoning questions

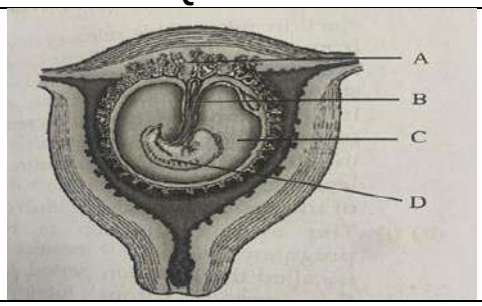
For questions 1 to 6 in each of questions given below there two statements marked as Assertion (A) and Reason (R). Choose the correct answer out of following choices.
(a) If both (A) and (R) are true and (R) is correct explanation of (A).
(b) If both A and R are true, but (R) is not the correct explanation of (A).
(c) If (A) is true, but (R) is false.
(d) If (A) is false, but (R) is true.
1. Assertion (A) : In the testis, spermatogenesis occurs in the seminiferous tubules and testosterone secretion takes place in the Sertoli cells.
Reason (R) : Testosterone brings growth and maturation of primary sex organs and also development of accessory sex characters.

Ans. (d) both A and R are false.
2. Assertion (A): Testis originates in the abdomen but later descend into the scrotum under the influence of testosterone.
Reason (R): The interstitial (Leydig's cells) of the testes secrete male sex hormone, inhibin.
Ans.(c) A is true, but R is false.
Explanation: Inhibin is secreted by Sertoli cells. Sertoli cells are also called nurse cells.
3. Assertion (A): Testis is located in the scrotum, outside of coelom.
Reason (R) : A vaginal coelom partly surrounds the testis in the scrotum.
Ans.(c) A is true, but R is false.

CASE BASED QUESTIONS

1. The female reproductive system consists of primary as well as secondary sex organs varies are considered as the primary sex organs of female that are responsible for producing female gametes known as ovum part from this the ovaries also secrete several steroid hormones also known as ovarian hormones. The ovaries are almond shaped structure that lies in the lower part of the abdomen held to the broad ligament by two fold of peritoneum called mesovarium. Secondary sex organs in females are known as oviducts of fallopian tubes and it also includes the accessory glands known as balance gland and mammary glands
(i) Identify the structure to which the fallopian tube carries the egg from the ovaries:
(a) placenta (b) uterus (c) medulla (d) cervix
Ans. (b) uterus
Explanation: Fallopian tubes are the two small tubes that lie on the other side of the uterus near the kidney. These tubes help in carrying the egg from the ovary to the uterus and provides the appropriate environment for its fertilisation
(ii) Which layer of uterus for home has many blood vessels and is responsible for undergoing cyclic changes during the menstrual cycle :
(a) outer perimetrium (b) middle myometrium (c) inner endometrium (d) all of these
Ans. (c) inner endometrium.
Explanation: Inner endometrium layer of the uterus is considered as a important layer as it undergoes cyclic changes during the menstrual cycle if the egg is not fertilized. This layer is a glandular layer with many blood vessels.

LONG ANSWER QUESTIONS

	In the given figure, choose and name the correct part (A, B, C or D) that act as a temporary endocrine gland and substantiate you answer. Why is it also called the functional junction? (b) Mention the role of B in the development of the embryo. (c) Name the fluid surrounding the developing embryo. How is it misused for sex- determination

Ans Please see the text given above
(c) Amniotic fluid; a foetal sex determination test is based on the chromosomal pattern of the cells in the amniotic fluid surrounding the FOETUS
2. (a) Draw a diagrammatic view of the female reproductive system of human and label its parts.
Explain the following phases in the menstrual cycle of a human female.
(i) Menstrual Phase(ii) Follicular Phase(iii) Luteal Phase
3. with reference to female reproductive system
(i) Where does the secondary oocyte develops? (ii) Which helps in collection of ovum after ovulation?
(iii) Where does fertilisation takes place? (iv) Where does implantation of embryo occurs in the embryo.
v) What are the different parts of oviduct. Name them.

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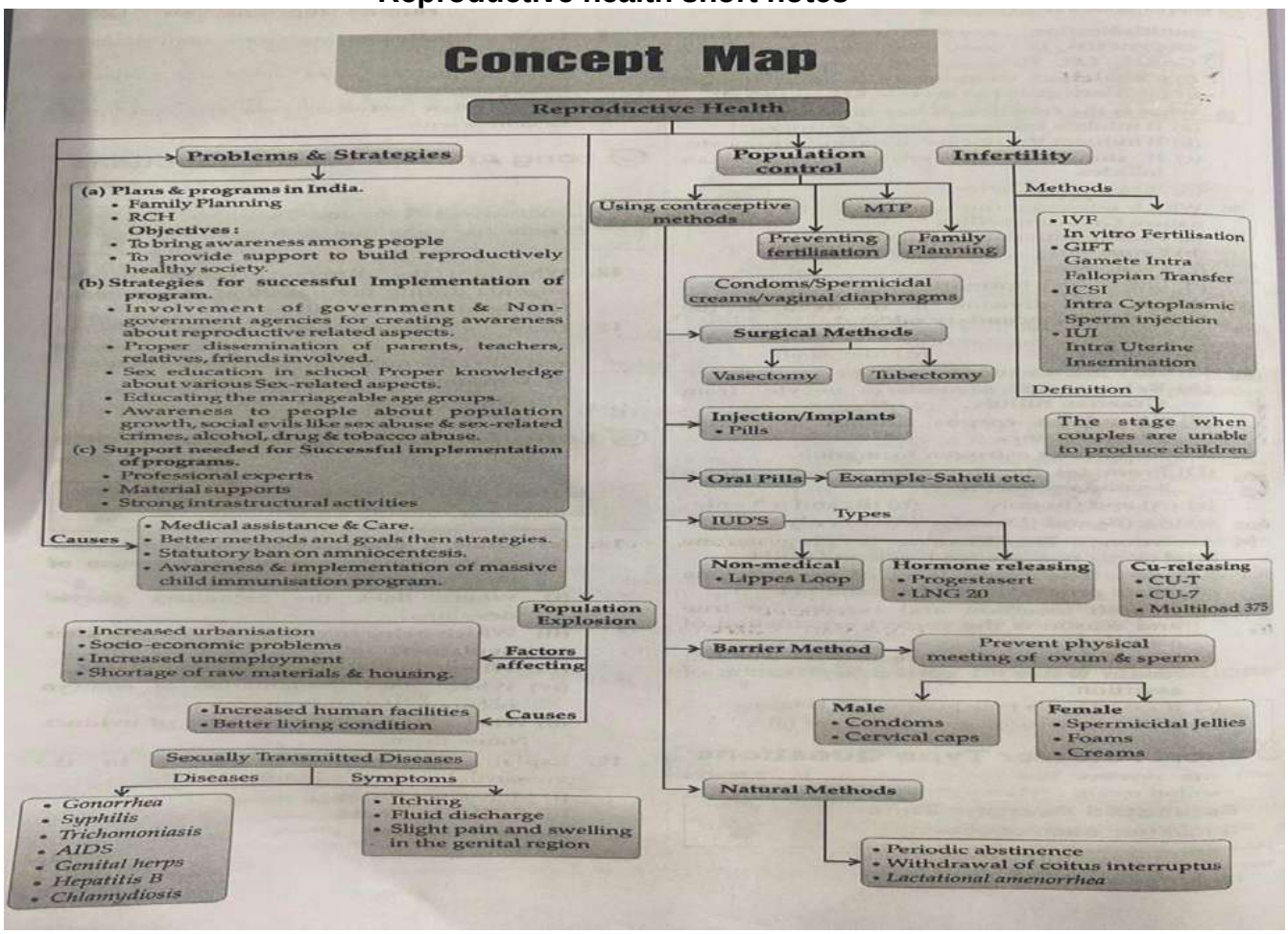
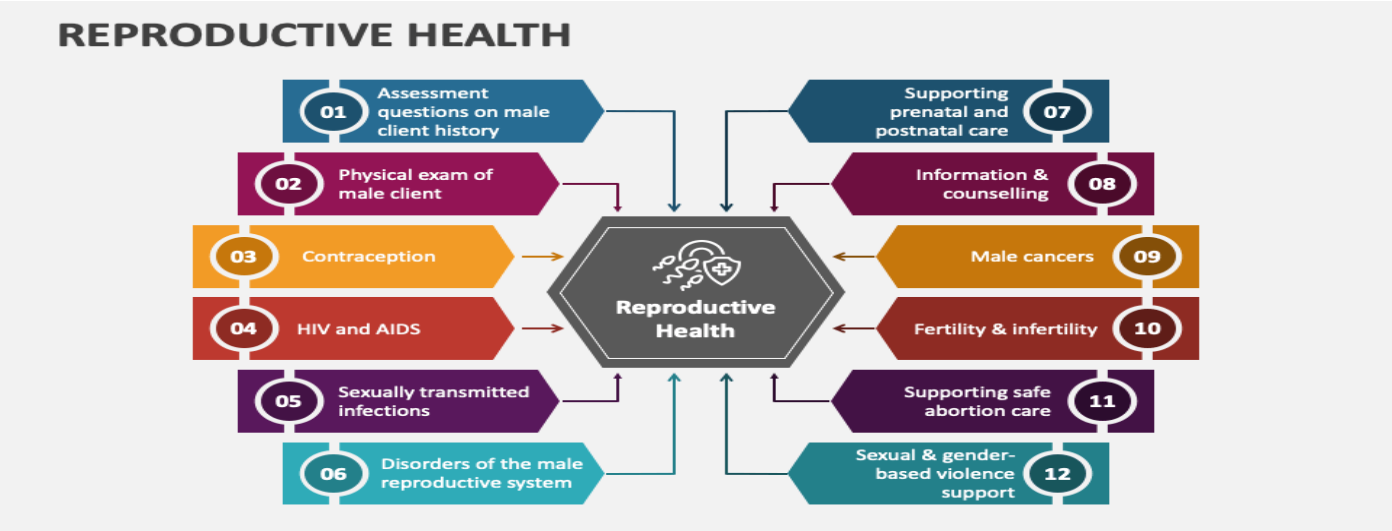
CHAPTER-3.REPRODUCTIVE HEALTH

Reproductive health short notes

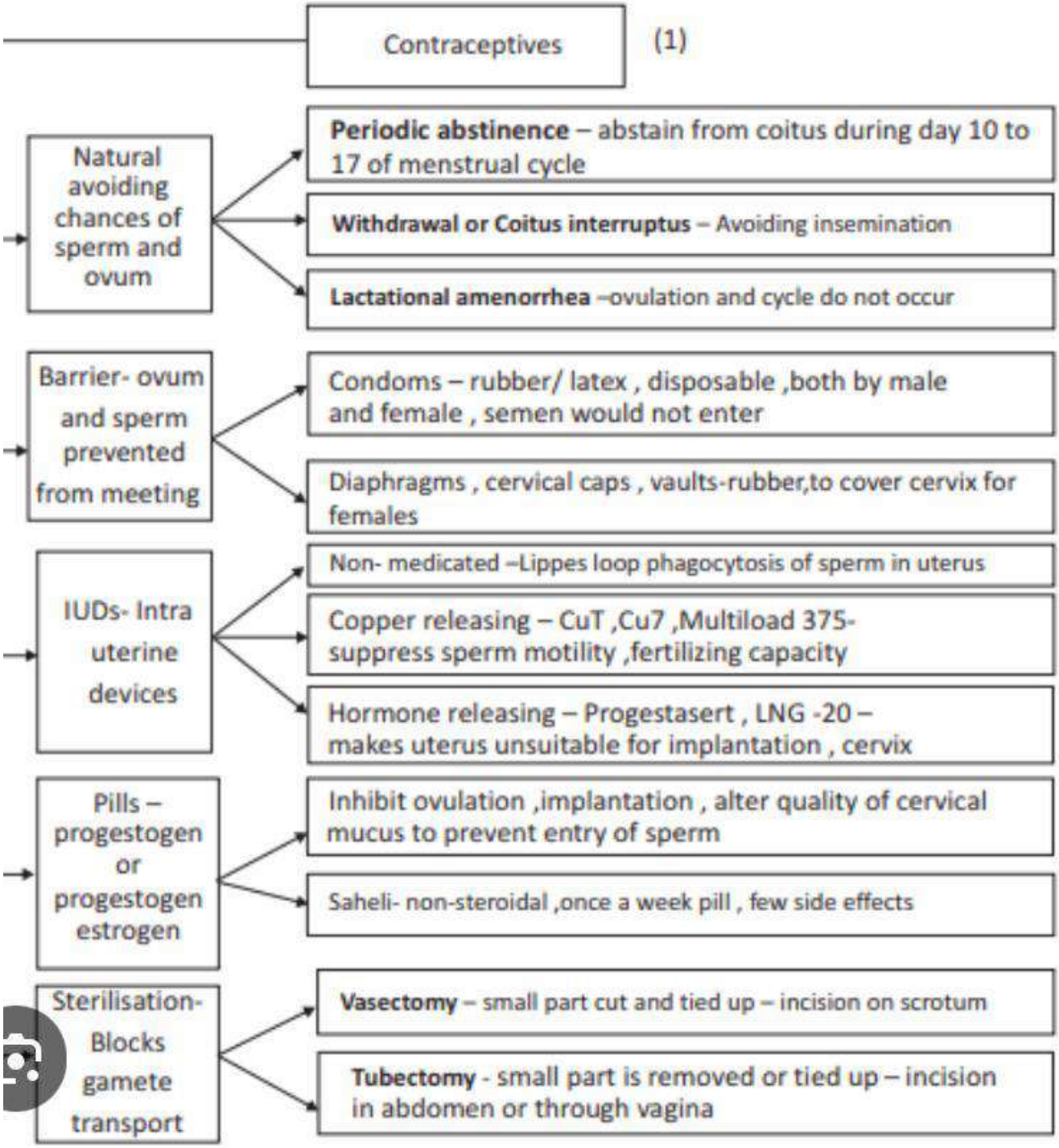




Key points

Increase in number of people in reproducible age
Increase in health facilities
Measures Taken by Government to Check Population
Motivate smaller families by using various contraceptive methods and by slogans "Hum do Hamare do", in advertisements and posters .Urban couples adopting: "One child norm".
Statutory raising of marriageable age:Female 18 years ,Male 21 years incentives given to couples with small families
adopting: "One child norm".

Birth Control/Contraception

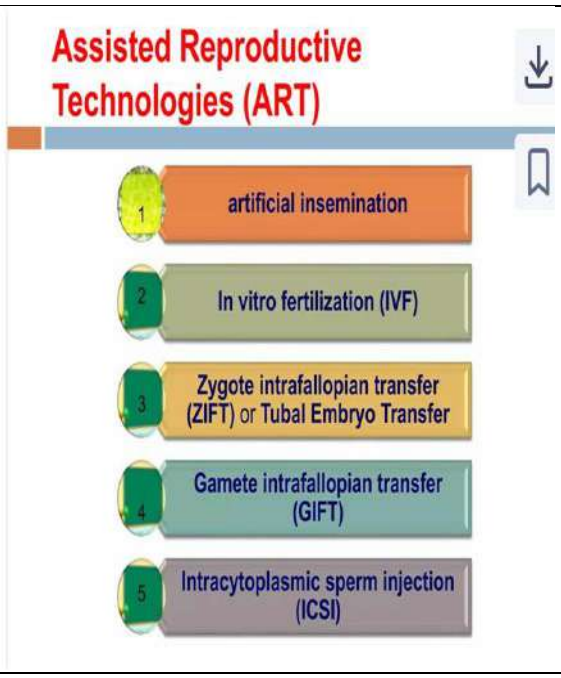


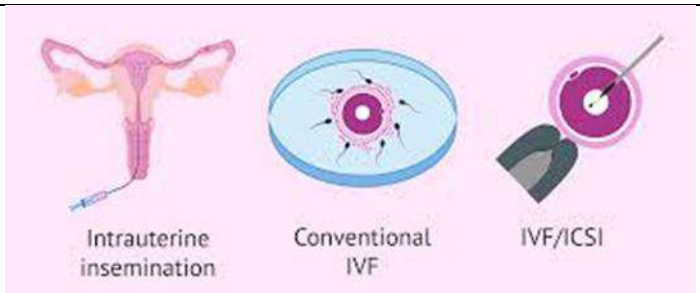
Points of importance

Natural methods Natural/Traditional Methods *Periodic abstinence *Withdrawal method/Coitus interuptus
Artificial methods Features of an Ideal *Contraceptive: *User-friendly *Easily available *Effective *Reversible *No/least side-effects *No interference with libido or act of coitus Eg condoms, cervical caps
Intention behind MTP amendment act 2017, (Government of India) + Reducing the incidence of illegal abortion. Decrease consequent maternal mortality and morbidity. MTPs are safe upto 12 weeks but riskier in 2nd trimester yet both are illegal and legal only in certain circumstances. + Amniocentesis and MTPs have been misused in context of female foeticide.

Sexually Transmitted Infections (STIs)/Venereal diseases (VD) / reproductive tract infections (RTIs)

High vulnerability/risk group: 15-24 years.
Bacterial and protozoan diseases are completely curable if detected early and treated properly.
Mode of Transmission:
+ Sexual intercourse.
Sharing of injection needle, surgical instruments with infected persons.
Transfusion of blood.
From infected mother to foetus.





Questions

MCQs

1.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.
2. Which of the following correctly describes the measures that can be used to control over population?
a. Educating people about the advantages of a small family.b. Raising the age of marriage.
c. Encouraging family planning programme.d. All of the above
3. The correct surgical procedure as a contraceptive method is:
a. ovariectomy b. hysterectomy c. vasectomy d. castration
4. Which one of the following groups includes sexually transmitted diseases caused by bacteria only?
a. Syphilis, gonorrhoea, chancroid b. Syphilis, chlamydiasis, chancroid
c. Syphilis, gonorrhoea, scabies d. Syphilis, scabies, pediculosis
5 . An IUD recommended to promote the cervix hostility to the sperms is :
a. Cu-T b. Multiload-375 c. LNG-20 d. Cu-7
6. Identify the disease which is not a sexually transmitted disease.
a. Gonorrhoea b. Syphilis c. Amoebiasis d. Chlamydiasis
Ans: 1b, 2d, 3c,4a, 5c, 6c.

VERY SHORT ANSWER QUESTIONS

1. A mother of one-year old daughter wanted to space her second child. Her doctor suggested Cu-T. Explain its contraceptive actions.
Ans. Cu-T increases phagocytosis of sperms within the uterus and the Cu2+ ions released suppress sperm motility and the fertilising capacity of sperms
2. Why do intensely lactating mothers not generally conceive?
Ans. Due to suppression of gonadotropins, ovulation and menstrual cycle do not take place in lactating mothers. So, they do not generally conceive
3. Mention any two events that are inhibited by the intake of oral contraceptive pills to prevent pregnancy in humans.
Ans. Two events that are inhibited by the intake of oral contraceptive pills to prevent pregnancy in humans are ovulation and implantation.
4. A doctor has observed the chromosomal disorders in developing foetus and advised the couple to undergo abortion. Suggest the technique by which doctor absorbed the chromosomal disorders.
OR
Give the technical term for foetal sex determination test based on the chromosomal pattern in the amniotic fluid surrounding the developing embryo.
Ans. Amniocentesis is such a technique.
5. At what stage zygote can be introduced in the Fallopian tube in Zygote Intra Fallopian Transfer (ZIFT)?
Ans. Zygote can be introduced in the Fallopian tube in ZIFT at 8-celled stage.
6. How do copper and hormone releasing IUDs act as contraceptives? Explain.
Ans. Copper and hormone releasing IUDs act as contraceptives in the following ways:
(i) The copper releasing IUDs release Cu ions, which suppress sperm motility and the fertilising capacity of sperms.
(ii) The hormone releasing IUDs make the uterus unsuitable for implantation and the cervix hostile to the sperms.

SHORT ANSWER QUESTONS

1.Mention the problems that are taken care of by Reproduction and Child Healthcare programme,
(ii) What is amniocentesis and why there is a statutory ban on it?
Ans. (i) Reproduction and Child Healthcare programmes take care of uncontrolled population growth, STDs and social evils like sex abuse and sex related crimes.
(ii) Foetal sex determination tests based on chromosomal pattern in the amniotic fluid to study chromosomal abnormalities in the foetus is called amniocentesis. It is banned so as to legally check female foeticide.
2.Name two hormones that are constituents of contraceptive pills. Why do they have high and effective contraceptive value? Name a commonly prescribed non-steroidal oral pill.
Ans. Progestogen-estrogen combination, Progestogen or Progesterone are present in contraceptive pills. They inhibit ovulation, implantation and alter quality of cervical mucus to retard entry of sperm. Saheli is a commonly prescribed non-steroidal oral pill.
1.A woman has certain queries as listed below, before starting with contraceptive pills. Answer them.
(i) What do contraceptive pills contain and how do they act as contraceptives?
(ii) What schedule should be followed for taking these pills?
Ans. (i) Contraceptive pills contain progestogen or progestogen-estrogen combination. They act as contraceptives by either of the following way:
(a) inhibit ovulation
(b) inhibit implantation
(c) alter quality of cervical mucus to prevent or retard entry of sperms
(ii) Contraceptive pills should be taken daily for a period of 21 days starting within first five days of menstrual cycle (to be repeated after a gap of 7 days).
2. Within what age group Sexually Transmitted Diseases (STDs) are reported to be very high? Mention three practices to avoid them.
Ans. In the age group of 15-24 years, STDs are reported to be very high. Following are the three practices to avoid them:
(i) Abstain sexual contact with unknown partners or multiple partners.
(ii) Always use condoms during coitus.
(iii) In case of any doubt, medical help should be taken for early detection.

CASE BASED QUESTIONS

1. Intra uterine devices are most widely accepted methods of contraception. These are used by females and are inserted by doctor or nurses in the uterus through vagina. However these devices are not recommended for those who eventually intend to conceive.
Q1. How does Cu prevent conception?
a. Cu ions make uterus unsuitable for implantation.b. Cu ions make cervix hostile to the sperms.
c. Cu ions suppress sperms motility. d. Cu ions inhibit ovulation.
Q2. Which of the following IUDs makes uterus unsuitable for implantation?
a. LNG-20 b. Multiload 375 c. Cu-7 d. Lippes' loop
Q3. Identify the correct statement for IUDs.
a. They slowly release synthetic progesterone in the body. b. They increase phagocytosis of sperms within the uterus. c. They block entry of sperms through the cervix. d. Both b. and c.
Q4. Select the correctly they matched pair:
a. Hormone releasing IUD - LNG-20 b. Non-medicated IUD - Progestasert
c. Copper releasing IUD - Lippes' loop d. None of the above

ASSERTION REASONING QUESTIONS

Each of the following questions consists of two statements, one is Assertion (A) and the other is Reason (R). Select the correct answer to these questions from the codes a, b, c and d as given below.

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. Assertion is false but reason is true.

1.Assertion (A): Determining the sex of an unborn child followed by MTP is an illegal practice.
Reason (R): Amniocentesis is a practice to test the presence of genetic disorders also.
Q2. Assertion (A): Lactational amenorrhea is the natural method of contraception.
Reason (R): It increases the phagocytosis of sperm.
Q3. Assertion (A): Saheli, an oral contraceptive for females, contains a steroidal preparation.
Reason (R): It is a "once a week" pill with very few side-effects.
Hint: 1b, 2c, 3d

LONG ANSWER QUESTIONS

Suggest and explain any three Assisted Reproductive Technologies (ART) to an infertile couple.
Ans. (i) Test Tube Baby Programmes
(a) In this method, ova from the wife/donor (female) and the sperms from the husband/ donor (male) are collected and induced to form zygote under simulated conditions in the laboratory. This process is called In Vitro Fertilisation (IVF).
(b) The zygote or early embryo with up to 8 blastomeres is transferred into the Fallopian tube (process is called Zygote Intra Fallopian Transfer or ZIFT) and embryo with more than 8 blastomeres is transferred into the uterus (process is called Intra Uterine Transfer or IUT).
(c) In females who cannot conceive, embryos formed by fusion of gametes in another female (called in vivo fertilisation) are transferred.
(ii) Gamete Intra Fallopian Transfer (GIFT) It is the transfer of an ovum collected from a donor into the Fallopian tube of another female who cannot produce one, but can provide suitable environment for fertilisation and further development of the embryo.
(iii) Intra Cytoplasmic Sperm Injection (ICSI) It is a procedure to form an embryo in the laboratory by directly injecting the sperm into an ovum.
(iv) Artificial Insemination (Al) (a) In this method, the semen collected either from the husband or a healthy donor is artificially introduced into the vagina or into the uterus (Intra Uterine Insemination or IUI). This technique is used in cases where the male is unable to inseminate sperms in the female reproductive tract or due to very low sperm counts in the ejaculation.

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CHAPTER:4PRINCIPLES OF INHERITANCE AND VARIATION

Genetics: Is a branch of biology concerned with the study of inheritance, as well as the variation of characters from parents to offspring.
Heredity: The process of genetic inheritance of characteristics from one generation to another;
Inheritance: The process by which characters are passed on from parent to progeny; it is the basis of heredity.
Variation: Is the degree by which progeny differ from their parents.

MENDEL'S LAWS OF INHERITANCE

- Gregor Johann Mendel is considered as 'father of genetics'
- Gregor Mendel conducted hybridization experiments on garden peas for seven years (1856-1863) and proposed the laws of inheritance in living organisms.
- Mendel conducted artificial pollination/cross pollination experiments using several true-breeding pea lines. A true-breeding line is one that, having undergone continuous self-pollination, shows the stable trait inheritance and expression for several generations.

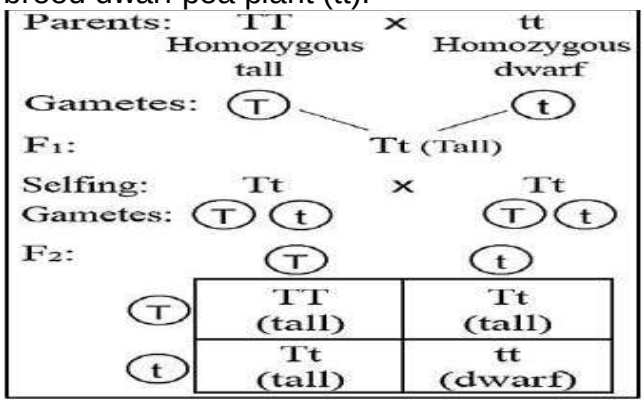
Why Mendel selected garden pea (*Pisum sativum*) plant for his hybridization experiments?

- They can be grown easily in open ground or even in pots.
- They have a short period of growth cycle.
- They produce self-pollinating flowers, large number of seeds and fertile hybrids on cross-pollination.
- They show contrasting heritable characters.

MONOHYBRID CROSS

The crossing between two plants, with respect to a single contrasting character is called monohybrid cross.

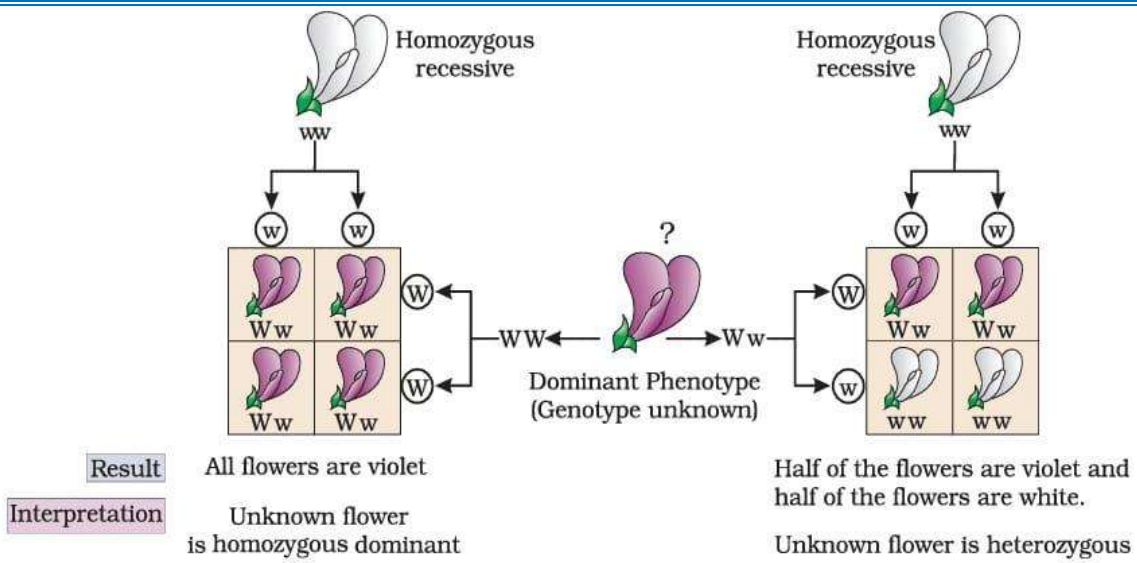
- Mendel conducted hybridization experiment by crossing true-breed tall pea plant (TT) with true-breed dwarf pea plant (tt).



Phenotypic ratio	**Genotypic ratio**
3 Tall : 1 Dwarf	Pure tall : Hybrid Tall : Pure Dwarf
1 TT : 2 Tt : 1tt	

TEST CROSS

The cross made between unknown plant (or F1 hybrids) with the recessive parent is called test cross. It.is useful to find the genotype an unknown plant



- Based on his observations on monohybrid crosses Mendel proposed two general rules to consolidate his understanding of inheritance in monohybrid crosses.

Law of dominance: It states that "In a dissimilar pair of factors one member of the pair dominates (dominant) the other one (recessive).
Law of Segregation: This law states "A pair of alleles segregate from each other during gamete formation, such that a gamete receives only one of the two factors".
Law of Independent assortment: The law states that "When two pairs of traits are combined in a hybrid, segregation of one pair of characters is independent of the other pair of characters".

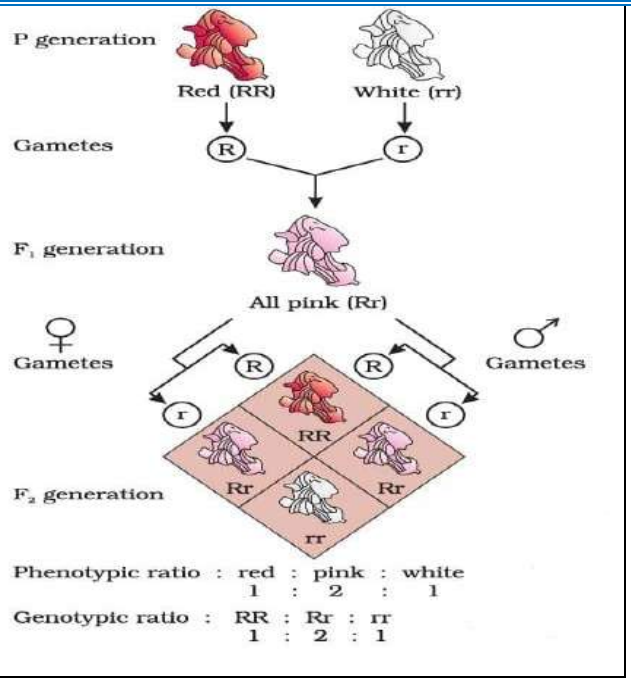
CO-DOMINANCE:

- The Alleles which are able to express themselves independently, even when present together are called co-dominant alleles and this biological phenomenon is called co-dominance.
- A good example is different types of red blood cells that determine ABO blood grouping in human beings.
- ABO blood groups are controlled by the gene I.
- The gene (I) has three alleles ^{IA}, ^{IB} and i. The alleles ^{IA} and ^{IB} produce a slightly different form of the sugar while allele i does not produce any sugar.
- In other words when I^A and i are present only I^A expresses (because i does not produce any sugar), and when I^B and i are present I^B expresses. But when I^A and I^B are present together they both express their own types of sugars: this is because of co-dominance. Hence red blood cells have both A and B types of sugars.

INCOMPLETE DOMINANCE

- It's a phenomenon in which the F1 hybrid exhibits intermediate characters of the parental gene
- It is seen in flower colours of Mirabilis jalapa (4 O'clock plant and Antirrhinus majus (Snapdragon).
- In a cross between true breeding red flowered (RR) and true breeding white flowered plants (rr), the F1 (Rr) was pink.
- When the F1 was self-pollinated the F2 resulted in the following ratio 1 Red (RR) : 2 Pink (Rr) : 1 White (rr).
- Here the phenotypic ratio deviates from the Mendel's monohybrid cross.

Both phenotypic and genotypic ratio will be the same 1:2:1.

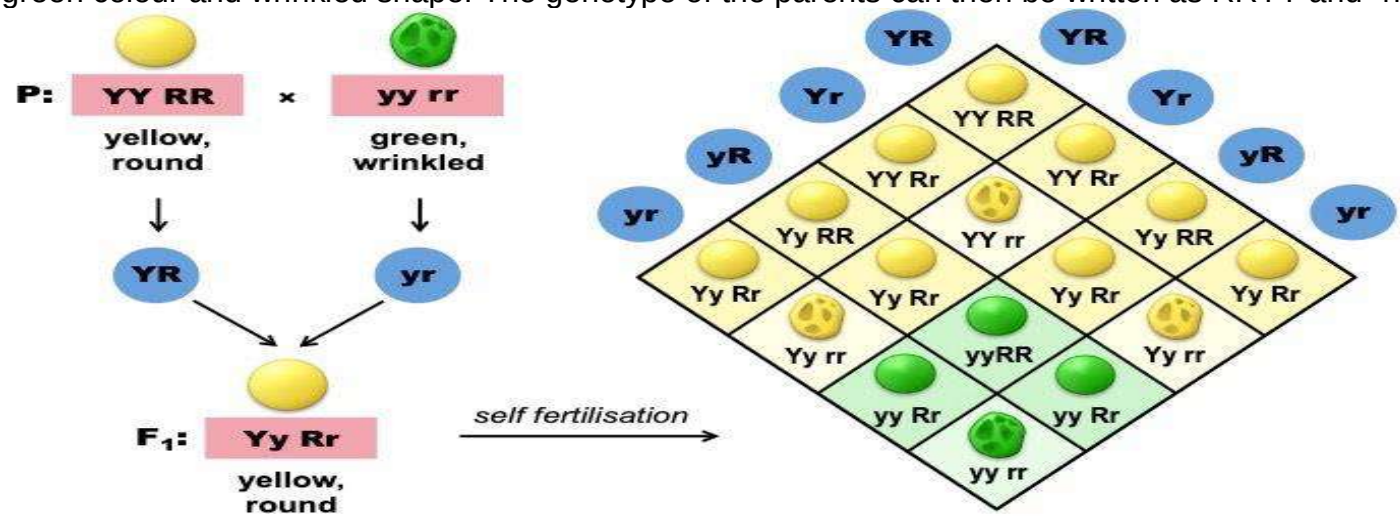


MULTIPLE ALLELISM:

Multiple allelism describes a genetic situation where more than two alleles exist for a single trait in a population. While individuals typically inherit only two alleles for each gene (one from each parent), multiple allelism indicates that a gene has multiple variations, leading to a wider range of possible phenotypes. A classic example is the ABO blood group system in humans, where there are three alleles (IA, IB, and i) for the same gene, resulting in four different blood types (A, B, AB, and O).

DIHYBRID CROSS (INHERITANCE OF TWO GENES)

- The cross between two parents differed in two pairs of contrasting traits; is called dihybrid cross.
- Mendel also worked with and crossed pea plants that differed in two characters, as is seen in the cross between a pea plant that has seeds with yellow colour and round shape and one that had seeds of green colour and wrinkled shape. The genotype of the parents can then be written as RRYY and rryy.



Phenotypic ratio: Round Yellow: Round Green : Wrinkled yellow : Wrinkled green

9 3 3 1

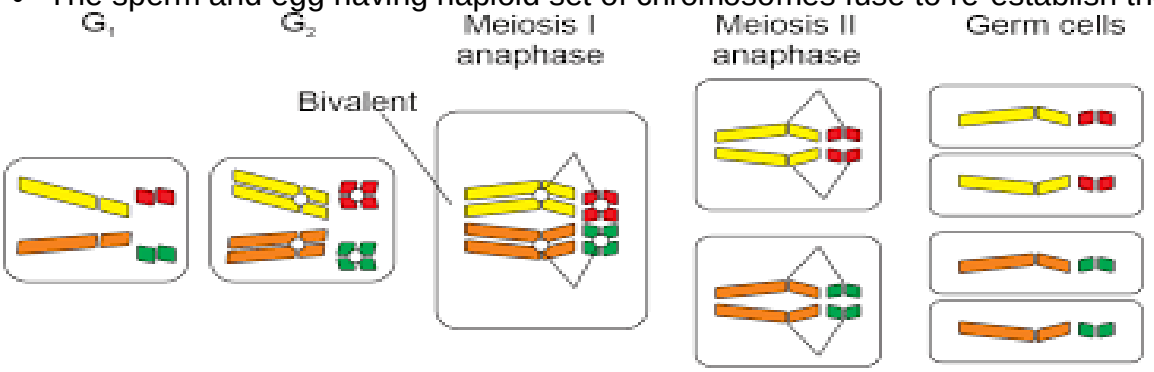
CHROMOSOMAL THEORY OF INHERITANCE

In 1900, three Scientists (de Vries, Correns and von Tschermak) independently rediscovered Mendel's results on the inheritance of characters.

Walter Sutton and Theodore Boveri noted that the behaviour of chromosomes was parallel to the behaviour of genes and used chromosome movement and proposed chromosomal theory of inheritance (in 1902).

According to Chromosomal Theory of inheritance;

- All hereditary characters must be carried through sperm and egg cells.
- The hereditary factors are carried in the nucleus in the form of chromosomes and genes.
- Like the mendelian alleles chromosomes are also found in pairs.
- The pairing and separation of a pair of chromosomes would lead to the segregation of a pair of factors they carried.
- The sperm and egg having haploid set of chromosomes fuse to re-establish the diploid state.



LINKAGE AND RECOMBINATION

Later Thomas Hunt Morgan, experimentally verify the chromosomal theory of inheritance. Morgan worked with tiny fruit flies, *Drosophila melanogaster.*

Morgan carried out several dihybrid crosses in Drosophila to study genes that were sex linked. The crosses were similar to the dihybrid crosses carried out by Mendel in peas.

Morgan hybridized yellow-bodied, white-eyed females to brown-bodied, red-eyed males and intercrossed their F1 progeny.

He observed that the two genes did not segregate independently of each other and the F2 ratio deviated very significantly from the 9:3:3:1 ratio.

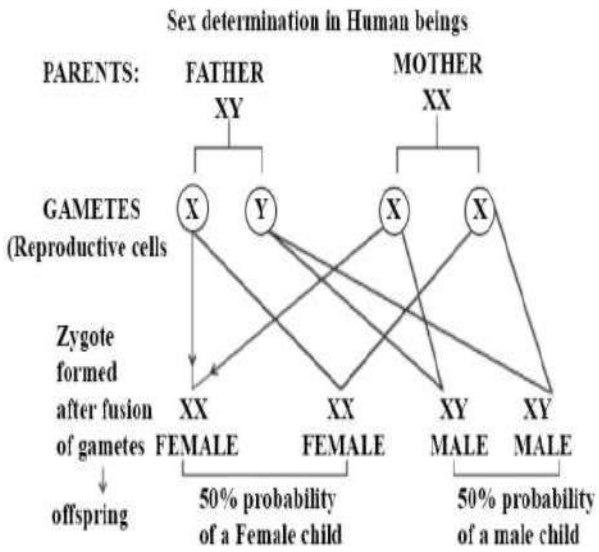
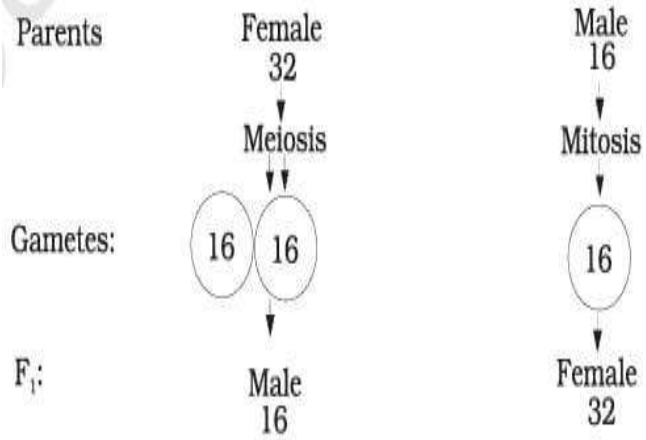
Linkage: The physical Association of two genes on a chromosome is termed as linkage.

Recombination: The generation of non-parental gene combinations is termed as recombination.

SEX DETERMINATION

- Finalization of sex at the time of zygote formation is called sex determination.
- Two types of chromosomes are present in individuals – sex chromosomes (which determine the sex of individual) and autosomes.

I. XX-XY type This type of sex determination seen in many insects and mammals including humans. Males have X and Y chromosomes along with autosomes and females have a pair of X chromosomes. Male heterogamety: In this case males produce two different types of gametes in term of the sex chromosomes.	II. XX-XO type This type of sex determination seen in grasshopper. Males have only one X chromosomes along with autosomes and females have a pair of X chromosomes.	III. ZZ-ZW type This type of sex determination seen in birds, fowl and fishes. Females have one Z and one W chromosome whereas males have a pair of Z chromosomes. Female heterogamety: In this case females produce two different types of gametes in term of the sex chromosomes.

SEX DETERMINATION IN HUMANS	**SEX DETERMINATION IN HONEYBEE**
	 **Figure 4.13** Sex determination in honey bee

MUTATION

Mutation is a phenomenon which results in alteration of DNA sequences and consequently results in changes in the genotype and the phenotype of an organism.

The sudden, stable, inheritable change in genetic material of an organism is termed as mutation.

The organism which undergoes mutation is called mutant.

The agent of mutation is called mutagen. E.g., UV radiations and some chemicals.

When mutation takes place due to change in a single base pair of DNA is called point mutation. E.g., Sickle-cell anaemia.

When mutation takes place due to deletion or insertion of a segment of DNA, alteration of chromosomes is called chromosomal aberration. Its common in cancer cells.

PEDIGREE ANALYSIS

The study of Inheritance of genetic traits in several generations of human family in the form of a family tree diagram is called pedigree analysis.

- It helps in genetic counselling to avoid disorders.
- It shows the origin of trait and flow of trait in a family.
- It is possible to know the expressive recessive allele that can cause genetic disorders.
- It predicts the harmful effects of marriage between close relatives.

GENETIC DISORDERS

Genetic disorders may be grouped into two categories Mendelian disorders and chromosomal disorders.

MENDELIAN DISORDERS

Mendelian disorders are mainly caused due to the alteration or mutation in the single gene.

Haemophilia	• Sex linked recessive disease. • Blood clotting protein is affected • The disease is controlled by two alleles,H (normal) & h (haemophilic). • In females haemophilia is very rare because it happens only when mother is atleast carrier and father haemophilic.
Sickle-cell anaemia	• Autosome linked recessive disease. • RBC becomes sickle shape • Heterozygous dominant (Hb^AHb^A): normal • Heterozygous (Hb^AHb^S) carrier: sickle cell trait • Homozygous recessive (Hb^SHb^S):affected • It is due to substitution of Glutamic acid by Valine at the 6th position of the β-globin chain of the haemoglobin molecule. • It is due to the single base substitution at the sixth codon of the beta globin gene from GAG to GUG
Thalassemia	• It is an autosome-linked recessive disease. • It occurs due to either mutation or deletion resulting in reduced rate of synthesis of one of the globin chains of haemoglobin. • Anaemia is the characteristic of this disease.
Phenylketon uria	• It is an in born error of metabolism and is inherited as the autosomal recessive trait. • The affected individual lacks an enzyme called phenylalanine hydroxylase that converts the amino acid phenylalanine into tyrosine in liver. • Phenylalanine is accumulated and converted into phenylpyruvic acid and other derivatives. This affects the brain results in mental retardation. These are also excreted through urine because of its poor absorption by kidney.
Colour	• It is a sex-linked recessive disorder.

blindness	• It results in defect in either red or/and green cone of eye, resulting in failure to determinate between red and green colour. • The gene for colour blindness is present on X-chromosome. • It is observed more in males (XcY) because of presence of only one X-chromosome as compared to two chromosomes of female.
Down's syndrome	• Down's syndrome is caused by an extra copy of chromosome number 21 (trisomy of 21). • This disorder was first discovered by Langdon Down (1866). • Short statured with small round head. • Partially open mouth with protruding furrowed tongue. • Palm is broad with characteristic palm crease. • Physical, psychomotor and mental development is retarded.
Klinefelter's syndrome	• Klinefelter's syndrome is caused by the presence of an additional copy of X-chromosomes, resulting in the karyotype of 44+XXY. • Sex of the individual is masculine but possess feminine characters. • Gynaecomastia i.e., development of breasts. • Poor beard growth and often sterile. • Feminine pictched voice
Turner's syndrome	• Turner's syndrome is caused by the absence of one of the X-chromosomes. i.e., 44+XO • Sterile female with rudimentary ovaries. • Shield shaped thorax. • Webbed neck. • Poor development of breasts. • Short stature, small uterus, puffy fingers.

QUESTION BANK

Multiple Choice Questions:

1. A child with blood group A has father of blood group B and mother with blood group AB. What would be the possible genotypes of parents and the child? Choose the correct option:

	Father	Mother	Child
(a)	I^Ai	I^Bi	I^Ai
(b)	I^AI^B	I^Ai	I^AI^A
(c)	I^Bi	I^AI^B	I^Ai
(d)	I^BI^B	I^AI^B	I^AI^A

2. The non-disjunction of 21st pair of autosomal chromosome leads to :

(a) Sickle cell anaemia
(b) Klinefelter's syndrome
(c) Turner's syndrome
(d) Down's syndrome

3. Which one of the gene pair is expected to give a ratio of 1: 1: 1: 1 in the progeny of Mendelian Dihybrid cross?

(a) AaBb x AaBb

(b) AABB x AaBb
(c) AaBb x aabb
(d) AABB x aabb

4. Both husband and wife have normal vision though their fathers are colour blind. The probability of their son becoming colour blind is
(a) 0% (b) 50% (c) 25% (d) 75%

5. Which one of the following statements is correct?
(a) Homozygous sex chromosome (ZZ) determines female sex in birds.
(b) XO type of sex chromosomes determines male sex in grasshopper.
(c) XO condition in human as found in Turner's syndrome determine female sex .
(d) Homozygous sex chromosomes (XX) produces male in *Drosophila*.

1	(c)	2	(d)	3	(c)	4	(c)	5	(b)

Assertion and Reason type questions:
The following questions consists of two statements, one is Assertion (A) and the other is Reason (R). Select the correct answer to these questions from the codes a,b,c and d as given below.
(a) Both reason and Reason are true but Reason is the correct explanation of Assertion.
(b) Both reason and Reason are true but Reason is the not the correct explanation of Assertion.
(c) Assertion is true but Reason is false.
(d) Both Assertion and Reason are false.
1. **Assertion (A)** : In thalassemia an abnormal myoglobin chain is synthesized due to a gene defect.
Reason (R) : α-thalassemia is controlled by genes HBA-1 and HBA-2 on chromosome 16.
2. **Assertion (A)** : Accumulation of phenylalanine in the brain results in mental retardation in phenylketonuria.
Reason (R) : The affected person lacks phenylalanine which is therefore not converted to tyrosine.
Ans. 1- (d) 2- (c)
Two marks questions:

1. A geneticist interested in studying variations and patterns of inheritance in living beings prefers to choose organisms for experiments with shorter life cycle. Provide a reason.
Ans. This is because many generations can be obtained in a short time and selection of character becomes faster.

2. Why in a test cross did Mendel cross a tall pea plant with a dwarf pea plant only?
Ans. This is to determine the genotype of the tall plant, whether it is homozygous dominant or heterozygous, as dwarfness is a recessive trait which is expressed only in homozygous condition and he was sure of genotype of dwarf plant.

3. In a dihybrid cross,when would the proportion of parental gene combinations be much higher than non parental types, as experimentally shown by Morgan and his group?
Ans. When the genes are linked the proportion of parental gene combinations would be much higher than non parental types.

4. Why do normal red blood cells become elongated sickle shaped structures in a person suffering from sickle cell anaemia?

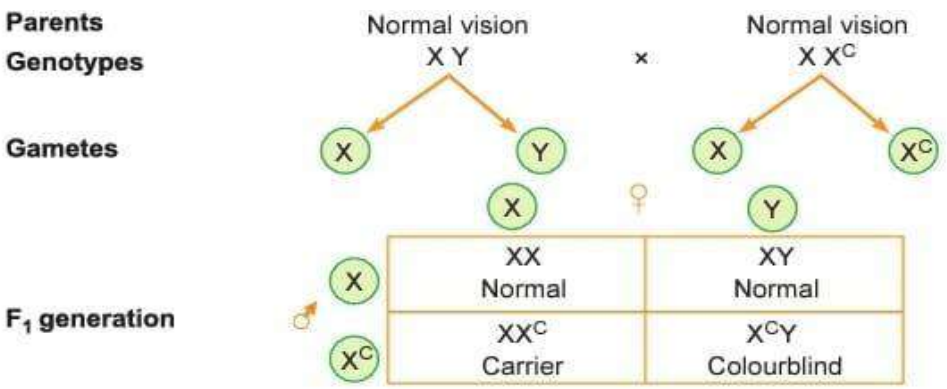
Ans. Due to point mutation,glutamic acid (Glu) is replaced by valine (Val) at the sixth position of β-globin chain of haemoglobin molecule. Under oxygen stress erythrocytes lose their circular shape and undergo polymerization to become sickle-shaped.

5. Why is it that the father never passes on the gene for haemophilia to his sons? Explain

Ans. Haemophilia is a sex linked recessive disease and the defective gene is present on X chromosome only and not on Y chromosome. Father never passes X chromosome to the son as father only contributes Y chromosome to the son.

Three marks questions :

1. One of the twins born to parents having normal colour vision was Down's blind whereas the other twin had normal vision. Work out the cross. Give two reasons how it is possible.
Ans.



.

It is possible when the mother is carrier of colour blindness gene. She will have normal vision but can pass on the gene to her child. Another possibility is that there is a mutation on the X-chromosome of one of the twins.

2. (*a*) Name the kind of diseases/disorders that are likely to occur in humans if
(*i*) mutation in the gene that codes for an enzyme phenylalanine hydrolase occurs,
(*ii*) there is an extra copy of chromosome 21,
(*iii*) the karyotype is XXY.
(b) Mention any one symptom of the diseases/disorders named above.

Ans.

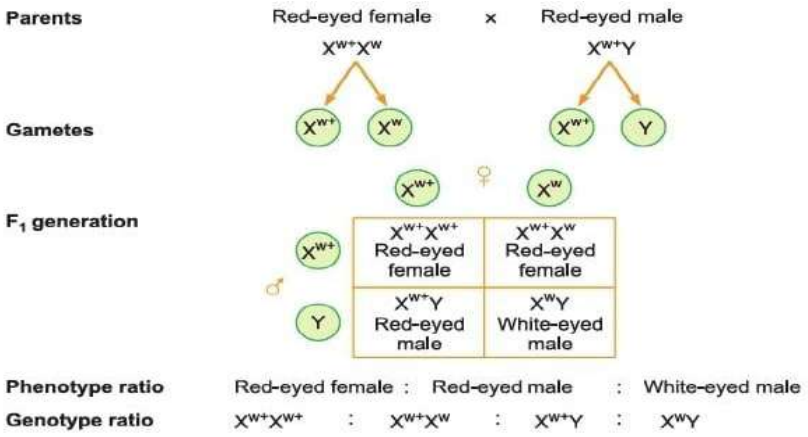
	Disease/Disorder	Symptoms
(i)	Phenylketonuria	Mental retardation
(ii)	Down's syndrome	Short stature/furrowed tongue
(iii)	Klinefelter's syndrome	Overall masculine development with feminine features (enlarged breast)

3.Explain the mechanism of 'sex determination' in birds. How does it differ from that of human beings?

Ans. Refer to the text given above

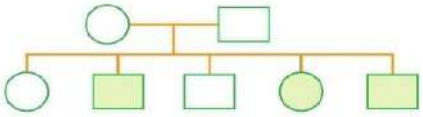
4.A red-eyed heterozygous female fruit fly is crossed with a red-eyed male. Work out all possible genotypes and phenotypes of the progeny. Comment on the pattern of inheritance of eye colour in fruit flies.

Ans. (i)



(ii) The gene for eye colour is sex-linked and is present on X chromosome. The character passes into the male from female and the male passes it to the female in the next generation. Male has only one X-chromosome and one Y-chromosome with no corresponding allele.

5.The pedigree chart given below, present a particular generation which shows a trait irrespective of sexes (*i.e*., present in both male and female). Neither of the parents of the particular generation shows the trait. Draw your conclusion on the basis of the pedigree.



Ans.The trait is autosome linked and recessive in nature. Both the parents are carriers (*i.e*., heterozygous). Hence, among the offsprings only few show the trait irrespective of sex. The other offsprings are either normal or carrier.

Case based questions:

1. Mendelian disorders are mainly determined by alteration or mutation in the single gene. These disorders are transmitted to the offspring on the same lines as we have studied in the principle of inheritance. The pattern of inheritance of such Mendelian disorders can be traced in a family by the pedigree analysis. Most common and prevalent Mendelian disorders are Haemophilia, Cystic fibrosis, Sicklecell anaemia, Colour blindness, Phenylketonuria, Thalassemia, etc.

I. Which of the following disorder is also called the Royal disease?

a) Colour blindness b) Haemophilia c) Sickle cell anaemia d) Alzheimer's disease

Ans. (b)

II. Which of the following genotypes and phenotypes in a man may be the correct result of aneuploidy in sex chromosomes?

a) 22 pairs + Y females b) 22 pairs + XY females c) 22 pairs + XXY females d) 22 pairs + XXXY females

Ans. (c)

III. Cystic fibrosis is an autosomal recessive genetic disorder. What are the chances that the child would have the disease if any one of the parent (either mother or father)is a carrier of the faulty cystic fibrosis gene (Cc)?

a) 100 per cent b) 50 per cent c) 25 per cent d) 0 per cent

Ans. (d)

IV. If the father in a family has a disease while the mother is normal, the daughters only are inherited by this disease and not the sons. Name this type of disease?

a) Autosomal recessive

b) Autosomal dominant

c) Sex-linked recessive

d) Sex-linked dominant

Ans. (d)

Five marks questions :

1.A pea plant with purple flowers was crossed with white flowers producing 50 plants with only purple flowers. On selfing, these plants produced 482 plants with purple flowers and 162 with white flowers. What genetic mechanism accounts for these results? Explain.

Hint: The gene for purple flowers is dominant over that of white flowers. So, when two pure varieties are crossed, the F1 generation has only purple flowers and on selfing, the flowers are produced in a 3 : 1 ratio in F2 generation.

2.Describe the mechanism of inheritance of the ABO system of blood group, highlighting the principle of genetics involved in it.

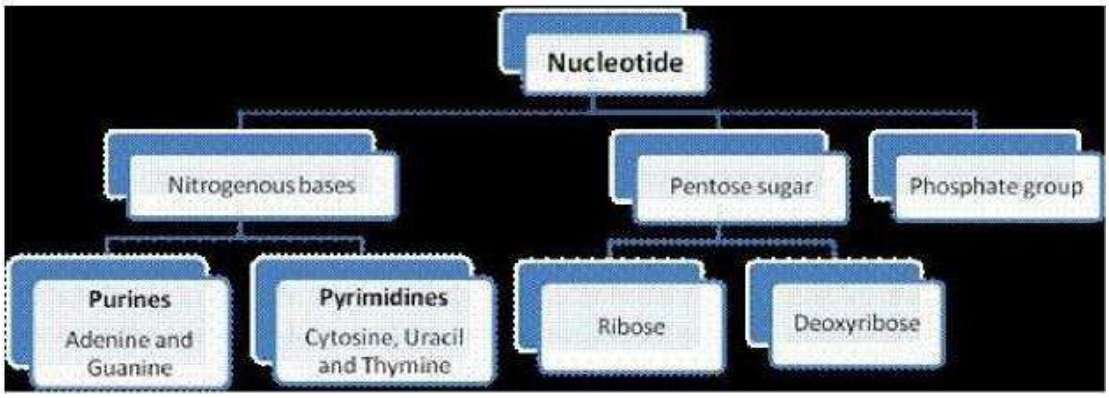
Hint: Refer to table 4.2 of NCERT.

CHAPTER: 5 MOLECULAR BASIS OF INHERITANCE

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

The DNA- It is a long polymer of deoxyribonucleotides. A pair of nucleotide is also known as base pairs. Length of DNA is usually defined as number of nucleotides present in it. *Escherichia coli* have 4.6×10^6 bp and haploid content of human DNA is 3.3×10^9bp.

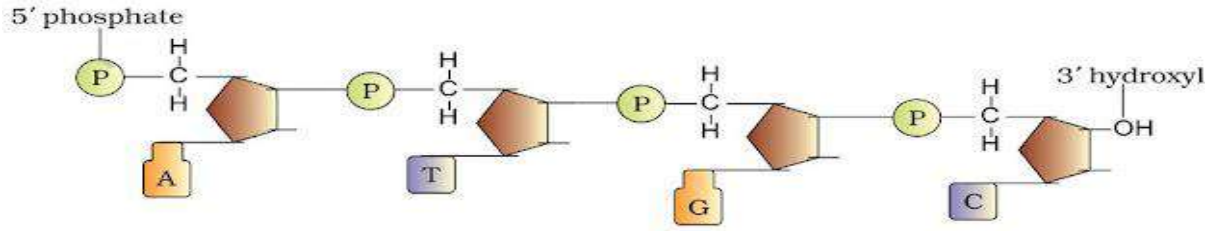
Structure of Polynucleotide Chain



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

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

A polynucleotide chain



A Polynucleotide chain

- A nitrogenous base is linked to pentose sugar with N-glycosidic linkage to form a nucleoside. When phosphate group is linked to 5'-0H of a nucleoside through phosphoester linkage nucleotide is formed.Two nucleotides are linked through 3'-5' phosphodiester linkage to form dinucleotide. More nucleotide joins together to form polynucleotide.

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

Structuraldifferences

DNA	RNA
a) The sugar present in DNA is deoxyribose.	(a)The sugar present in RNA is ribose.
(b) DNA contains cytosine and thymine as pyrimidine bases and guanine and adenine as purine bases.	(b) RNA contains cytosine and Uracil as pyrimidine bases and guanine and adenine as purine bases.
(c) DNA has double stranded-helix structure.	(c) RNA has a single stranded helix structure.
(d) DNA molecules are very large their molecular mass may vary from **6X10^{6}** - **16X10^{6} μ**	(d) RNA molecules are comparatively much smaller with molecular mass ranging from 20,000 -40,000.

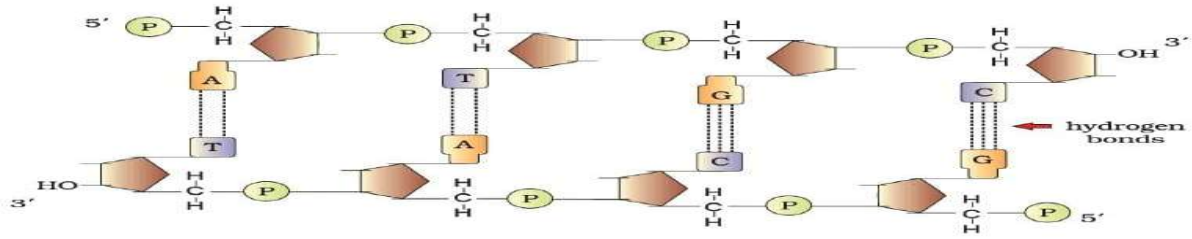
Functional differences

(a) DNA has unique property of replication.	(a) RNA usually does not replicate
(b) DNA controls the transmission of hereditary effects.	(b) RNA controls the synthesis of proteins

Double Helix Model for Structure of DNA-

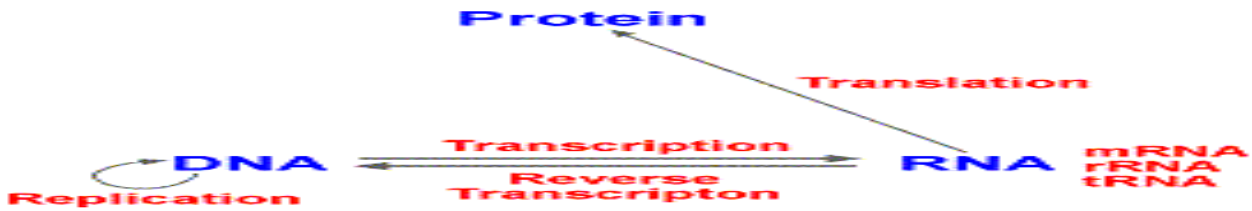
James Watson and Francis Crick, based on X-ray diffraction data produced by Wilkin and Rosalind proposed this model of DNA.The salient features of this model are-

1. DNA is made of two polynucleotide chains in which backbone is made up of sugar- phosphate and bases projected inside it.
2. Two chains have anti-parallel polarity.
3. The bases in two strands are paired through H-bonds. Adenine and Thymine forms double hydrogen bond and Guanine and Cytosine forms triple hydrogen bonds.
4. Two chains are coiled in right handed fashion.The pitch of helix is 3.4 nm and roughly 10 bp in each turn.
5. The plane of one base pair stacks over the other in double helix to confer stability.



Central Dogma in Molecular Biology:

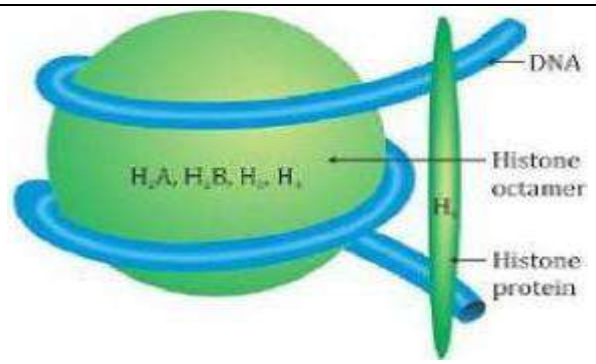
Francis Crick proposed the Central dogma in molecular biology, which states that the genetic information flows from DNA-----> RNA--------> Protein.



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

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

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

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

The search for Genetic Material

Transforming principle- Frederick Griffith in 1928 conducted experiment on bacteria *Streptococcus pneumonia* (bacterium responsible for pneumonia).There are two types of strain of this bacteria,someproducesmooth shiny colonies (S) and others produce rough colonies(R). Mice infected with the S strain (virulent) die from pneumonia infection but mice infected with the R strain donot develop pneumonia.

S strainInject in to miceMice died ⟶
R strainInject in to miceMice lived ⟶
S strain(heat-killed)Inject into miceMice lived ⟹
S strain(heat-killed) + R strain(live) ⟹ Inject in to mice ⟹ Mice died

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

Biochemical Characterisation of Transforming Principle

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

Experimental proof that DNA is the genetic material

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

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

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

Properties of Genetic Material:

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

b) It should chemically and structurally be stable.

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

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

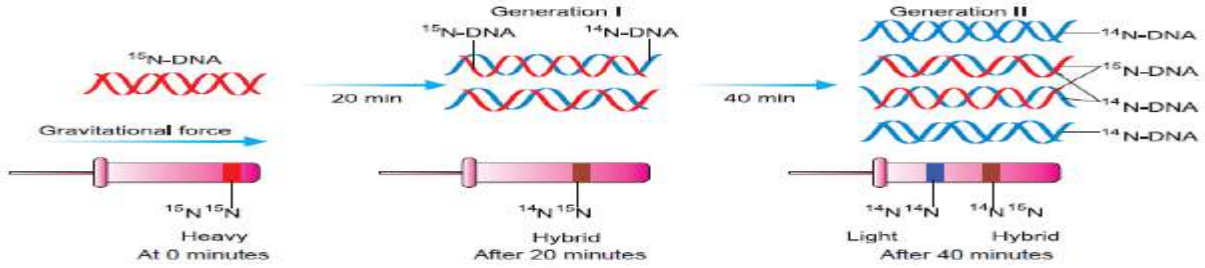
e) DNA is chemically less reactive but structurally more stable as compare to RNA. So, DNA is better genetic material.

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

Replication of DNA

Messelson and Stahl's shows experimental evidence of semi conservativereplication by growing E.coli on nutrient media containing nitrogensalts($^{15}NH_4Cl$) labelled with radioactive ^{15}N.^{15}N was incorporated into both the strands of DNA and such a DNA was heavier than the DNA obtained from E.coli grown on a medium containing ^{14}N.Then they ransferredthe E.coli cells on to a medium containing ^{14}N.

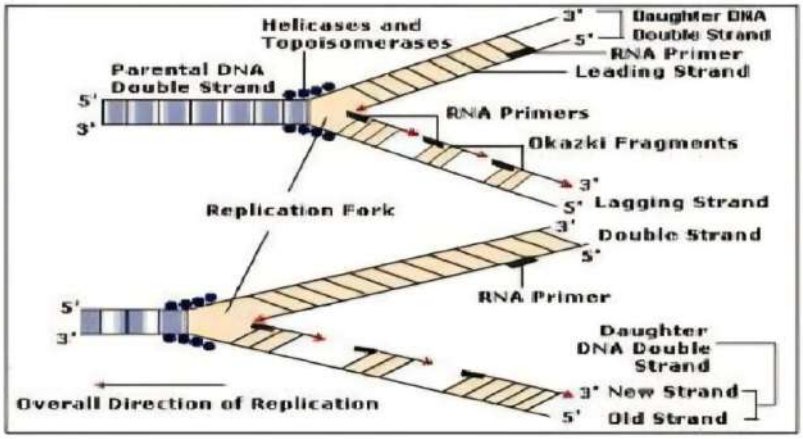
- After one generation, when one bacterial cell has multiplied into two, they isolated the DNA and evaluated its density. Its density was intermediate between that of the heavier ^{15}N-DNA and the lighter ^{14}N-DNA.
- This is because during replication, new DNA molecule with one ^{15}N-old strand and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



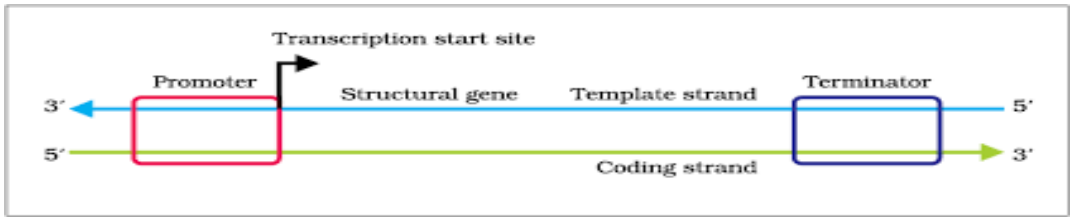
Replication :Replication of DNA require enzyme DNA polymerase that catalyse the polymerization in one strand 5'→3'only after unwinding with the help of Helicase enzyme. So,replication in one strand is continuous and other strand it is discontinuous to synthesise okazaki fragments that are joined together by enzyme DNA ligase.

Differences between leading and Lagging strands for DNA replication.

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



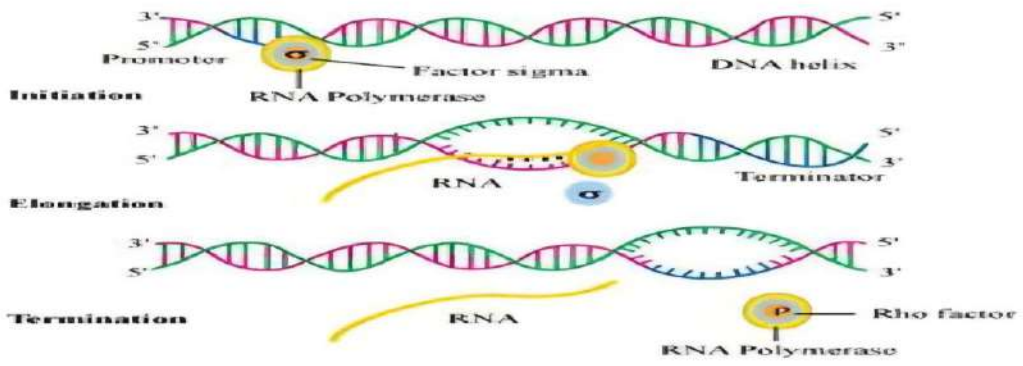
Transcription



It is the process of copying genetic information from one strand of DNA into RNA. In transcription only one segment of DNA and only one strand is copied in RNA.The Adenosine forms base pair with Uracil instead of Thymine.Transcription of DNA includes a promoter, the structural gene and a terminator. The strands that has polarity 3'→5'act as template and called template strand and other strand is called coding strand.Promoter is located at 5'end and that bind the enzyme RNA polymerase to start transcription.Sigma factor also help in initation of transcription.The

terminator is located at 3'end of coding strand and usually defines the end of transcription where rho factor will bind to terminate transcription

Transcription in Prokaryotes

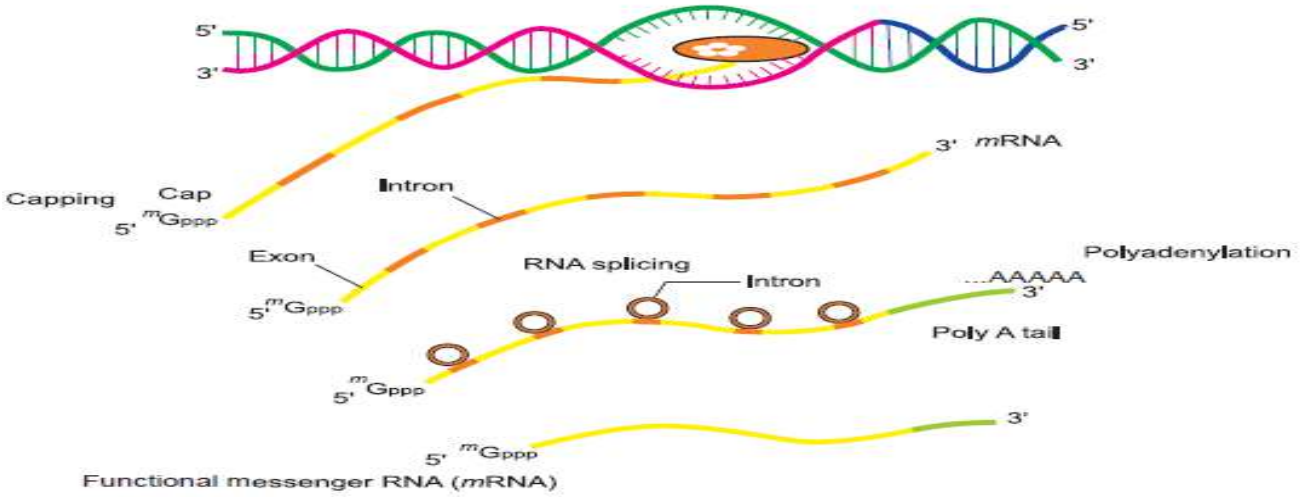


Exons are those sequences that appear in mature and processed RNA. Exons are interrupted by introns. Introns do not appear in mature and processed RNA.

Transcription in Eukaryotes

In eukaryotes, there are three different RNA polymerase enzymes I,IIand III, they catalysethe synthesis of all types of RNA.

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



- The primary transcript contains both exon and intron and is non-functional.It undergoes the process of splicing in which introns are removed and exons are joined in a defined order.
- The hnRNA (heterogeneous nuclear RNA) undergo additional processing called as capping and tailing.In capping an unusual nucleotide (methylguanosine triphosphate) to the 5'end of hnRNA. In tailing polydenylate tail is added at 3' end in a template at independent manner.

Genetic Code:

Genetic Code is the relationship of amino acids sequence in a polypeptide and nucleotide /base sequence in hnRNA.It directs the sequence of amino acids during synthesis of proteins. George Garnow suggested that genetic code should be combination of 3 nucleotides to code 20 amino acids.H.G.Khorana developed chemical method to synthesising RNA molecules with defined combination of bases.Marshall Nirenberg's cell free system for protein synthesis finally helped the code to be deciphered.

Salient features of Genetic Code are-

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

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

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

iv. The codon is read in mRNA in a continuous fashion with out any punctuation.

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

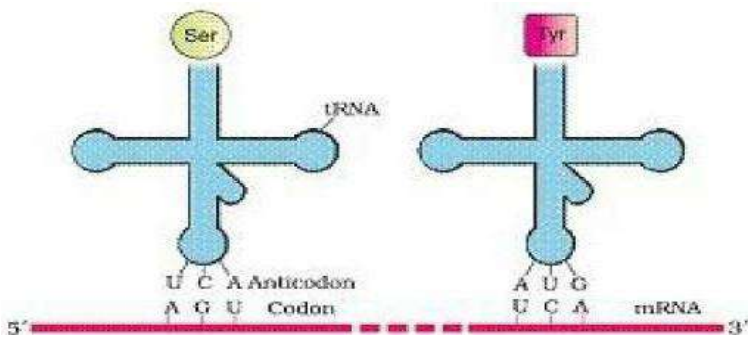
Mutations and Genetic code

- A change of single base pair (point mutation) in the 6th position of Beta globin chain of Haemoglobin results due to the change of amino acid residue glutamate to valine. These results into diseased condition called sickle cell anaemia.
- Insertion and deletion of three or its multiple bases insert or delete one or multiple codons hence one or more amino acids and reading frame remain unaltered from that point onwards. Such mutations are called frame-shift insertion or deletion mutations.

tRNA– the Adapter Molecule

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

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



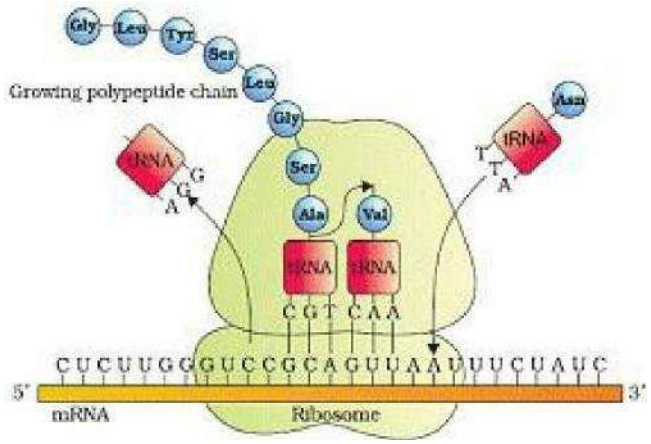
Translation process:

Translation is the process of polymerization of amino acids to form a polypeptide.Theorderandsequenceofaminoacidsaredefinedbythesequenceofbasesin the mRNA. Amino acids are joined by peptide bonds. It involves following steps-

Charging of t-RNA.

a) Formation of peptide bonds between two charged tRNA.

• The start codon is AUG. An mRNA has some additional sequence that are not translated called untranslated region(UTR).For initiation ribosome binds to mRNA at the start codon. Ribosomes moves from codon to codon along mRNA for elongation of protein chain. At the end release factors binds to the stop codon, terminating the translation and release of polypeptide form ribosome.

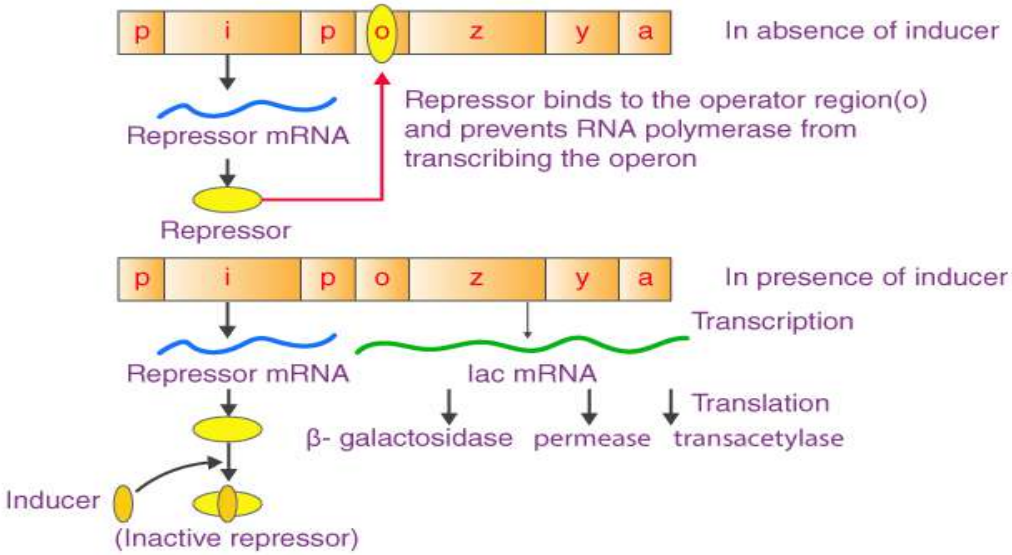


Regulation of Gene Expression:

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

The Lac Operon

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



- Lactose is the substrate for enzyme beta-galactosidase and it regulates switching on and off

of the operon, so it is called inducer.

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

Goal of HGP

a) Identify all the genes (20,000 to 25,000) in human DNA.

b) Determine the sequence of the 3 billion chemical base pairs that make up human DNA.

c) Store this information in database.

d) Improve tools for data analysis.

e) Transfer related information to other sectors.

f) To address the legal,ethical and social issues that may arise due to project.

The method involved the two major approaches- first identifying all the genes that expressas RNA called Express sequence tags(EST). The second is the sequencing the all set of genome that containedall the coding and non-coding sequence called sequence Annotation.

Salient features of Human Genome:

a) The human genome contains 3164.7 million nucleotide bases.

b) The average gene consists of 3000 bases, but sizes vary greatly, with the largest known human gene being dystrophin at 2.4 million bases.

c) Less than 2 percent of the genome codes for proteins.

d) Repeated sequences make up very large portion of the human genome.

e) Repetitive sequences are stretches of DNA sequences that are repeated many times, sometimes hundred to thousand times.

f) Chromosome 1 has most genes (2968), and the Y has the fewest (231).

g) Scientists have identified about 1.4 million locations where single base DNA differences (SNPs-single nucleotide polymorphism) occur in humans.

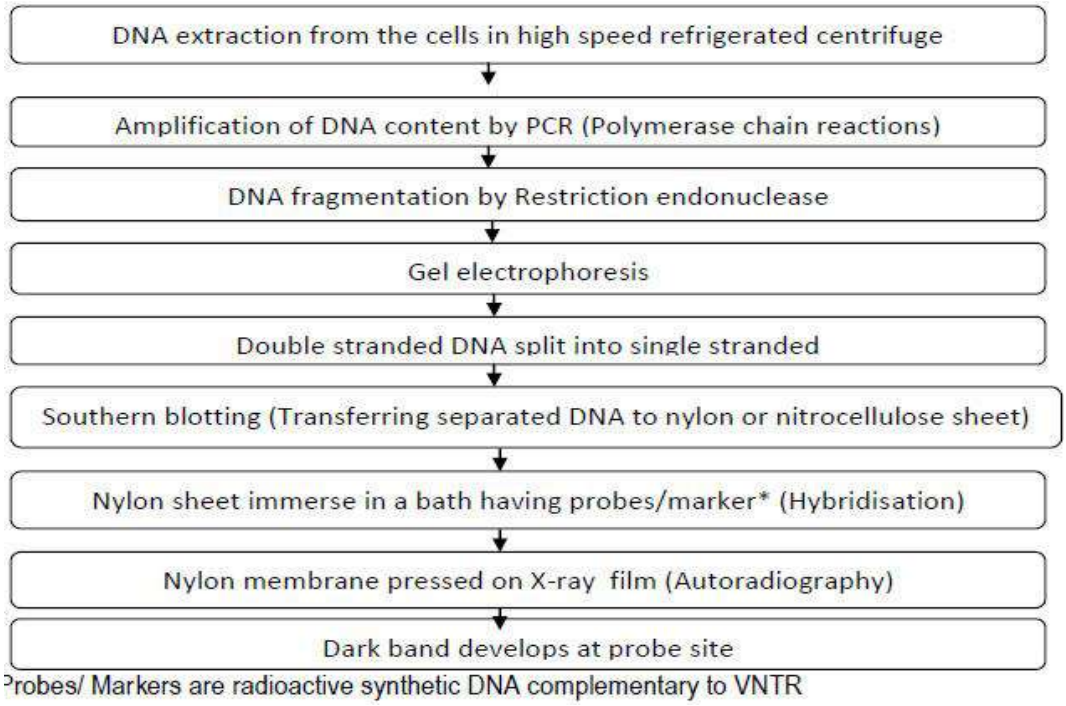
DNA finger printing

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

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

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

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



Question Bank

MCQs:

1. In *E.coli*, the *lac* operon gets switched on when
(*a*) lactose is present and it binds to the DNA repressor
(*b*) repressor binds to operator
(*c*) RNA polymerase binds to the operator
(*d*) lactose is present and it binds to RNA polymerase

2 .If the sequence of nitrogen bases of the coding strand of DNA in a transcription unit is: 5' - A T G A A T G - 3', the sequence of bases in its RNA transcript would be

(*a*) 5' - A U G A A U G - 3'
(*b*) 5' - U A C U U A C - 3'
(*c*) 5' - C A U U C A U - 3'
(*d*) 5' -G U A A G U A - 3'

3 .While analysing the DNA of an organism a total number of 5386 nucleotides were found, out of which the proportion of different bases were: Adenine = 29%, Guanine = 17%, Cytosine = 32%, Thymine = 17%. Considering the Chargaff's rule it can be concluded that
(*a*) It is a double stranded circular DNA (*b*) it is single stranded DNA
(*c*) It is a double stranded linear DNA (*d*) no conclusion can be drawn

4.Discontinuous synthesis of DNA occurs in one strand, because
(*a*) DNA molecule being synthesised is very long
(*b*) DNA dependent DNA polymerase catalyses polymerisation only in one direction (5′ → 3′)
(*c*) it is a more efficient process (*d*) DNA ligase joins the short stretches of DNA

Ans. 1a, 2a, 3b, 4a

Assertion and Reason type questions:

The following questions consists of two statements, one is Assertion (A) and the other is Reason (R). Select the correct answer to these questions from the codes a,b,c and d as given below.

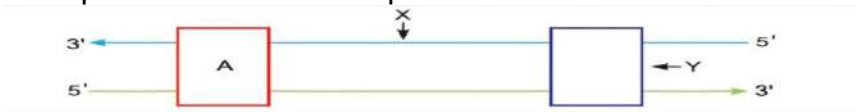
a) Both reason and Reason are true but Reason is the correct explanation of Assertion.
b) Both reason and Reason are true but Reason is the not the correct explanation of Assertion.
c) Assertion is true but Reason is false.
d) Both Assertion and Reason are false.

1.Assertion : In Griffith's experiment, the mixture of heat-killed virulent *R* bacteria and live non-virulent S bacteria, lead to the death of mice.
Reason : The transforming principle got transferred from *S* strain to heat-killed *R* strain and made it virulent.
2.**Assertion :**DNA is considered to be a better genetic material than RNA for most organisms.
Reason :2'–OH group present in DNA makes it less reactive.
Ans. 1(d) 2 (c)

Two marks questions:

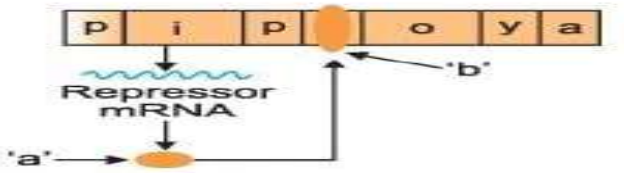
1. Why does hn RNA undergo splicing? Where does splicing occur in the cell?
Ans.RNA undergoes splicing to remove non-coding sequences, i.e. introns and joins exons. Splicing occurs in the nucleus of the cell.

2. What do 'X' and 'Y' represent in the transcription unit of the DNA molecule shown?



Ans. X—Template Strand Y—Terminator

3. Given below is a schematic representation of a *lac* operon in the absence of an inducer. Identify '*a*' and '*b*' in it.



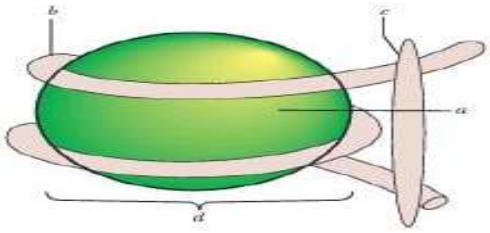
Ans. *a*–Repressor
b–Repressor bound to the operator and prevents transcription of structural genes.

4. Explain the role of 35S and 32P in the experiments conducted by Hershey and Chase.
Ans.See the text given above
5.A template strand is given below. Write down the corresponding coding strand and the *m*RNA strand that can be formed, along with their polarity.

3′ **ATGCATGCATGCATGCATGCATGC** 5′
Ans.Coding strand: 5′ TACGTACGTACGTACGTACGTACG 3′
*m*RNA strand: 5′ UACGUACGUACGUACGUACGUACG 3′

Three marks Questions:

1.

(*a*) What is this diagram representing? (*b*) Name the parts *a*, *b* and *c*. (*c*) In the eukaryotes, the DNA molecules are organised within the nucleus. How is the DNA moleculeorganised in a bacterial cell in absence of a nucleus?	

Ans. (*a*) Nucleosome (*b*) *a*—Histone octamer, *b*—DNA, *c*—H1 histone
(*c*) In bacterial cell, DNA in nucleoid is organised in large loops held together by proteins.
2. It is established that RNA is the first genetic material. Explain giving three reasons.
Ans.(*i*) Processes like metabolism, translation and splicing evolve around RNA.
(*ii*) RNA is reactive and catalyses reactions.
(*iii*) In some viruses, RNA is the hereditary material.
(*iv*) RNA is unstable and can be easily mutated leading to evolution. (*Any three*)
3.The base sequence in one of the strands of DNA is TAGCATGAT.
(*i*) Give the base sequence of its complementary strand.
(*ii*) How are these base pairs held together in a DNA molecule?
(*iii*) Explain the base complementarity rules. Name the scientist who framed this rule.
Ans.(*i*) The complementary strand is ATCGTACTA.
(*ii*) The base pairs are held together by hydrogen bonds in a DNA molecule. A and T are held by two hydrogen bonds while G and C are held by three hydrogen bonds.
(*iii*) Watson and Crick framed the base complementarity rule. The rule states that the ratios between

adenine and thymine, and guanine and cytosine are constant and equals one.

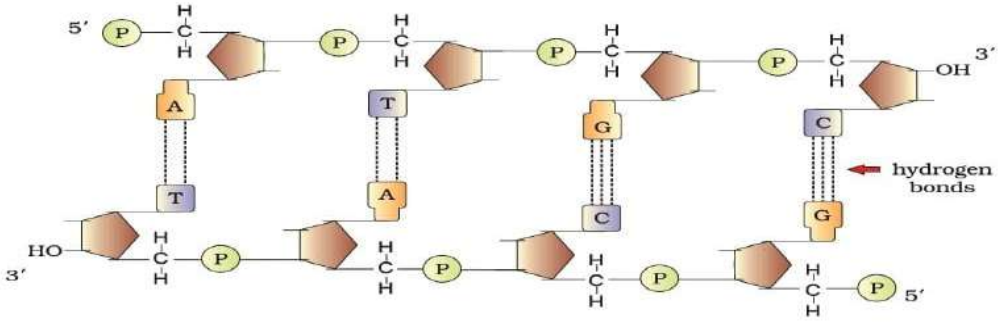
4. What are the three types of RNA? Mention their relation to protein synthesis.

	Types of RNA	**Functions**
(i)	Messenger RNA (mRNA)	(i) It stores the genetic information from DNA. (ii) It decides the sequence of amino acid in a polypeptide.
(ii)	Transfer RNA (tRNA)	(i) It acts as an adaptor molecule that at one end reads the code on mRNA and accordingly bind to amino acid on the other end. (ii) It recognises the codon on mRNA by its anticodon and leaves amino acid at the protein synthesis site.
(iii)	Ribosomal RNA (rRNA)	(i) It constitutes the ribosomal structure. (ii) It helps to form peptide bond.

5. How is *hn*RNA processed to form *m*RNA?
Ans. The *hn*RNA undergoes the following processes to form *m*RNA:
(*i*) Capping: Addition of methyl guanosine triphosphate at 5’-end.
(*ii*) Tailing: Addition of 200-300 adenylate residues at 3’-end.
(*iii*) Splicing: Removal of introns and rejoining of exons.

Case Based Questions:

1. Observe the diagram of the polynucleotide chain and answer the questions.



(*i*) The fact that a purine base always pairs through hydrogen bonds with a pyrimidine base in the DNA double helix leads to
(*a*) The antiparallel nature (*b*) The semiconservative nature (*c*) Uniform width throughout DNA
(*d*) Uniform length in all DNA
(*ii*) How does the flow of genetic information in HIV deviate from the 'Central dogma' proposed by Francis Crick?
(*iii*) Write the role of histone protein in packaging of DNA in eukaryotes.

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CHAPTER: 6 EVOLUTION

- Origin of life is believed to be a unique event in the history of universe.
- The **Big Bang** Theory attempts to explain to us the origin of universe.

The Big Bang theory:

- A singular huge explosion of very dense matter from a point of singularity caused the universe to expand and the temperature to fall drastically.After sometime hydrogen and helium were formed.
- The gases condensed due to gravitation. They later formed the galaxies in the universe. The Earth is believed to have been formed about 4.5 billion years back in the solar system of the Milky Way galaxy.

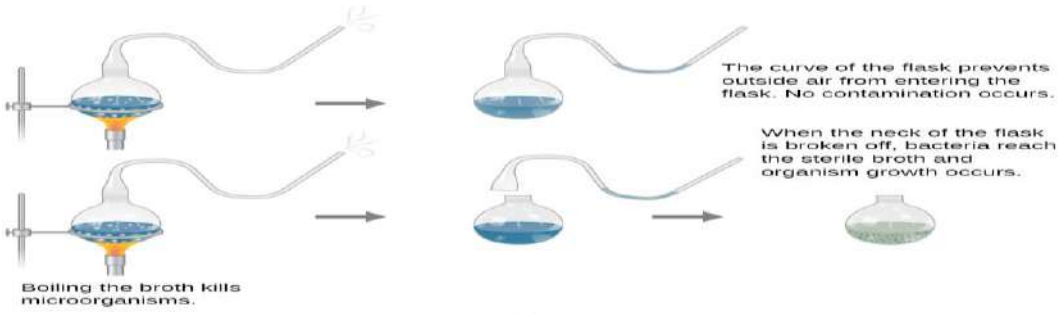
Condition of early earth:

- The Earth was formed 4.5 billion years back with no atmosphere on early earth.
- Water vapor, methane, carbon dioxide and ammonia released from molten mass covered the surface.The UV rays from the sun caused decomposition of water into hydrogen and oxygen.Hydrogen gas being lighter escaped into space.
- Oxygen that remained behind combined with ammonia and methane to form water,CO_2 and other compounds.The ozone layer was formed.
- As the water vapor cooled,it fell as rain, to fill all the depressions and form oceans.

Origin of Life (theories):

- Early Greek believed that units of life called **spores** were brought to different planets including earth. This theory is called as **Panspermia** and is still favored by many astronomers.
- For a long time it was also believed that life could originate from decaying and rotting matter like straw,mudetc.
- This was the **theory of spontaneous generation.** It was disproved by Louis Pasteur by his swan-neck flask experiment.

Louis Pasteur experiment:

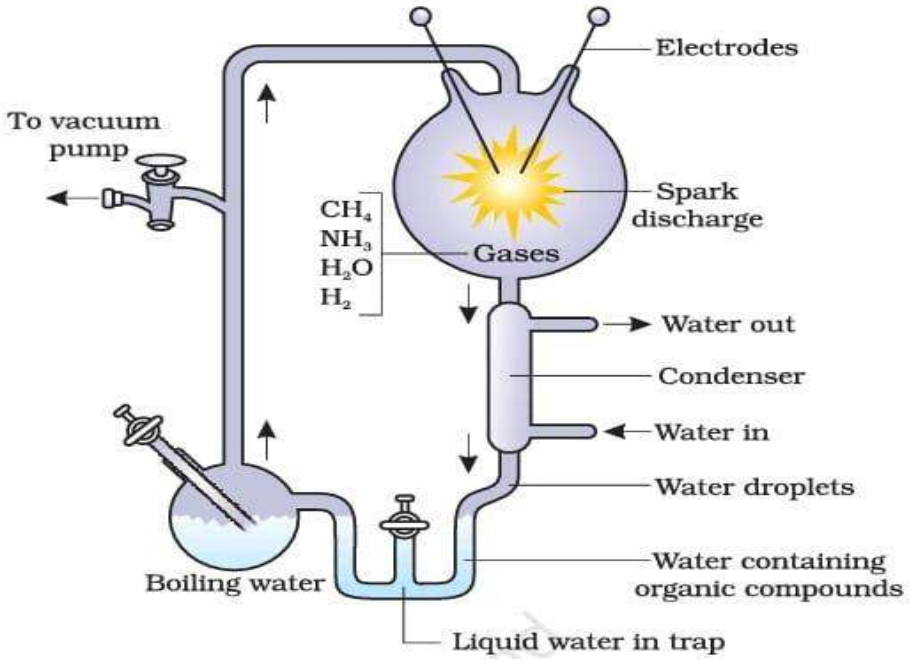


Oparin–Haldane theory of origin of life:

- Oparin of Russia and Haldane of England proposed that the first forms of life originated from pre- existing non- living organic molecules (e.g. RNA, protein etc.).
- Formation of life was preceded by chemical evolution i.e. formation of diverse organic molecule from inorganic constituents.
- In1953,S.L.Miller,an American scientist demonstrated the same experimentally in a laboratory scale

Urey and Miller Experiment:

- **The Conditions of the Earth were–**
  (1)High Temperature. (2)Volcanic Storms. (3)Reducing atmosphere containing CH_4,NH_3etc.
- **In 1953 S.L.Miller** an American scientist created similar conditions in laboratory scale.
  - To simulate conditions of primitive earth he created electric discharge in a closed flask. This raised the temperature up to 800ºC.
  - Used CH_4,H_2,$NH_3$and water vapor inside the flask.
- He observed the formation of **amino acids**



Diagrammatic representation of Miller's experiment

- Miller observed the synthesis of amino acids from simple inorganic chemicals. He did this by recreating the conditions that were believed to exist on primitive earth in the laboratory.
- In similar experiments formation of sugars,nitrogen bases,pigment and fats were also observed by other scientists.

Theory of Origin of Species by Natural Selection:-

Survival of the fittest: The fitness according to Darwin refers ultimately to the ability to survive a change. Therefore only the fittest organisms survive and produce more progeny then others.

- These,therefore,have better survival capacities and hence are selected by nature. He called it as natural selection.
- Alfred Wallace, a naturalist who worked in Malay Archipelago had also come to similar conclusions around the same time.

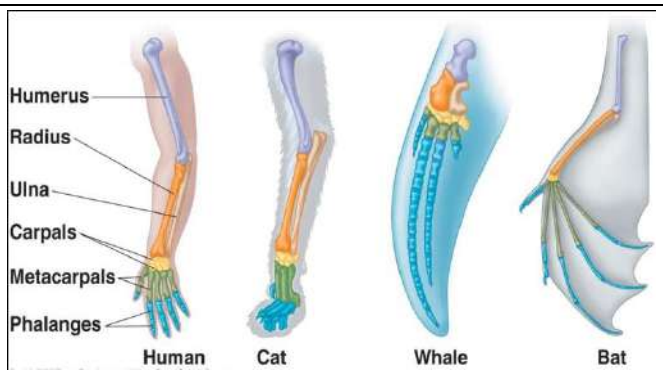
WHAT ARE EVIDENCES FOR EVOLUTION?

Paleontological evidence:

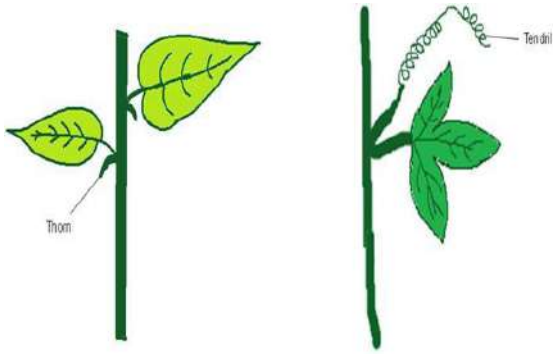
- Fossils are remains of hard parts of life-forms found in rocks.
- Different-aged rock sediments contain fossils of different life-forms who probably died during the formation of the particular sediment.
- They represent the extinct organisms(e.g.Dinosaurs).
- All this called **Paleontological evidence.**

Divergent evolution:

- Different mammals like bats,whales,cheetah and humans share similarities in the pattern of bones of forelimbs.These forelimbs perform different functions in these animals but they have similar anatomical structure .Thus it can be seen that the same structure developed along different directions due to adaptation to different needs.
- This direction of evolution is called as **divergent evolution** and these structures are **homologous** to each other.
- Homology indicates common ancestry.
- Other examples of homologous organ are vertebrate hearts and brains.
- Thorn of **Bougainvillea and tendrils of Cucurbita** represent homology.



Homologous organs: Forelimbs of mammals

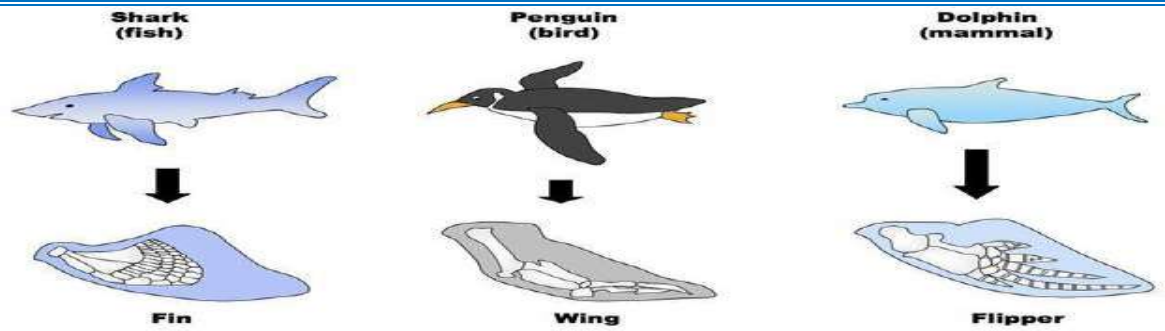


Homologous organs in Plants

Convergent Evolution:

- Anatomically they do not have similar structure though they perform **similar function.**Hence **analogous** structures are a result of **convergent evolution**.

- Eyes of different organisms like that of octopus of mammals,Flippers of Penguins and Dolphins,Sweet potato (root modification) and potato (stem modification) for storage of food, Wings of butterfly and of birds both appear similar.



Biochemical evidences:

- Similarities in proteins and genes performing a specific function among different organisms give clues regarding common ancestry.

Embryological support forevolution:

- Ernst Heckel proposed this evidence as evolution based on observation of certain common features during embryonic stage of all vertebrates but are absent in adult.
- All vertebrate embryos including human embryo develop a row of vestigial gill slits just behind the head.It is seen that it is a functional organ only in fish. Gills are not found in any other adult vertebrates.

Evolution by natural selection:

- A popular example is the change in frequency of moth population in England in 1850.
- Before industrialization set in more white-winged moths were observed on trees than dark winged or melanised moths.
- After industrialization *i.e*.1920,the proportion was reversed as there were more dark-winged moths in the same area.

Evolution by anthropogenic action:

- Excess use of herbicides, pesticides etc., has resulted in selection of the resistant varieties in a much lesser time scale.This has also been observed for microbes against which we use antibiotics or drugs.
- These are the examples of evolution by **anthropogenic action.**

WHAT IS ADAPTIVE RADIATION?

Darwin's Finches:

- Darwin's theory was based on observation of certain birds in the Galapagos Islands. The small black birds he observed have since been called Darwin's Finches.
- He observed that there were many varieties of finches in the same island which were originally adapted with seed-eating features. From these many other forms evolved with altered beaks depending on the food habit.
- This process of evolution of different species in a given geographical area starting from a point and radiating to other areas of geography is called as **adaptive radiation.**

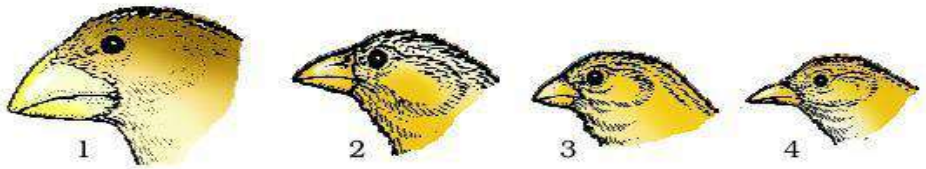


Figure 7.5 Variety of beaks of finches that Darwin found in Galapagos Island

Australian marsupial:

- In Australia it was seen that a number of marsupials had evolved from an ancestral stock.These marsupials were all different from each other.
- When more than one adaptive radiation appears to have occurred in an isolated geographical area(representing different habitats), it can be called as **convergent evolution.**
- **Placental mammals** in Australia were also seen to exhibit adaptive radiation.

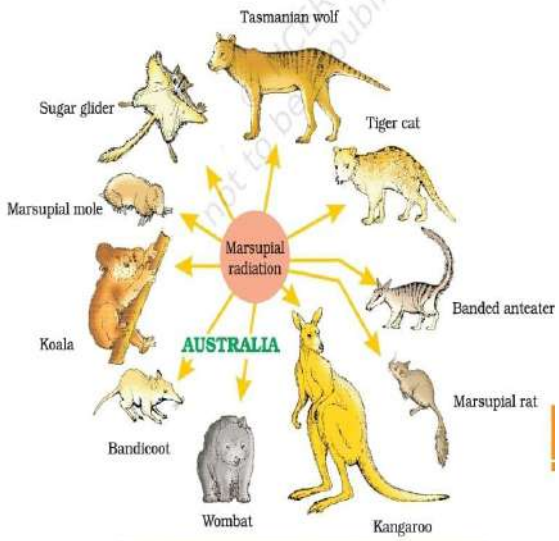


Figure 7.6 Adaptive radiation of marsupials of Australia

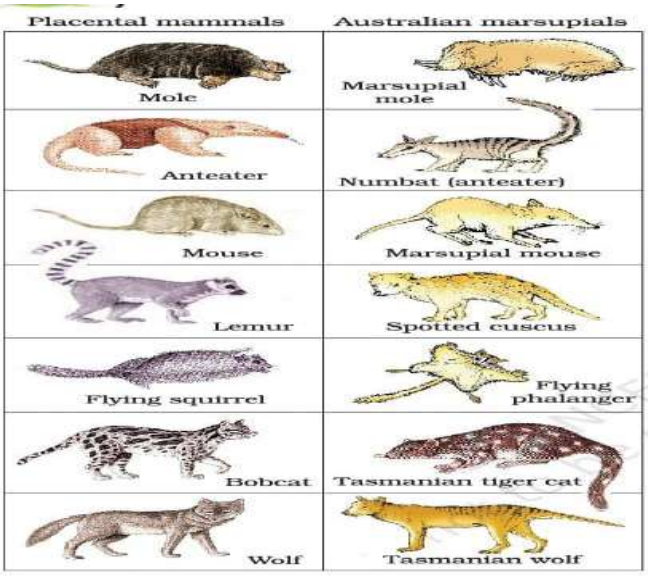


Figure 7.7 Picture showing convergent evolution of Australian Marsupials and placental mammals

BIOLOGICAL EVOLUTION:

- **Natural selection** is the essence of Darwinian Theory about evolution.
- Organisms with favorable variations are better adapted to survive in a hostile environment.
- The key concepts of Darwinism are:
  - **Natural selection:** Survival of the fittest by the nature in face of changing environment.

- **Theory of Common Descent:** Organisms are descended from common ancestors due to accumulation of variations

Lamarck theory of evolution: (theory of inheritance of acquired characters)

- French Naturalist Lamarck proposed that evolution of life forms occurs due to **use and disuse** of organs.
- He explained this theory using giraffes as an example. He claimed that giraffes formed long necks in an attempt to forage leaves on tall trees. This character was acquired based on a need to adapt and survive and was passed to succeeding generations. Giraffes, therefore, came to develop long necks slowly over the course of many years.

MECHANISM OF EVOLUTION:

- **Hugo de Vries** worked on **evening primrose.** He gave the idea of **mutations**.
- Mutation is the difference arising suddenly in a population.

Hugo de Vries theory of mutation differs from Darwin's theory of natural selection.

- He stated that mutation causes evolution and not the minor variations that as suggested by Darwin.
- Mutations are sudden ,random and directionless while Darwinian variations are small and directional.
- Evolution according to Darwin was slow and gradual whereas Hugo de Vries believed that mutation caused large changes that led to speciation. He therefore called it **saltation** (single step large mutation).

HARDY–WEINBERG PRINCIPLE:

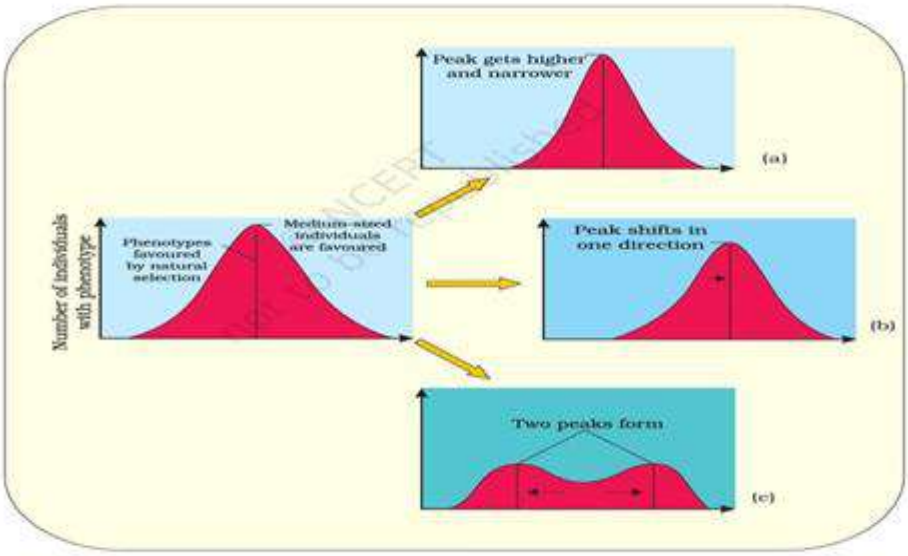
- For given population the frequency of occurrence of alleles of a particular gene present on a specific locus can be calculated.
- This frequency is usually fixed and remains the same throughout different generations.
- Hardy-Weinberg principle expressed the same using algebraic equations. This is called as the **Hardy-Weinberg Principle.**
- The principle states that allele frequencies in a population are stable and are constant from generation to generation.
- The **genepool** (total genes and their alleles in a population) remains a constant.This is called **genetic equilibrium**.
- Sum total of all the allelic frequencies is 1.
- The principle can be represented mathematically as follows:
- $\mathbf{(p+q)^2= p^2+ 2pq + q^2=1.}$
- p and q represent the individual allele frequencies.
  Therefore,p^2= frequency of homozygous condition represented by p
  And q^2 = frequency of homozygous alleles represented by q
  And pq = frequency of heterozygous condition
- Disturbance in genetic equilibrium (Hardy Weinberg equilibrium) or change of frequency of

alleles in a population can then be interpreted as accumulation or change in variations that results in evolution.

- Five factors are known to affect Hardy- Weinberg equilibrium**:**
- **Gene migration:** When a section of population migrates to another place gene frequencies will change in the original as well as in the new population. New genes /alleles will be added to the new population and the same are lost from the old population.
- **Genetic recombination:** crossing over
- **Gene flow:** When gene migration occurs frequently it is termed as geneflow.
- **Genetic drift:** Change in gene frequency that occurs due to a random event or by chance.
- **Founder effect:** Sometimes the change in allelic frequency is so drastic that in the new sample of population the variants form a different species. The original drifted population from which the variants arose becomes founder species and this effect is called **founder effect**.

<u>Operation of natural selection on different trait</u>:

- Natural selection can lead to:
    - **Stabilization:** In which more individuals acquire mean character value.
    - **Directional changes**: Occurs when more individuals acquire value other than the mean character value.
    - **Disruption:** more individuals acquire peripheral character value at both ends of the distribution curve.



Diagrammatic representation of the operation of natural selection on different traits : (a) Stabilising (b) Directional and (c) Disruptive

<u>A BRIEF ACCOUNT OF EVOLUTION:</u>

- Approximately 2000 million years ago (mya) the first forms of life appeared on earth.They were cellular.Certain cellular forms developed the ability to photosynthesize and thus release O_2. The atmosphere slowly became rich in oxygen.This inturn promoted the development and evolution of more aerobic forms of organisms.Slowly and gradually the single cell organisms started to form multi-cellular life forms.

ORIGIN AND EVOLUTION OF MAN:

- About 15 mya primates such as ***Dryopithecus*** and ***Ramapithecus*** existed.They appeared to be similar to gorillas and chimpanzees in their appearance and walking.
- *Ramapithecus* was more similar to man whereas *Dryopithecus* was more similar to apes.
- Few fossils of bones that resemble human bones have been discovered in Ethiopia and Tanzania..
- Two mya ***Australopithecines*** existed.They most likely lived in East African grasslands.
  - They used stone weapons for hunting.
  - Essentially had a fruit-based diet.
  - The first human-like organism was the hominid and was called **Homo habilis.**
  - Brain capacity was 650–800 cc.
  - They also survived on plant-based diet and did not eat meat.
  - Fossils discovered in Java in 1891 seemed to be of the next stage i.e. ***Homoerectus***. They evolved about 1.5 mya.
  - Had large brain with capacity around 900 cc.
  - Probably ate meat.
  - **<u>Neanderthal man:</u>**
  - Brain size was around 1400cc.
  - Lived in east and central Asia between 1,00,000-40,000 years back.
  - They developed use of animal hides to protect their body.
  - Buried their dead.
- **<u>Homo sapiens:</u>**

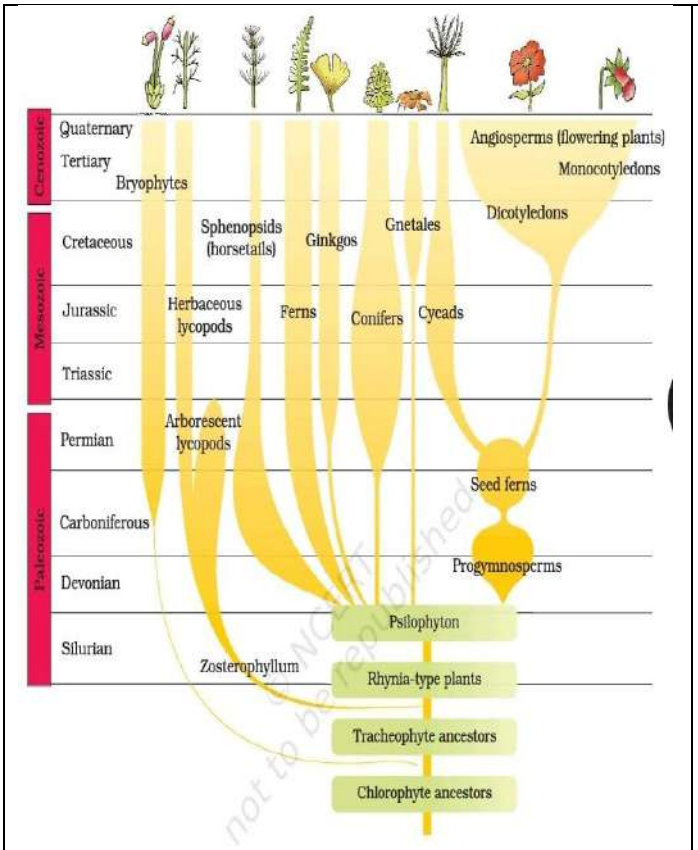


Figure 7.9 A sketch of the evolution of plant forms through geological periods

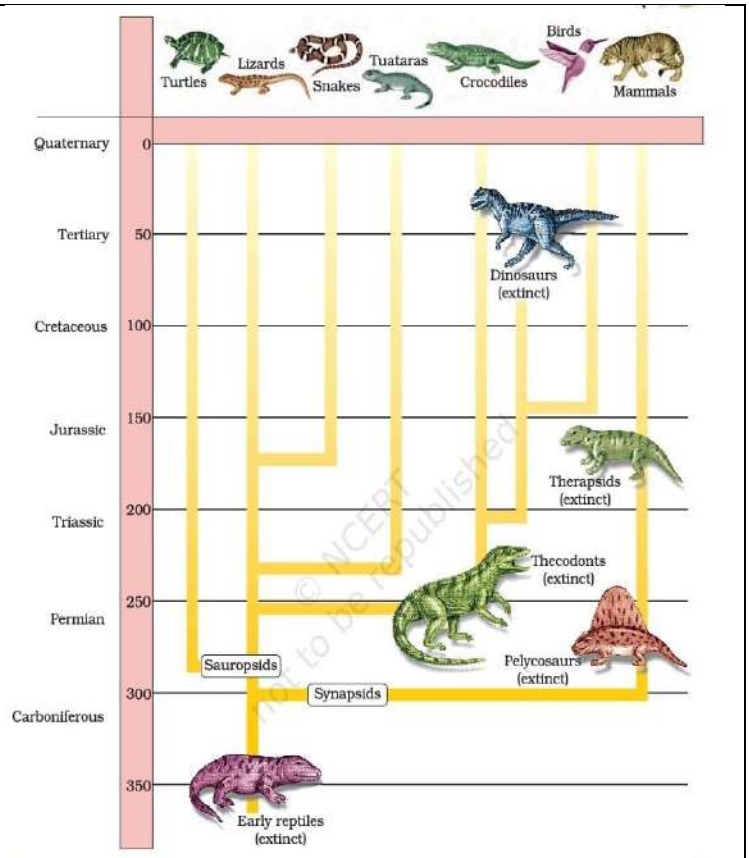
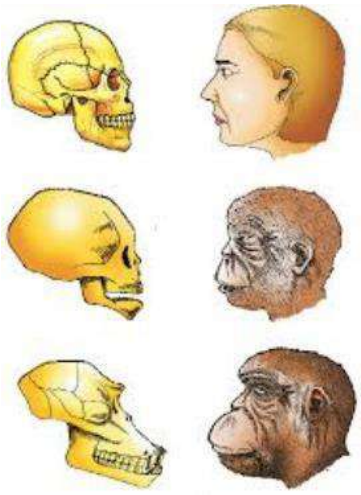


Figure 7.10 Representative evolutionary history of vertebrates through geological periods

- Arose in Africa and migrated across continents and developed distinct races.

- During ice age75,000-10,000 years ago modern Homo sapiens arose.
- Prehistoric cave art developed about 18,000 years ago.
- Agriculture came around 10,000 years back and human settlement started.



Comparison of skulls of adult human, baby chimpanzee and adult chimpanzee

ASSESSMENT

Multiple Choice Questions:

1. When two species of different genealogy come to resemble each other as a result of adaptation, the phenomenon is termed as

(*a*) Microevolution (*b*) co-evolution (*c*) convergent evolution (*d*) divergent evolution.

2. Match the scientists listed under column 'I' with ideas listed column 'II'.

Column I	Column II
A. Darwin	(*i*) Abiogenesis
B. Oparin	(*ii*) Use and disuse of organs
C. Lamarck	(*iii*) Continental drift theory
D. Wagner	(*iv*) Evolution by natural selection

(*a*) A-(*i*); B-(*iv*); C-(*ii*); D-(*iii*) (*b*) A-(*iv*); B-(*i*); C-(*ii*); D-(*iii*)
(*c*) A-(*ii*); B-(*iv*); C-(*iii*); D-(*i*) (*d*) A-(*iv*); B-(*iii*); C-(*ii*); D-(*i*)

3. Which type of selection explains industrial melanism observed in moth, *Biston bitularia*?
(*a*) Stabilising (*b*) Directional (*c*) Disruptive (*d*) Artificial

4. Which of the following organs are homologous?
(*a*) Forelimbs of man and wings of bat (*b*) Wings of Bat and bird
(*c*) Wings of Bat and Petrodactyl (*d*) None of these

5. The theory of spontaneous generation stated that
(*a*) life arose from living forms only
(*b*) life can arise from both living and non-living
(*c*) life can arise from non-living things only.
(*d*) life arises spontaneously, neither from living nor from the non-living

Hint: 1c, 2b, 3b, 4a, 5c

Assertion and Reason type questions :

The following questions consists of two statements, one is Assertion (A) and the other is Reason (R). Select the correct answer to these questions from the codes a,b,c and d as given below.

(a) Both reason and Reason are true but Reason is the correct explanation of Assertion.
(b) Both reason and Reason are true but Reason is the not the correct explanation of Assertion.
(c) Assertion is true but Reason is false.
(d) Both Assertion and Reason are false.

1. 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.

2. Assertion: Hardy Weinberg principle explains the occurrence of variations in population and species.

Reason: It concludes that disturbances in genetic equilibrium results in evolution.

Ans. 1(b) 2(d)

Two Mark Questions:

1.Select two pairs from the following which exhibit divergent evolution. Give reasons for your answer.

(*i*) Forelimbs of Cheetah and mammals (*ii*) Flippers of dolphins and penguins
(*iii*) Wings of butterflies and birds (*iv*) Forelimbs of whales and mammals

Ans. (*i*) and (*iv*) exhibit divergent evolution. There pairs have similar anatomical structure or origin but perform different functions.

2. (*a*) Select the homologous structures from the combinations given below:
(*i*) Forelimbs of whales and bats (*ii*) Tuber of potato and sweet potato
(*iii*) Eyes of octopus and mammals(*iv*) Thorns of *Bougainvillea* and tendrils of *Cucurbita*

(*b*) State the kind of evolution they represent.

Ans. (*a*) (*i*) Forelimbs of whales and bats. (*iv*) Thorns of *Bougainvillea* and tendrils of *Cucurbita*.
(*b*) Divergent evolution.

Placental mammal	Marsupial mammal
Ant eater	(i)
(ii)	Spotted cuscus
Bobcat	(iii)
(iv)	Tasmanian wolf

3. Fill in the blank (*i*), (*ii*), (*iii*), (*iv*) with name of the mammals of Australia.

Ans. (*i*) Numbat(*ii*) Lemur (*iii*) Tasmanian tiger cat (*iv*) Wolf

Three mark questions:

1.Explain the increase in the numbers of melanic (dark winged) moths in the urban areas of post-industrialisation period in England.

Ans. Refer to notes and fig 7.4 of NCERT

2.Evolution is a change in gene frequencies in a population in response to changes in the environment in a time scale of years and not centuries. Justify this statement with reference to DDT. How does the theory of Hugo de Vries support this?

Ans. Refer to notes.

According to Hugo de Vries, evolution is caused by sudden large differences in the population and not minor variations.

3.Rearrange*Ramapithecus, Australopithecus* and *Homo habilis* in the order of their evolution on the Earth. Comment on their evolutionary characteristics.

Ans. The order of evolution on the earth is: *Ramapithecus → Australopithecus → Homo habilis*

Case based questions:

Case Study: According to the Hardy-Weinberg principle, the allele frequencies in a population are stable and remain constant through generations. When the frequency differs from the expected values, the difference indicates the extent (direction) of evolutionary change. Disturbance in the genetic equilibrium or Hardy-Weinberg equilibrium in a population can be interpreted as resulting in evolution.

I. What does the Hardy-Weinberg principle describe?
A) The process of natural selection
B) The stability of allele frequencies in a population
C) The mechanism of genetic mutations
D) The rate of evolutionary change over time

II. If a population is in Hardy-Weinberg equilibrium, what can be said about the allele frequencies?
A) They change rapidly from generation to generation
B) They remain constant from generation to generation
C) They oscillate periodically
D) They follow a predictable pattern of change

III. What does a deviation from Hardy-Weinberg equilibrium suggest?

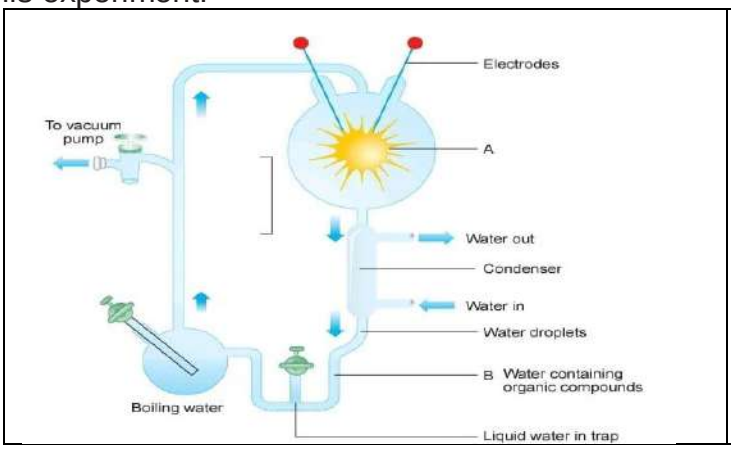
AnsWhat does Hardy-Weinberg equation $p2 + 2pq + q2 = 1$ convey?

Ans. I-B, II-B, III-. That the population is evolving

IV-Hardy–Weinberg equation conveys genetic equilibrium, *i.e.*, sum total of all allelic frequencies is 1.

Five mark questions:

1. Given below is a diagrammatic representation of the experimental set-up used by S.L. Miller for his experiment.



(i) Write the names of different gases contained and the conditions set for the reaction in the flask.
(ii) State the type of organic molecule he collected in the water.
(iii) Write the conclusion he arrived at.

Ans. (i) CH_4,water vapour,hydrogen and nitrogen
(ii) amino acids
(iii)Organic compounds like amino acids can be synthesized from inorganic compounds under conditions that were present on early earth.

2. Darwin found the varieties of finches that in travelled to Galapagos Islands and observed variations in them.

(i)What role does an individual organism play as per Darwin's theory of natural selection?
(ii) How did Darwin explain the existence of different varieties of finches on Galapagos Islands?
(iii) What is "fitness of an individual" according to Darwin?

Ans.See the text given above

****

CHAPTER-7: HUMAN HEALTH & DISEASE

Health: Health is defined as a state of complete physical, mental, and social well-being.
Factors affecting health: Genetic Disorders, Infections, Life style.
Disease: Any deviation in the normal functioning that causes discomfort or impairs the health of a living organism is called a disease.
Diseases can be broadly grouped into

1. Infectious/Communicable diseases
2. Non-infectious/Non communicable diseases

INFECTIOUS/COMMUNICABLE DISEASES-

Name of the Disease	Causative Agent	Affected parts/organ	Symptoms	Mode of Transmission	Treatment
common cold	*Rhinovirus*	Nose & nasal tract	sneezing, runny nose, nasal obstruction, sore throat,cough	-Droplet infection	Antibiotics
Pneumonia	*Streptococcus pneumoniae*	Alveoli of one or both lungs	Cough Headache Muscular stiffness and aching Shortness of breath Fever, Chills Sweating Fatigue	-Droplet infection -Fomite borne	Antibiotics
Typhoid	*Salmonella typhi*	small intestine	sustained fever, severe headache, nausea, severe loss of appetite, rose-colored spots on the chest	contaminated food and water	-Antibiotics -Vaccines (Typhoid) -Widal Test (confirmatory test)
Malaria	*Plasmodium vivax*	Liver, RBC	headache, nausea, muscular pain, recurring chill & fever	By the bite of infectious female Anopheles mosquito	Antimalarial drugs
Chikungunya	*Chikungunya virus*	Liver, muscle, joints, brain, etc	fever up to 104 °F severe joint pain, muscle pain, headache, rash nausea, fatigue,	By the bites of *Aedes* mosquitoes	No specific treatment
Amoebiasis	*Entamoeba histolytica*	large intestine	Abdominal pain and cramps, Stools with excess mucus and blood spots	contaminated food and water	Antibiotics

Life cycle of plasmodium:

Plasmodium enters the human body as small sporozoites through the bite of infected female anopheles mosquito and multiplies within the lever cells. Later attacks the RBCs resulting the rapture with the release of toxic substance, haemozoin, which is responsible for high fever and chill recurring every three to four days.Malarial parasite requires two hosts, human and anopheles mosquito to complettheir life cycle. Female Anopheles is vector of this disease to human beings.

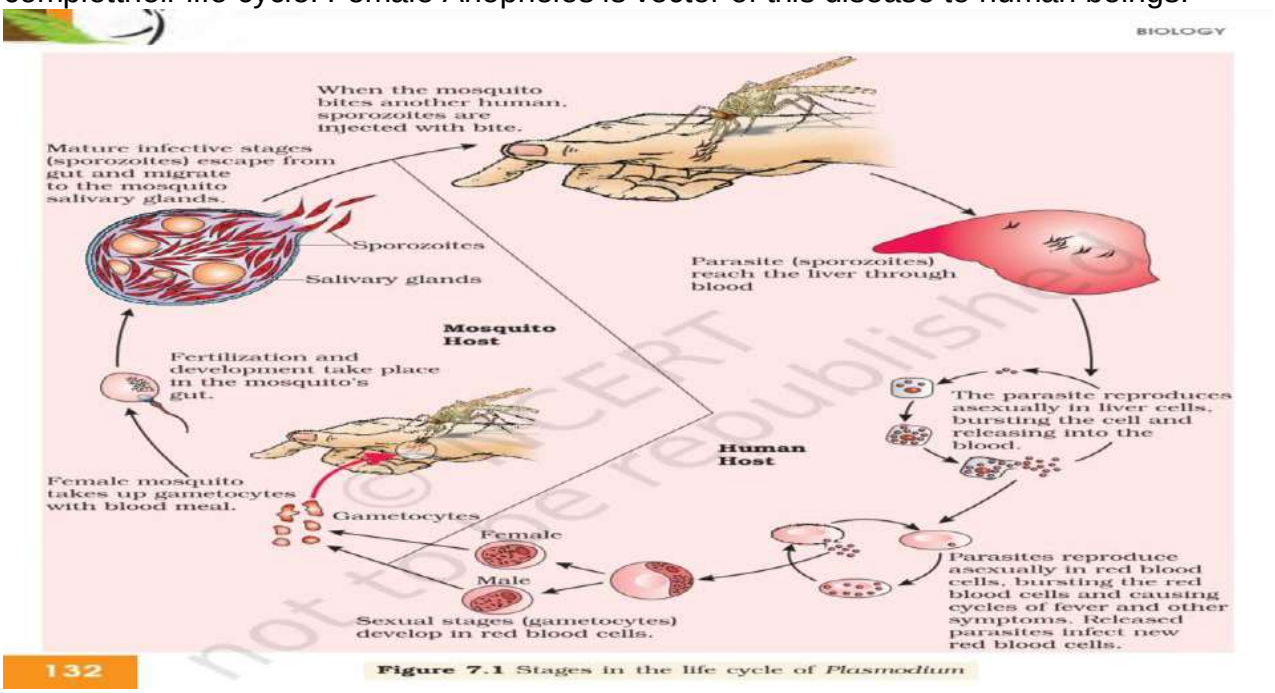


Figure 7.1 Stages in the life cycle of *Plasmodium*

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

Innate immunity – Non-specific types of defence presents at the time of birth and provide different kinds of barriers to the entry of foreign agents into the body. It consists of four types of barrier. Physical barrier, physiological barrier, cellular barrier, cytokine barrier	**Acquired Immunity-** Pathogenspecific defence. When our body encounters a pathogen first time produces a primary response of low intensity. Same pathogen produce highly intensified response called secondary response. It is carried out with the help of B-lymphocytes and T-lymphocytes. B-lymphocytesproduce army of protein called antibody.

Structure of an Antibody:

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

It involves two types of lymphocytes –• B lymphocytes: humoral immune response (HI)

• T lymphocytes: cell mediated immunity (CMI)

• **Active immunity**: Body produces its own antibodies against antigens.

• **Passive immunity**: Readymade antibody is transferred from one individual to another.

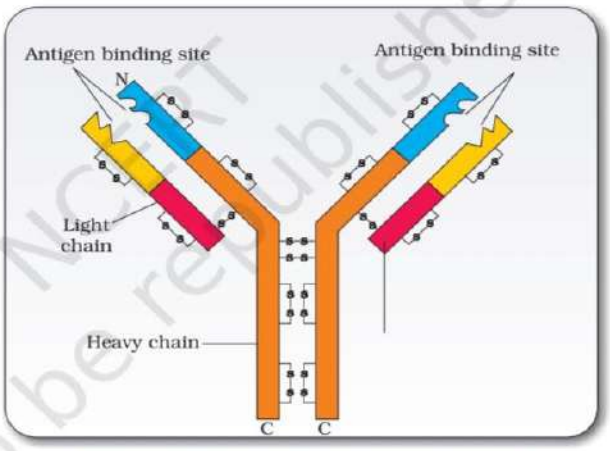


Figure 7.4 Structure of an antibody molecule

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

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

• Transfusion of contaminated blood and blood products
• Sharing infected needles as in intravenous drug abusers
• Infected mother to her child through placenta.

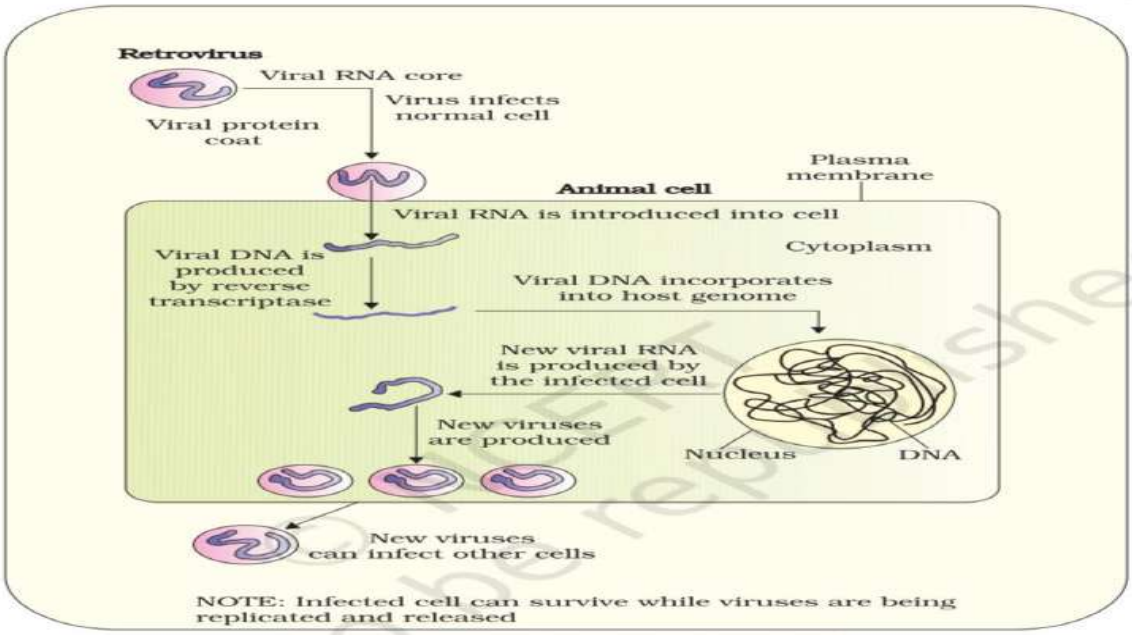


Figure 7.6 Replication of retrovirus

Cancer

Normal cells show a property called contact inhibition by virtue of which contact with other cells inhibit their uncontrolled growth. Cancer cells lost this property

Two kind so tumors

(a)Benign tumors (b) Malignant tumors

-

Tumours

Benign Tumour
1. It remains confined to the affected organ.
2. Rate of growth is usually slow
3. It causes limited damage to the body.
4. There is no metastasis.
5. It is non-cancerous

Malignant Tumour-
1. It also spreads to other organs of the body.
2. Rate of growth is usually rapid.
3. The cancer cells migrate to other sites of the body.
4. There is metastasis.
5. It is cancerous

Causes of cancer	Cancer detection and diagnosis	Treatment of cancer---
cancerous neoplastic cell may be induced by physical, chemical and biological agents called carcinogens	Cancer detection is based on biopsy and histopathological study, Radiography, CT (computed Tomography), MRI (magnetic resonance imaging).	Surgical, Radiotherapy, Chemotherapy, Immunotherapyetc.

Drug and alcohol abuse

Opioids are the drugs which bind to receptors in central nervous system and gastrointestinal tract. Ex-Heroin (smack) extracted from the latex of poppy plant (*Papaver somniferum*).Generally taken by snorting and injection, heroin is a depressant and slows down body Functions.

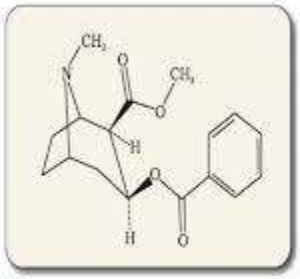


Figure 8.7 Chemical structure of Morphine

Figure 8.8 Opium poppy

Cannabinoids -are a group of chemicals which interact with cannabinoid receptors present principally in the brain. Natural cannabinoids are obtained from the inflorescences of the plant Cannabis sativa. Its various combinations are marijuana, hashish, charas and ganja. Generally taken by inhalation and oral

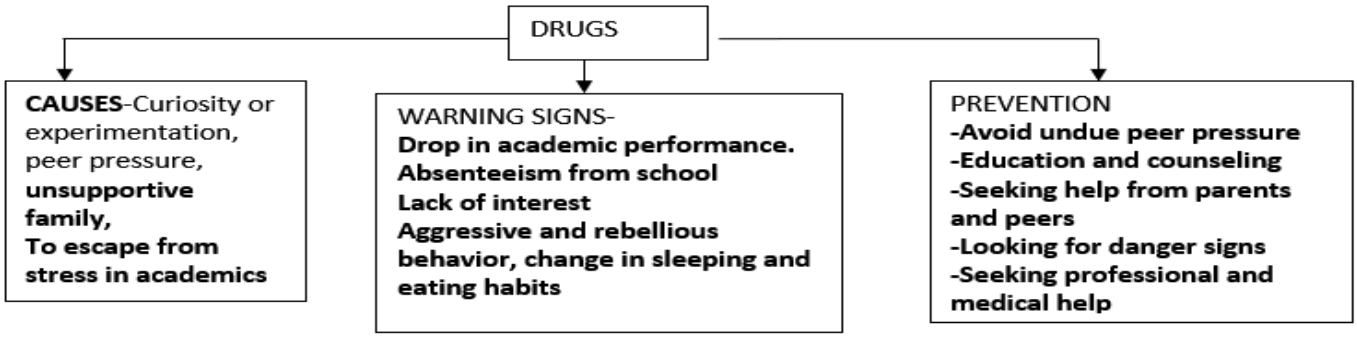
ingestion, these are known for their effects on cardiovascular system of the body.

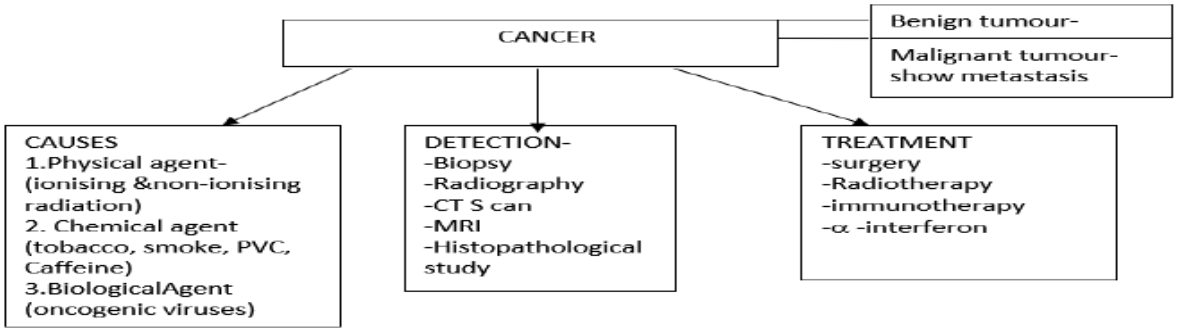
Cocaalkaloid or cocaine is obtained from coca plant Erythroxylum coca. It interferes with the transport of the neuro-transmitter dopamine. Cocaine, commonly called coke or Crack is usually snorted. It has a

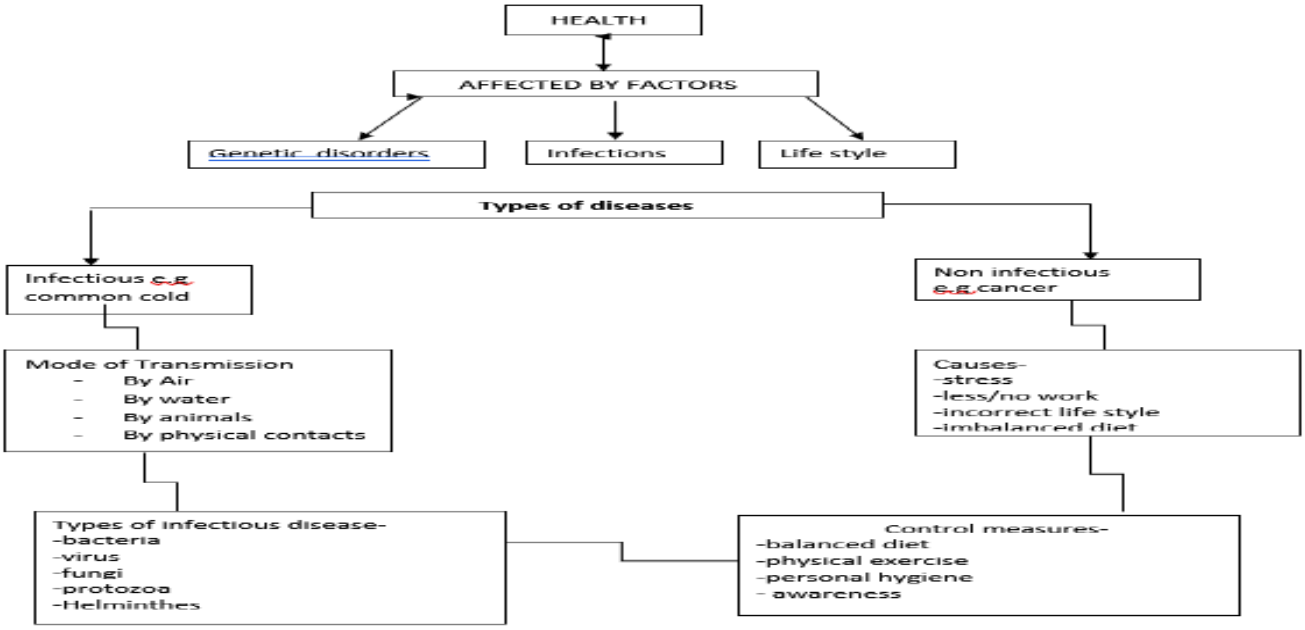
potent stimulating action on central nervous system, producing a Sense of euphoria and increased energy.

Adolescence and Drug abuse

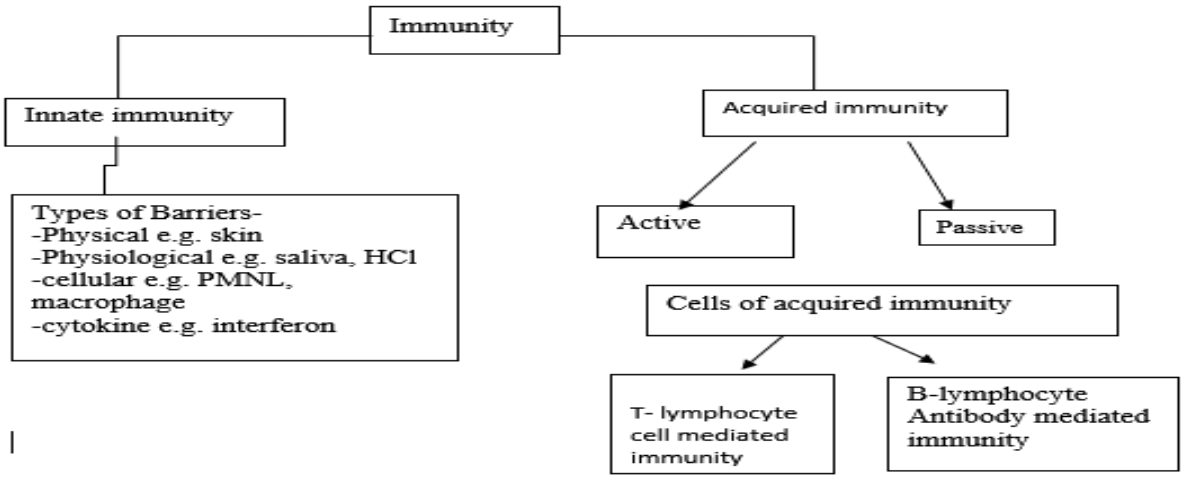
Causes of drug abuse	Effects of drug/alcohol abuse	Prevention
Curiosity,adventure,excitement, experimentation,stress or pressure to excel in the examination	Reckless behaviour, malicious, mischief Violence, drop in academic performance depression,isolation,aggressiveness, Anxiety, shakiness,nausea and sweating.	-avoid undue peer pressure, education & counselling, seeking helps from parents and peers,seeking professional and medical help etc.







Types of immunity



Questions

MCQs

Q.1 In an area with stagnant water, many people are reporting fever every alternate day. Health workers suspect a vector-borne disease. Which organism is most likely responsible, and how can it be controlled?
a) Plasmodium, by fogging and removing stagnant water
b) Salmonella, by chlorinating drinking water
c) HIV, by using clean syringes d) Wuchereria by mass deworming
Q. 2 Question 2: Identify the correct pairing from the table-

Immune Cell	Function
A.B-Lymphocyte	I. Produces antibodies
B.T-Lymphocyte	ii. Helps in cell-mediated immunity
C.Macrophage	iii. Phagocytosis of pathogens

Which of the following is the correct option?
a) A–ii, B–I, C–iii b) A–I, B–ii, C–iii c) A–iii, B–I, C–ii d) A–I, B–iii, C–ii
Q. 3 A drug addict shares a needle with others. He is at high risk of contracting:
a) Typhoid and Cholera b) Malaria and Denguec) AIDS and Hepatitis B
d) Influenza and Tuberculosis
Q. 4 Find the correct match between disease and symptoms
a. Cancer- Chill and recurring high feverb .AIDS- increased number of RBCs
c. Ascariasis - Inflammation of lymph nodes in lower limbsd. Pneumonia- fever, chills, cough and headache.
Q.5 Primary lymphoid organs are
a. Spleen and thymus b. Bone marrow and thymus
c. Bone marrow and lymph node d. Thymus and Malt
Q6. Which of the following approaches is/are used for the treatment of cancer?
a. Gene therapy and Immunotherapyb. Surgery
c. Radiotherapy and Chemotherapyd. Surgery, Radiation therapy, Immunotherapy, Chemotherapy
Q. 7. The drug which is being excessively taken by some sports persons nowadays..
a. Opioids b. Barbituratesc. Cannabinoidsd. LSD
Q. 8. Select the incorrect statement in respect of cancer

a. Benign tumors are normally confined to the original.
b. UV rays cause DNA damage leading to neoplastic transformation.
c. During metastasis cancerous cells die and form normal cells.
d. Oncogenic virus causes cancer

Q. 9 When are interferon secreted?

a. During antigen antibody interaction.
b. When serotonin is released.
c. When lymphocytes become active
d. When our body cells are infected by virus then that cell secrete interferon

Q. 10 HIV attacking the immune system. Which type of cell is primarily targeted by HIV?
a) B-lymphocytesb) Helper T-lymphocytesc) Cytotoxic T-lymphocytes
d) Macrophages
Hint: 1a, 2b, 3c, 4d, 5c, 6d, 7c, 8c,9d, 10b

Assertion –Reason

The following questions consist of two statements, one is Assertion (A) and the other is Reason (R). Select the correct answer to these questions from the codes a,b,c and d as given below.

a) Both reason and Reason are true but Reason is the correct explanation of Assertion.
b) Both reason and Reason are true but Reason is the not the correct explanation of Assertion.

c) Assertion is true but Reason is false.
d) Both Assertion and Reason are false.

1. Assertion – Recurring chills and fever is a common symptom observed in patients suffering with Malaria.
   Reason – Haemozoin released due to rupture of RBCs is responsible for the chills.
2. Assertion – Antivenom injection is an example of passive immunity.
   Reason – The injection which is given to the patients, contain preformed antibodies against the snake venom

Hint:1a, 2a

2 MARK QUESTIONS

Q1.a) Macrophages are referred to as HIV factory. Justify it. b) Name another cell which is also infected by the virus after it enters human body. c) Write the result of such infection?
Ans. a) Initially HIV infects macrophages and multiplies to produce virus. b) Helper T lymphocyte. c) Number of T helper cell decrease/patient starts suffering from various infections .
Q.2 a) Write the scientific names of two causal organisms of ringworm. b) Mention the symptoms of this disease.
Ans. a) Epidermophyton/Trichophyton/Microsporum b) Dry scaly lesion on skin, nail and scalp/intensely itchy lesion

Q3 a) Name the disease which is detected by Widal test? b) Write the symptoms of this disease? c) How does it spread from infected to a healthy person?
Ans. a) Typhoid b) Sustained high fever (39° C to 40° C)/weakness/headache/loss of appetite/intestinal perforation in critical case. c) Contaminated food and water.

Q.4a) Write the scientific name of this plant? b) Write the method to obtain this drug?c)How does this drug affect human body?

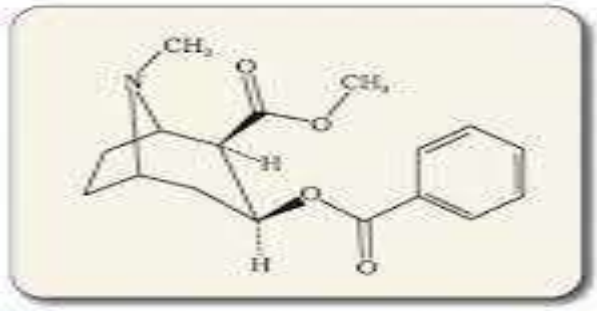


Figure 8.7 Chemical structure of Morphine

Figure 8.8 Opium poppy

Ans. a) *Papaver somniferum* b) By acetylation of morphine extracted from latex of the plant. c) Depressant/slows down body function.
Q.5 Name the infective stage of malaria parasite in human. In which organ of mosquito it is situated?
Ans: Sporozoite. Situated in mosquito salivary gland

3 MARKS QUESTIONS

Q.1Primary immune response is of slow intensity than secondary immune response. Justify the statement.
Ans: When our body pathogen for the first time it produces primary response which is of low intensity. Subsequent encounter with the same pathogen shows quick and highly intensified secondary or anamnestic response. This is because in primary response antibodies are formed which have property of memory.
Q.2 What are the different diagnosis techniques to detect cancer in a patient?

Ans: CT scan, MRI, Biopsy, Blood and bone marrow tests are done for increased cell counts in case of leukaemia, X ray, Monoclonal antibodies test.
Q 3. (i) Name two wide-spread diseases caused by Aedes mosquitoes. (ii) Mention the name of two pathogens which are responsible ringworm disease. (iii) Which pathogen infects alveoli (of the lungs) that result in severe breathing problem?
Ans: (i) Dengue and Chikungunya (ii) Microsporum, Trichophyton (iii) Streptococcus pneumoniae or Haemophilus influenzae.
Q.4 A person undergoes ELISA testing and tested positive- (i) ELISA is widely conducted to diagnose which disease. (ii) Write the causative agent of that disease.
(iii) Which organization in India educates people about that disease?
Ans: (i)AIDS , (ii) HIV , (iii) NACO (National AIDS Control Organisation)
Q.5 A disease has symptoms of high fever with chill. The causative agents depend on red blood cells of human body for their life cycle. Based on the statement answer the following questions- (i) Why do patients suffer from high fever with chill? (ii) Name the disease and its causative agent. (iii) Represent the life cycle of the pathogen diagrammatically.
Ans. (i) due to release of chemical haemozoin from ruptured RBC, (ii) Malaria, Plasmodium (P. vivax, P. malariae and P. falciparum). (iii) Life cycle of Plasmodium: Fig. from NCERT
Q.6 Study the figures given below and answer the questions that follow.
(i) Why do sports persons often fall a victim to cocaine addiction?
(ii) Why sharing of injection needle between two individuals is not recommended?
(ii) Mention the useful as well as the harmful drug obtained from the latex of Poppy plant?
Ans. (i) Plant source of cocaine is Erythroxylum coca. It has a potent stimulating action on central nervous system, producing a sense of euphoria and increased energy. Excessive dosage of cocaine causes hallucinations.
(ii) Sharing of needles can transmit diseases like HIV, AIDS, Hepatitis B or C from infected to non-infected individuals.
(ii) Useful drug—morphine, Harmful drug—heroin

Case based questions

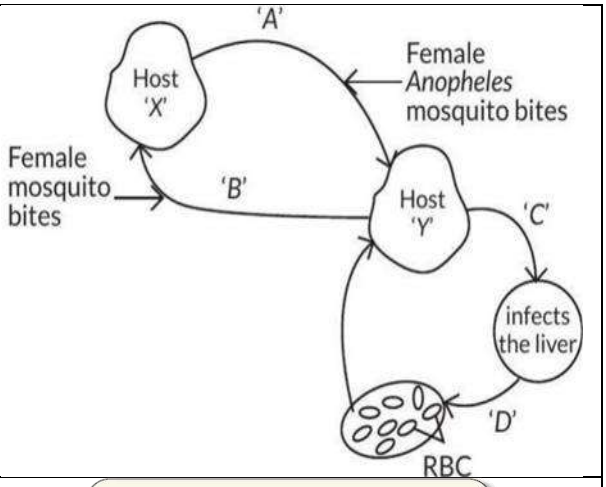
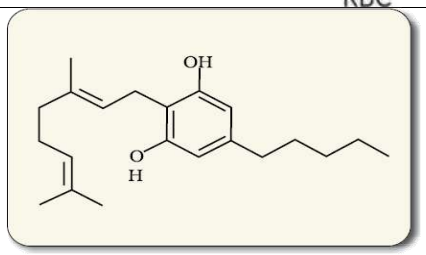
1. Ramesh, a 17-year-old boy, started experiencing severe episodes of sneezing, runny nose, and difficulty in breathing whenever he visited his friend's house where a pet cat was kept. His doctor conducted some tests and found that Ramesh was hypersensitive to certain allergens like cat fur and pollen grains. The doctor explained that his immune system was overreacting to harmless substances, resulting in an exaggerated response. He was prescribed antihistamines and advised to avoid known allergens.Answer the following questions:

a) What type of disorder is Ramesh suffering from?
b) Name the chemical substance responsible for the symptoms seen in him.Name the antibody type that is responsible for allergic reactions.
c) What is the role of antihistamines in the treatment of this condition?Or
d) How is the immune response in this disorder different from a normal immune response?

Ans- a).an allergy,
b).histamine, IgE ,
c).Antihistamines block the action of histamine, thereby reducing allergic symptoms like sneezing and inflammation or
d) In a normal immune response, the immune system targets harmful pathogens. In an allergic reaction, the immune system overreacts to harmless substances (allergens) by producing IgE antibodies and releasing histamine, leading to inflammation and symptoms.

5 MARKS QUESTIONS

Q.1 The diagram shows the life cycle of a pathogenic protozoan.

a) Name the parasitic stage that is being transferred from host ‘ X ‘ to host ‘ Y ‘ b) Write the changes the parasite undergoes in the liver. c) Write the changes the parasite undergoes when it enters the RBC. d) Trace the changes the parasite undergoes when the host ‘X ‘takes its blood meal from infected host e) At which stage during the life cycle of the pathogen does the host ‘X’ experience the symptoms of the disease? Name the disease and the toxic substance responsible for these symptoms.	
2. a) Mention the group of drugs this structure represents. b) How these drugs are taken by drug abusers? c) Name the source of plant from which these are isolated. d) Which part of human body is affected by this drug? e)Provide any two common names for this drug.	

Ans.- a) Cannabinoids b) Oral Ingestion or inhalation c) Cannabis sativa d) Cardiovascular system e)Charas, ganja

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CHAPTER-8 MICROBES IN HUMAN WELFARE

1) Microbes are diverse.
   ex-protozoa, bacteria, fungi ,microscopic plants ,viruses, viroids and also prions (proteinaceous infectious agents).
2) Microbes like bacteria and fungi can be grown in nutrient media to form colonies and can be seen in naked eyes.
3) Some microbes' causes diseases and some are useful for human being.

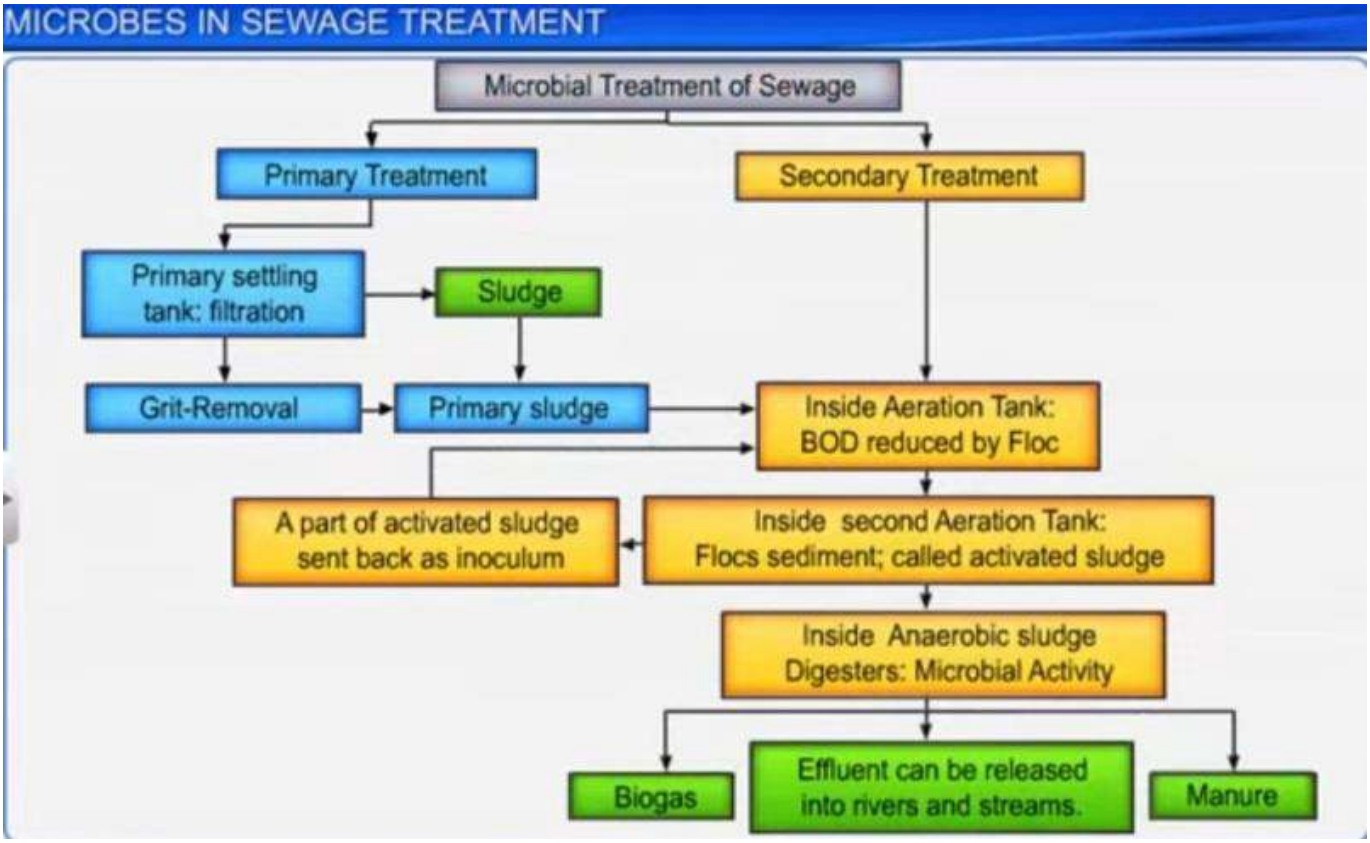
Where used	Microbes Type	Use
Household products	LAB (Lactic acid bacteria)	Curd + increasing vitamin B12
	Propionibacterium sharmanii(Bacterium)	Swiss chess
	Saccharomyces cerevisiae (Fungi)	Idli , dosa , toddy, bread
	Penicillium roqueforti (Fungi)	Roquefort cheese
Industrial Products	*Saccharomyces cerevisiae(Fungi)*	Ethanol
	Aspergillus niger (Fungi)	Citric acid
	Penicillium notatum (Fungi)	Antibiotics
	Acetobacter aceti (Bacterium)	Acetic acid
	Clostridium butylicum(Bacterium)	Butyric acid
	Lactobacillus (Bacterium)	Lactic acid
Enzymes	**Streptokinase**- *Streptococcus(*Bacterium)	Clot buster
	Lipases-*Bacillus and pseudomonas (Bacterium)*	Removes stains of grease and oil
	Pectinases & Proteases- *Aspergillus niger (Fungi)* *Bacillus subtilis (Bacterium)*	Clearing bottled juice
Bioactive molecules	*Trichoderma polysporum (Fungi)*	Cyclosporin-A (Immunosuppressant)
	Monascus purpureus(Fungi)	Statins(Blood cholesterol lowering agents)
Biocontrol-agents	*Nucleopolyhedrovirus(Virus)*	Caterpillar & insect -resistant
	Bacillus thuringiensis (Bacteria)	Insect resistant plant

MICROBES IN SEWAGE TREATMENT

This municipal waste-water is also called sewage. Sewage treatment is done in two stages- primary treatment and secondary biological) treatment

Primary Treatment -This involves physical removal of particles through filtration and sedimentation.The effluent from the primary settling tank is taken for secondary treatment.

Secondary treatment (Biological treatment)-The primary effluent is passed into **largeaeration tanks** where air is pumped into it. This allows vigorous growth **flocs.** These microbes consume the major part of the organic matter reduces the BOD. Once BOD reduced the effluent is then passed into a **settling tank** where the bacterial 'flocs' are allowed to sediment. This sediment is called **activated sludge**. A small part of the activated sludge is pumped back into the **aeration tank**. The remaining major part of the sludge is pumped into large tanks called **anaerobic sludge Digesters**. Here anaerobic bacteria produce biogas (methane, hydrogen sulphide and carbon di oxide.



MICROBES IN PRODUCTION OF BIOGAS-

Biogas is (containing methane) produced by the microbial activity of methanogen on cow dung and cellulosic waste. Cow dung is common source of methanogens e.g. **Methanobacterium..**The biogas is used for cooking and lightning

MICROBES AS BIOFERTILISERS-

Bacteria- Rhizobium in the root nodule of leguminous plants fixes atmospheric nitrogen into organic forms. Azospirillum and Azotobacter are also used as nitrogen enriching bio fertilizers. Some other examples-Fungi,(Mycorrhiza).e.g.- Genus Glomus form mycorrhiza. Cyanobacteria (Anabaena, Nostoc,Oscillatoria etc)

Questions:

MCQs

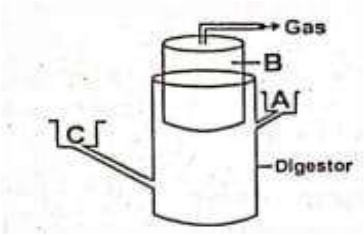
Q1. Raghu was asked by his teacher to list the use of microbes in household products. What couldn't have been his answer from the following list:

a) Fermentation of batter to produce dosa-idli b) Use of Rhizobium bacteria

c) Conversion of milk to curd.d) Fermentation of dough to produce bread-cake

a.i and ii b. ii and iv c. iii and iv d. only i

Q.2 The diagram below shows a typical biogas plant. With few structures labelled as A, B and c. Identify A, B and C.



a. A-Sludge, B-Methane, Oxygen C- Dung, water

b. A- Sludge, B- Methane, Carbon-dioxide, C-Dung, water

c. A- sludge, B- Ethylene, Carbon dioxide, C-Dung, water
d. A-Sludge, B- Methane, Carbon-dioxide, C-Sewage

Q3.The events of sewage treatment is given below -(a). Filtration (b).Chlorination (c). Biological treatment (d).Sedimentation. Which one is the correct sequence of steps involved in sewage treatment?

(a)Steps A, B, C and D (b). Step B C, A, and D
(c). Steps A, D, C and B (d). Steps A, D, B and C

Q.4 Match the following columns:

Column I	Column II
A.Statin	1. Aspergillus
B.Cyclosporin A	2. Monascus
C.Streptokinase	3. Streptococcus
D.Citric acid	4. Trichoderma

A B C D
a. 2 4 3 1
b. 3 4 2 1
(HINT:1b, 2b, 3c, 4a,

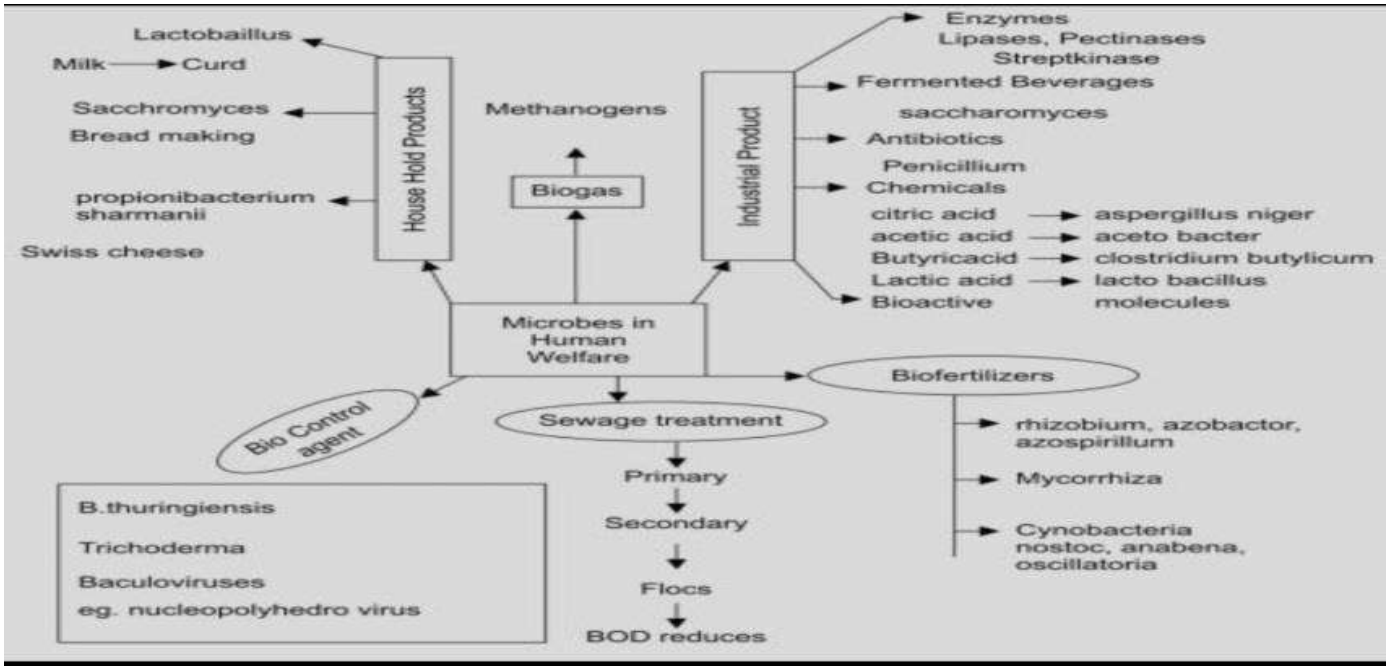
A B C D
c. 4 1 2 3
d. 3 2 1 4

ASSERTION AND REASON

In the following questions a statement of Assertion (A) is followed by a statement of Reason(R) mark the correct choice as:

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.

Q 1. Assertion: Biocontrol agents based on microbes are considered environmentally friendly



alternatives to chemical pesticides.

Reasoning: Microbial biocontrol agents are specific in their action and do not pose long-term environmental risks.

Q 2. Assertion: Fermentation by microbes is used in the production of alcoholic beverages.

Reasoning: During fermentation, microbes convert sugars into water and carbon dioxide.

Ans.1a, 2c,

2 MARKS QUESTIONS

Q.1 The given diagram shows the root system of a leguminous plant.

a)Name the microbe present inside the root nodule and mention the role of it.

b)How is this microbe differ from Nostoc?

Ans- a)Rhizobium, Can fix atmospheric nitrogen.

b)Rhizobium is symbiotic nitrogen fixer, but Nostoc is photosynthetic free living.

Q.2 Alexander Fleming observed that in the presence of Penicillium notatum a particular species “A” cannot grow. Identify A& Give the reason for the observation.

Ans: “A” is Staphylococci bacteria. ‘A’ is unable to grow because the chemical Penicillin (now called as antibiotic) is released by Penicillium notatum

Q.3 Name the microbes used in the production of ethanol. Write the reaction involved.

Ans-Saccharomyces cerevisiae (yeast)

Reaction: Glucose → Ethanol + CO_2 (under anaerobic conditions)

Q.4 Name the microbes that help production of the following products commercially.

(a) Statin (b) Citric acid (c) Penicillin (d) Butyric acid

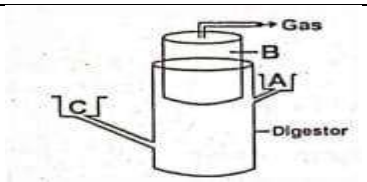
Q.5 a)Choose any three microbes, from the following which are suited for organic farming which is in great demand these days for various reasons.

b) Mention one application of each one chosen- Mycorrhiza; Monascus; Anabaena; Rhizobium; Methanobacterium; Trichoderma.

Ans-choose microbes and write its use.

3 MARKS QUESTIONS

Q.1 Observe the given diagram and answer the questions:

a).What is a and how is it useful to us? b).Name the main gases collected in b. c).Name the microbes present in the digester part.	

Ans-a)Spent slurry/ sludge, used as manure. b) CH4,CO2,H2S, H2

c) Methanogens / Methanobacterium

Q.2 A farmer is advised to add a culture of microorganisms in the soil before sowing the crop-

a) Name two microorganisms which can be helpful for farmer.

b) How these microbes useful to the crop?

Ans- a)Biofertilizers: Rhizobium, Cyanobacteria b) They can fix atmospheric nitrogen into organic forms, which is used by the plants as nutrient.

Q.3 Identify a, b, c, d, e and f in the table given below.

S. No.	Organism	Products/Bioactive molecule	Use
1	Trichoderma polysporum	a	b
2	c	statin	d
3	e	f	Used as 'clot-buster' for removing clots from blood vessels of patients undergoing myocardial infarction

Ans-See the text chart above.

Q.4.a) Organic farmers prefer biological control of diseases and pests to the use of chemicals for the same purpose. Justify.
(b) Give an example of a bacterium, a fungus and an insect that are used as biocontrol agents.
Ans-a)Chemical pesticides pollute the environment, cause harm to non-target organisms. Biological control methods are eco-friendly, target-specific, and sustainable.
b)Bacterium: Bacillus thuringiensis (Bt),Fungus: Trichoderma speciesInsect: Ladybird beetle etc
Q.5 a) Give an example of a genus of virus used as narrow spectrum insecticidal biocontrol agent.
b) How does its use serve as an aid in overall integrated pest management programme?
Ans-a)Nucleopolyhedrovirus , b) Highly specific to certain insect pests, particularly Lepidopterans (moths and butterflies) .They do not harm non-target organisms.

CASED BASED QUESTIONS

Q.1Lactic acid bacteria are a kind of microorganisms that can ferment carbohydrates to produce lactic acid, and are currently widely used in the fermented food industry. They are used to improve the flavor of fermented foods, increase the nutrition of foods, reduce harmful substances, increases shelf life, and so on. They can also be used as probiotics to promote health in the body.
a)Give the full form of LAB.
b)Which type of food would have lactic acid bacteria? Give 2 example.
c)i.How is curd formed? ii. What happens to the milk protein during formation of the curd?

LONG ANSWER TYPE QUESTIONS

Q.1a) Explain the process of sewage water treatment before it can be discharged into natural water bodies. b) Why is this treatment essential?
Hint:-a)primary and secondary treatment with diagramb)To reduce BOD
Q.2 a) What are biofertilisers? b) Describe their role in agriculture.c) Why are they preferred to chemical fertilizers?
Hints-a)Definition b) any 3 imp role c)less polluted, no harm on humans etc.

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CHAPTER-09BIOTECHNOLOGY: PRINCIPLES AND PROCESSES

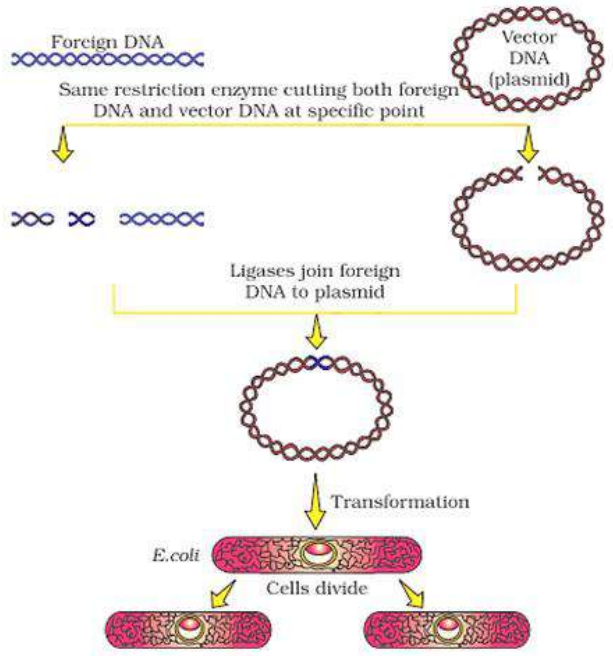
Biotechnology Definition:

Biotechnology involves using living organisms or their enzymes to create products beneficial to humans. Examples: Curd, bread, wine (traditional), and modern techniques such as genetically modified organisms, hormones, vaccines, gene therapy.

The European Federation of Biotechnology (EFB) defines biotechnology as “The integration of natural science and organisms, cells, parts thereof and molecular analogues for products and services”.

Principles of Biotechnology:

1. Genetic engineering − Technique to introduce foreign genetic material (DNA/RNA) into the host’s genome and altering its phenotype.
2. Maintenance of sterile (microbial contamination free) ambience in chemical engineering processes for manufacture of products such as protein, antibiotics, vaccines, etc



Basic steps in recombinant DNA technology.

a) Identification of DNA with desirable genes: Gene of interest (e.g., disease resistant gene).

b) Introduction of the identified DNA into the host: A vector DNA such as plasmid is used to deliver an alien (foreign gene /Gene of interest) piece of DNA into the host organism.

c) Maintenance of introduced DNA in the host and transfer of the DNA to its progeny:

Construction of First Recombinant DNA Molecule

- First recombinant DNA (rDNA) was produced by Stanley Cohen & Herbert Boyer (1972).
- They isolated an antibiotic resistance gene (piece of DNA) from a plasmid of Salmonella typhimurium.
- It was linked with a plasmid vector and transferred into E. coli
- As a result, the gene was expressed & multiplied in E. coli and makes the E.coli cell resistant against that antibiotic.

Tools of Recombinant DNA Technology

Restriction Enzymes:

Discovered in 1963; enzymes that cut DNA at specific sequences.

Restriction enzymes belongs to Nucleases and are of two kinds:

Endonucleases − Cut the DNA at specific positions within the Restriction sites.

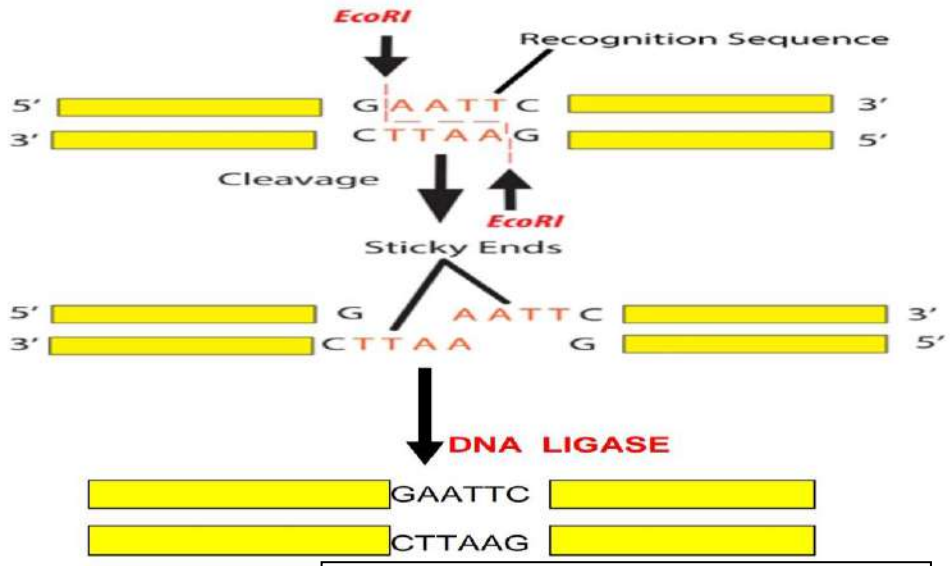
Exonucleases − Cut the DNA at the ends (Remove the nucleotides at the ends of the DNA)

Over 900 restriction enzymes have been isolated, all of which recognize different DNA sequences. (Recognition sequences) These sequences are Pallindromic in DNA.

Restriction enzymes cut a little away from the center of palindrome site, but between the same two bases on the opposite strands. As a result, overhangs (called sticky ends) are generated on each strand. ● Sticky ends form hydrogen bonds with their complementary counter parts with help of DNA ligases to form rDNA molecule.

E.g., Palindromic nucleotide sequence for EcoRI (cleaves the H-H bonds between the bases G-A of the palindrome sites GAATTC of both the strands) is

5‘ —— GAATTC —— 3‘
3‘ —— CTTAAG —— 5‘



RECOMBINANT DNA MOLECULE

Naming/Nomenclature of the Restriction enzymes:

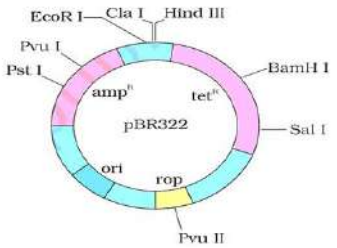
First letter indicates the first letter of Genus.

The second two letters indicate species. The third letter indicates the first letter of strain

Roman numbers is the order in which the enzymes were isolated from that strain of bacteria).

“EcoRI’ is isolated from the bacteria ***Escherichia coli***

E from Escherichia, **co** from coli, **R** from ‘RY13’, **‘I**’ isolated first from that bacteria



1. Origin of Replication (ori):	Initiates replication, controls copy number.
2. Selectable Markers:	Identify transformed cells, e.g., antibiotic resistance genes.
3. Cloning Sites:	Restriction sites for inserting foreign DNA.

Cloning Vectors:

- Plasmids and Bacteriophages: Capable of replicating independently within bacterial cells.

Vectors for Plants and Animals:

1.Agrobacterium tumefaciens (Ti plasmid) for plants, 2. Retroviruses for animals.

Competent Host: (For Transformation with Recombinant DNA)

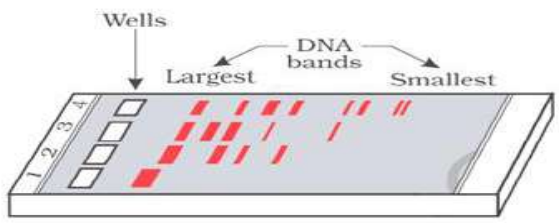
Method	Explanation
Divalent Cation	Treating a cell with a specific concentration of a divalent Cation, such as calcium, increases the cell's efficiency to take DNA.
Heat and shock	incubating the host cell under heat and then ice, create pores on the wall through which DNA enters the bacterium.
Micro-injection	rDNA is directly injected into the nucleus of an animal cell
Biolistic/ Gene gun method	plant cells are bombarded with high-velocity micro-particles of gold or tungsten coated with DNA.
Disarmed pathogen vectors	Infect host cell and transfer r- DNA into them

Processes of Recombinant DNA Technology

• Isolation of Genetic Material (DNA):	Breaking cells open to release DNA using enzymes like lysozyme (bacteria), cellulase (plants), chitinase (fungi). Removing RNA and proteins to purify DNA.
• Cutting of DNA at Specific Locations:	Using restriction enzymes to cut DNA at specific sites. Visualizing DNA fragments using agarose gel electrophoresis.
• Amplification of Gene of Interest using PCR:	In vitro synthesis of multiple DNA copies using PCR
• Insertion of Recombinant DNA into Host Cells:	Introducing ligated DNA into host cells to transform them, e.g., E. coli with antibiotic resistance genes. Selecting transformed cells using selective media.
• Obtaining the Foreign Gene Product:	Cloning genes into vectors and transferring into host cells for expression. Producing recombinant proteins in large scale using bioreactors
• Downstream Processing:	Purification and formulation of the product after biosynthesis. Clinical trials and quality control testing.

Gel Electrophoresis

a) The fragments of DNA obtained after cutting with restriction enzymes are separated by using gel electrophoresis.
b) Electric field is applied to the electrophoresis matrix (commonly agarose gel) and negatively charged DNA fragments move towards the anode.
c) Fragments separate according to their size by the sieving properties of agarose gel. Smaller the fragment, farther it moves.
d) Staining dyes such as ethidium bromide followed by exposure to UV radiations are used to visualize the DNA fragments.



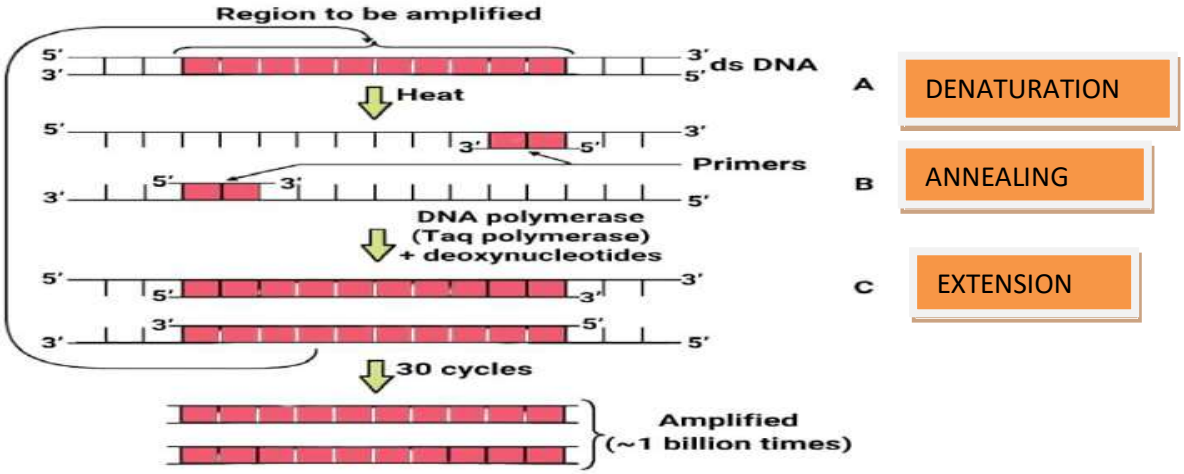
e) DNA fragments are visible as bright orange coloured bands in the agarose matrix.
f) These bands are cut from the agarose gel and extracted from the gel piece (elution).
g) DNA fragments are purified and these purified DNA fragments are used in constructing recombinant DNAs.

Polymerase Chain Reaction (PCR)

PCR consists of 3 steps:

Denaturation	Double helical DNA is denatured by providing high temperature (94 °C). DNA polymerase does not get degraded in such high temperatures since the DNA polymerase used in this reaction is thermostable as it is isolated from thermophilic bacteria, Thermus aquaticus (Taq).
Annealing	Joining of the two Primers at the 3' end of DNA template (at about 52 °C).
Extension	Addition of nucleotides to the primer and extending the chain (at about 72 °C).

This cycle is repeated several times to generate up to 1 billion identical copies of the DNA.

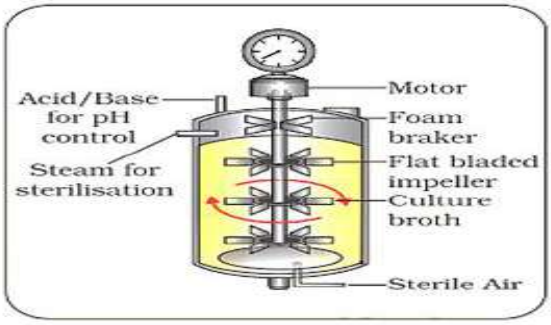


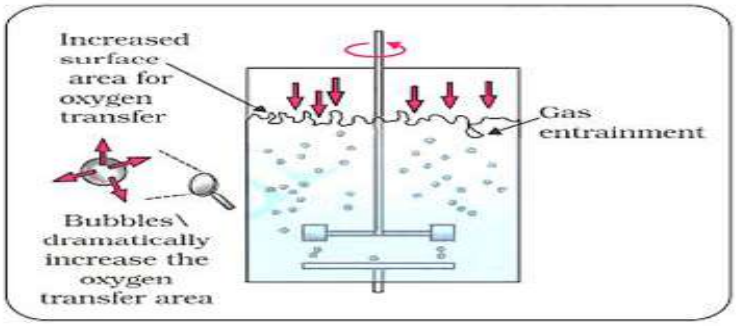
Bioreactors

- These are the vessels in which raw materials are biologically converted to specific products, enzymes etc., using microbial, plant, animal, or human cells.
- Bioreactors are used to produce large quantities of products. They can process 100-1000 litres of culture.
- A bioreactor provides the optimal growth conditions (pH, temperature, substrate, salts, and vitamins, oxygen) to get desired product.
- The most used bioreactors are of stirring type (stirred-tank bioreactor). It is usually cylindrical or with a curved base to facilitate the mixing of the reactor contents. The stirrer facilitates even mixing and oxygen availability. Alternatively, air can be bubbled through the reactor.

The bioreactor has the following facilities.

- 1. An agitator system 2. An oxygen delivery system
- 3. A foam control system 4. A temperature control system
- 5. pH control system 6. Sampling ports (for periodic withdrawal of the culture)





Downstream Processing: – It is a series of processes such as separation and purification of products after the biosynthetic stage.

– The product is formulated with suitable preservatives. Such formulation undergoes thorough clinical trials and strict quality control testing.

QUESTION BANK.

Multiple Choice Questions

1. Which of the following is a restriction enzyme?
a) DNA polymerase b) RNA polymerase c) EcoRI d) Ligase
2. The process of transferring DNA into bacterial cells is called:
a) Transcription b) Translation c) Transformation d) Translocation
3. The enzyme responsible for cutting DNA at specific sequences in recombinant DNA technology is called:
a) DNA ligase b) DNA polymerase c) Restriction enzyme d) RNA polymerase
4. The process of separating DNA fragments based on their size and charge using an electric field is called:
a) PCR (Polymerase Chain Reaction) b) DNA sequencing c) Gel electrophoresis d) DNA replication
5. Which of the following is a commonly used vector in genetic engineering? a) RNA b) Plasmid c) Ribosome d) Golgi apparatus
6. In gel electrophoresis, DNA fragments are separated on the basis of:
a) Size b) Charge c) Shape d) Colour
7. Taq polymerase is obtained from: a) *Escherichia coli* b) *Saccharomyces cerevisiae* c) *Thermus aquaticus* d) *Bacillus subtilis*
8. The fragmented DNA can be visualized by staining DNA with
(a) NaCl (b) Ethidium bromide(c) Ethylene bromide (d) NaBr

Answers

1 C	2 C	3 C	4 C	5 B	6 A	7 C	8 B

Assertion reason type question

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: Restriction endonucleases are also called 'molecular scissors'.
Reason: When fragments generated by restriction endonucleases are mixed, they join together due to their sticky ends
2. Assertion: In gel electrophoresis, DNA fragments are separated.
Reason: DNA is negatively charged, so it moves towards anode under electric field.
3. Assertion: A piece of DNA inserted into an alien organism generally does not replicate if not inserted into a chromosome.
Reason: Chromosomes have specific sequences called 'ori' region where DNA replication is initiated.
4. Assertion: E. coli having pBR322 with DNA insert at Bam HI site cannot grow in medium containing tetracycline.
Reason: Recognition site for Bam HI is present in tet^R region of pBR32
5. Assertion: Selectable markers helps in identifying and eliminating non transformants and selectively permitting the growth of transformants .
Reason: If a recombinant DNA bearing gene for resistance to ampicillin is transferred into E. coli cells, the host cells become transformed into ampicillin-resistant cells.
Answers: 1B, 2A, 3A, 4B, 5B

Very short answer type questions.

1. Define genetic engineering.

Ans. Genetic engineering is the manipulation of an organism's genes using biotechnology.

2. What is a restriction enzyme?

Ans. A restriction enzyme is an enzyme that cuts DNA at specific recognition sequences.

3. What is the function of a selectable marker?

Ans. To identify and select cells that have taken up the recombinant DNA.

4. Define the term 'bioreactor'.

Ans. A bioreactor is a vessel in which biological processes are carried out under controlled conditions.

5. What is the significance of the term 'transformation' in biotechnology?

Ans. Transformation refers to the process of introducing foreign DNA into cells.

6. Name the enzyme used to synthesize DNA in PCR.

Ans. Taq polymerase.

Short answer type questions

Q 1. Which enzyme is used to digest walls of bacteria and fungi in genetic engineering?

Ans: Lysozyme digests bacterial wall and chitinase digests fungal cell wall.

Q 2. What is Ti plasmid? Name the organism where it is found. How does it help in genetic engineering?

Ans: An extra-chromosomal DNA which delivers gene of interest into variety of plants and act as cloning vector is called Ti plasmid. They are present in Agrobacterium tumefaciens. Ti plasmid vectors are used for genetic transformation in many dicot plants. The tumour inducing (Ti) plasmid of Agrobacterium tumefaciens has now been modified into a cloning vector which is no more pathogenic to the plants but is still able to use the mechanisms to deliver genes of our interest into a variety of plants.

Q 3. How and why is the bacterium Thermus aquaticus employed in recombinant DNA technology? Explain.

Ans: DNA polymerase is obtained from the bacterium Thermus aquaticus. DNA polymerase from this organism (thermostable) remains active during the high temperature induced denaturation of double stranded DNA. The amplified fragment if desired can now be used to ligate with a vector for further cloning.

Q 4. What do you understand by the term selectable marker? Give two examples of selectable markers.

Ans: A selectable marker is a gene which is used in the selection of transformants and recombinants. Example: phenotypic marker (antibiotic resistant gene like ampR, tetR) and genotypic marker (beta-galactosidase)

Q.5. Explain how do “ori” “selectable markers” and “cloning sites” facilitate cloning into a vector.

Ans.See the text given above

Q 6. Why do DNA cannot pass through the cell membrane? Explain. How is a bacterial cell made ‘competent’ to take up recombinant DNA from the medium?.

(ii) DNA is a hydrophilic molecule; it cannot pass through cell membrane.

Long answer questions

Q1. Explain the principle and steps involved in recombinant DNA technology.

Ans.See the text given above.

Q2. What should be the properties of an Ideal vector? Discuss the various types of cloning vectors used in genetic engineering.

Ans.See the text given above.

Q3. Explain the process of gel electrophoresis and its applications in biotechnology.

Ans. See the text given above

Q4. (i) Explain the correct sequential step of polymerase chain reaction.

(ii) Which enzyme is used for PCR and why?

(iii) What is the source of that enzyme?

Ans: See the text given above.

Competency-Based Questions

Q.1. Nowadays says which matrix is used in gel electrophoresis? From which source one can get gel used in electrophoresis?

Ans: Nowadays the most commonly used matrix is agarose. The main source of this is seaweeds.

Q.2. Propose a method to verify the success of a gene cloning experiment using gel electrophoresis.

Ans. Gel Electrophoresis: See the text given above.

Q.3. Explain how you would use PCR to detect a genetic mutation in a patient's DNA sample.

Ans.Please refer to the text given above.

Q.4.Why it is considered that a single recognition site in a vector is better than multiple recognition?

Ans: The presence of more than one recognition site within the vector will generate several fragments, which will complicate gene cloning.

Case based questions

Read the following and answer the questions given below

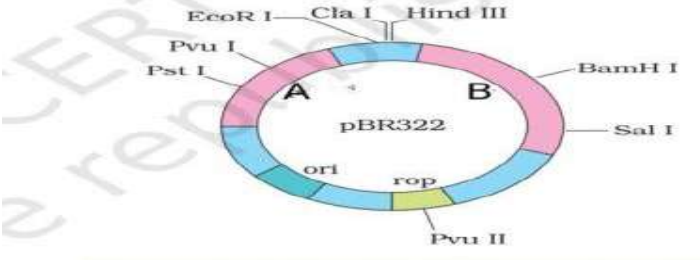
Case study

The vectors are DNA molecules that can carry a foreign DNA segment and replicate inside the host cell. Vectors may be plasmids, bacteriophages (viruses that attack bacteria), cosmids, yeast artificial chromosomes (YACs), Bacterial artificial chromosomes (BACs) and viruses. The most widely used, versatile, easily manipulated vector PBR 322 is an ideal plasmid vector. Features that are required to facilitate cloning into a vector includes origin of replication (Ori) which is a specific sequence of DNA bases responsible for initiating replication, selectable marker genes and cloning sites.

(i) p in pBR 322 denotes that it is a (a) plasmid (b) prokaryote (c) protist (d) plant cell.

(ii) Ori is a specific DNA sequence that help in (a) attachment of primers (b) initiation of replication (c) extension of DNA base (d) initiation of denaturation.

(iii) A and B shown in the figure respectively indicates



(a) Pvu II and Cla I (b) ROP and Sal I (c) ampR and tetR (d) tetR and ampR .

(iv) Selectable markers in vector (a) are responsible for replication (b) help in selecting transformants from non-transformants (c) code for proteins involved in the replicating plasmids (d) contain unique recognition sites.

(v) Plasmid vectors are (a) dsDNA molecule (c) present in bacteria and yeast (b) extra-chromosomal (d) all of these.

ANSWERS**:-**i) a ii) b iii) c iv) b v)d

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CHAPTER-10
BIOTECHNOLOGY AND ITS APPLICATIONS

Biotechnology deals with the industrial-scale production of biopharmaceuticals and biologicals using genetically modified organisms. Its applications are vast and include areas like therapeutics, diagnostics, genetically modified crops for agriculture, processed food, bioremediation, waste treatment, and energy production.
The critical research areas in biotechnology are:
1. Improved Catalysts: Using enhanced organisms or pure enzymes.
2. Optimal Conditions: Engineering the best environment for catalysts to act.
3. Downstream Processing: Technologies to purify proteins or organic compounds.

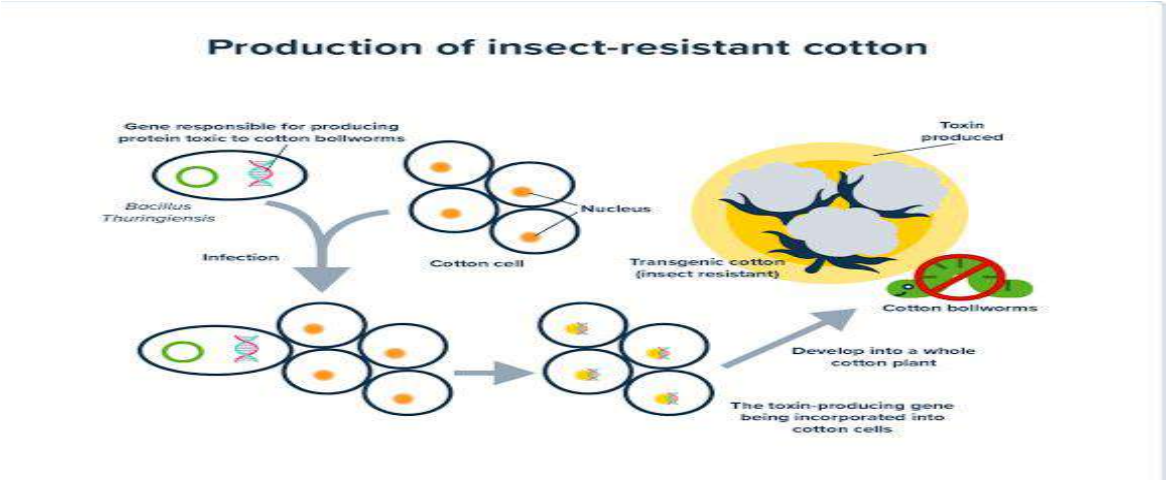
Biotechnological Applications in Agriculture
1. Increasing Food Production:
- Agro-Chemical Based Agriculture:-Use of fertilizers and pesticides.
- Organic Agriculture: Natural farming methods includes biofertilizers and biopesticides
- Genetically Engineered Crop-Based Agriculture: Use of genetically modified organisms (GMOs).

2. Genetically Modified Organisms (GMOs): Plants, bacteria, fungi, and animals whose genes have been altered through genetic engineering. Ex. Golden rice, BT cotton, BT corn, Flavr savr of tomato, Pest resistant tobacco etc

Benefits of GM crops:
- Tolerance to abiotic stresses (cold, drought, salt, heat).
- Reduced reliance on chemical pesticides.
- Decreased post-harvest losses.
- Improved nutrient efficiency and soil fertility.
- Enhanced nutritional value of food (e.g., golden rice enriched with Vitamin A).
- GM crops provide alternative resources to industries in the form of starches, fuels, and pharmaceuticals.

Pest Resistant Plants Pest-resistant plants are genetically engineered to withstand attacks from insects and other pests, reducing the need for chemical pesticides and improving crop yields. Bt-Cotton B.thuringiensis (bacterium) Gene of Bacillus thuringiensis Protein crystals (inactive prototoxin but toxic insecticidal protein Ingestion by insects/boll worms Inactive proteins activated by the alkaline pH of the insect's gut Activated toxin binds to the surface of midgut epithelial cells Creates pores, causes cell swelling, lysis of cells (cell death) – death of insect.

Bt. Cotton: The soil bacterium ***Bacillus thuringiensis***produces crystal protein called ***cry protein***that kills certain insect larvae such as cotton ballworms, corn borer, tobacco budworm, armyworm, beetles, and flies.
- Bt toxin protein exists as inactive *protoxins,*in the bacteriumbut once an insect ingests this inactive toxin it is converted into active form of toxin due to the alkaline pH of the gut which solubilise the crystal and binds to the surface of midgut epithelial cells. This causes swelling and lysis of cell leading to death of insect larvae.
- Bt toxin genes were isolated from *Bacillus thuringiensis* and incorporated into the several crop plants such as cotton, corn, rice, tomato, potato and soyabean to produce cry protein and make them resistant against these insects .
- The proteins encoded by *crylAc and cryllAb* control the cotton ballworms and *crylAb* control corn borer.



Pest Resistant Tobacco Plant:

RNA Interference (RNAi): RNAi is a biological process in which RNA molecules inhibit gene expression by neutralizing targeted mRNA molecules. This method is used to develop pest-resistant plants by silencing specific genes essential for pest survival. A nematode *Meloidegyne incognita* infects tobacco plants and reduces their yield.

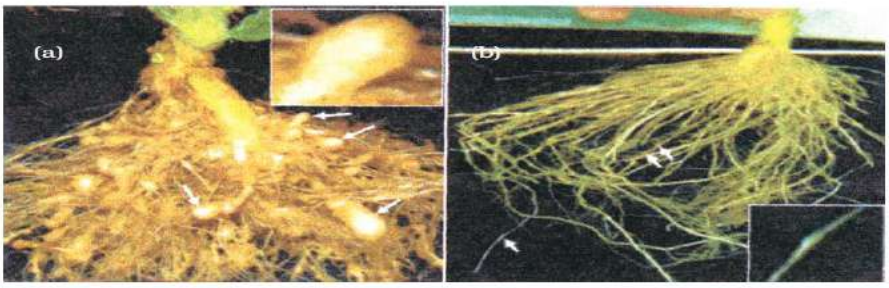


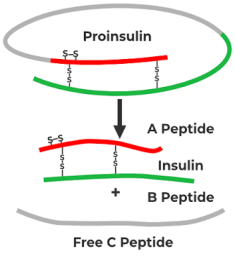
Figure 10.2 Host plant-generated dsRNA triggers protection against nematode infestation: (a) Roots of a typical control plants; (b) transgenic plant roots 5 days after deliberate infection of nematode but protected through novel mechanism.

- Nematode specific genes were into the host plant using *Agrobacterium* as vector.
- The introduction of DNA was such that it produced both sense and anti-sense RNA in the host cells.
- These two RNAs being complementary to each other formed a double stranded RNA (dsRNA) making it inactive.
- This dsRNA molecule binds to and prevents translation of mRNA of the nucleotide by the process called RNA interference (RNAi).
- In the result the parasite could not survive in the transgenic host and the transgenic plant got protected from the parasite.

Genetically Engineered Insulin

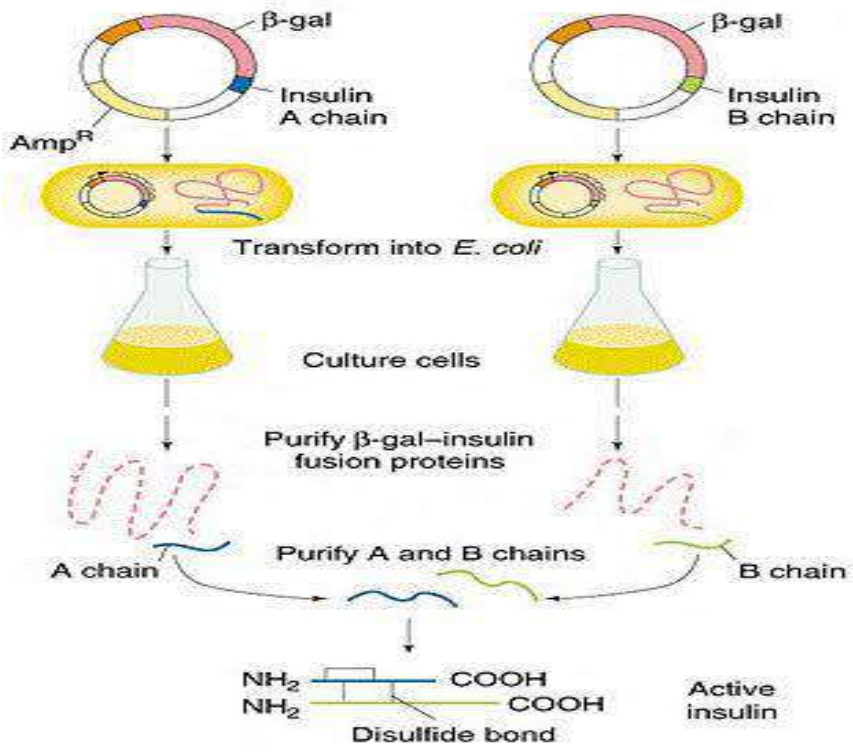
- Insulin is a hormone produced by the pancreas that regulates blood sugar levels and control the diabetes, Traditionally, insulin for medical use was extracted from the pancreas of slaughtered cattle and pigs. However, this animal-derived insulin could cause allergic reactions

Structure of Insulin

Insulin consists of two short polypeptide chains: Chain A and Chain B. • These chains are linked together by disulfide bridges. • In mammals, including humans, insulin is initially synthesized as a prohormone called Proinsulin. • Proinsulin contains an extra stretch called the C peptide, which is removed during maturation to form functional insulin	

Production of Genetically Engineered Insulin:-

- In the 1980s, Eli Lilly, an American pharmaceutical company, developed a method to produce human insulin in bacteria. The company prepared two separate DNA sequences encoding the A and B chains of human insulin and inserted them into different plasmids. These plasmids were then introduced into separate cultures of E. coli, leading to the separate production of A and B chains. The A and B were combined and chemically bonded through disulfide bridges to form functional human insulin.
- Advantages of Recombinant Insulin: Identical to Human Insulin: The structure of recombinant insulin is identical to natural human insulin, reducing the risk of allergic reactions.



Gene Therapy: Gene therapy is a collection of methods that allows the correction of a gene defect diagnosed in a child or embryo. It involves the delivery of a normal gene into the individual's cells and tissues to take over the function of and compensate for the non-functional gene.

Types of Gene Therapy

1. Somatic Gene Therapy:
   Targets somatic (body) cells. Genetic changes are not passed on to the next generation.
2. Germ line Gene Therapy:
   Targets germ cells (sperm / eggs/zygote or early embryos). Genetic changes are heritable and passed on to future generations. Currently not practiced in humans due to ethical and technical issues.

- The first clinical gene therapy was given in 1990 to a four years old girl with adenosine deaminase deficiency.
- This disorder is caused due to the deletion of the gene for adenosine deaminase enzyme responsible for the production of normal functional T- lymphocyte for normal immunity.

Possible cure for the ADA disorder

- Bone Marrow Transplantation: Can cure some children but has limitations.
- Enzyme Replacement Therapy: Functional ADA enzyme is given to the patient by injection but is not a permanent cure.
- Gene Therapy:-Lymphocytes from the blood of patient are grown in a culture. A functional ADA cDNA is then introduced into these lymphocytes and subsequently retured into the patients' body.As these cells are not immortal, the patient required periodic infusion of such genetically engineered lymphocytes.

- It could be a Permanent Cure if a functional gene is introduced into a bone marrow cells at early embryonic stage.

Molecular Diagnosis:

Recombinant DNA technology, Polymerase Chain Reaction (PCR) and Enzyme linked Immuno-Sorbent Assay (ELISA) are different molecular diagnosis.

- Recombinant DNA Technology involves the manipulation of DNA to identify genetic mutations or the presence of pathogens.
- PCR is now routinely used to detect HIV in suspected AIDS patients, mutations in genes in suspected cancer patient and to identify many genetic disorders. It can detect very low amounts of DNA in a sample, making it useful for early diagnosis
- ELISA is based on the principle of antigen-antibody interaction. Infection by pathogen can be detected by the presence of antigens or the antibodies produced against it.
- Autoradiography and DNA Probes A single-stranded DNA or RNA, tagged with a radioactive molecule (probe), is used to detect its complementary DNA

Reasons for Creating Transgenic Animals

1. Study of Gene Regulation and Development:	Transgenic animals are used to study how genes are regulated and how they affect normal physiology and development. For example, insulin-like growth factor studies involve introducing genes from other species that alter the formation of this factor and studying the resulting biological effects.
2. Modeling Human Diseases:	Transgenic animals are designed to serve as models for human diseases, allowing researchers to study the development and progression of these diseases. o Examples include models for cancer, cystic fibrosis, rheumatoid arthritis, and Alzheimer's disease.
3. Production of Biological Products:	Transgenic animals can be engineered to produce valuable biological products such as pharmaceuticals. For instance, the human protein alpha-1-antitrypsin used to treat emphysema is produced in transgenic animals. In 1997, the first transgenic cow, Rosie, produced human protein-enriched milk, which was more balanced nutritionally for human babies than natural cow milk
4. Testing Vaccine Safety:	Transgenic animals, particularly mice, are developed to test the safety of vaccines before they are used in humans. Transgenic mice have been used to test the safety of the polio vaccine, potentially replacing the use of monkeys in these tests
5. Chemical Safety Testing:	Also known as toxicity or safety testing, transgenic animals are made to carry genes that make them more sensitive to toxic substances than non-transgenic animals. These animals are exposed to toxic substances, and the effects are studied to obtain results more quickly.

Ethical issues: The manipulation of living organisms by humans, particularly through genetic engineering, raises several ethical issues. These concerns revolve around the morality, safety, and potential consequences of such activities on living organisms and the environment.

GMOs can have unpredictable results when such organisms are introduced into the ecosystem.

The modification/usage of living organisms for public services has also created problems with patents

Therefore Regulatory bodies like

Genetic Engineering Approval Committee (GEAC) in India oversee the validity of GM research and the safety of introducing GMOs for public services

There is a need for transparency, public engagement, and education to address concerns and build trust in biotechnological advancements.

Biopatent:-It is the Right given to the Inventor or a country about his invention or a biological resource to prevent the illegal use by others.

Biopiracy:- It refers to the unauthorized/illegal use of biological resources by multinational companies and organizations without proper compensation to the countries and people concerned.

An example of biopiracy is the case of Indian Basmati rice, where an American company was granted a patent on Basmati rice lines and grains, derived from Indian farmer's varieties. This patent allowed the company to sell Basmati rice in the US and abroad, potentially restricting the rights of Indian farmers and traditional practices

QUESTION BANK.

Multiple Choice Questions

1. Which of the given statements is not a critical research area of biotechnology?
A.Optimum conditions for the catalyst, B. The pure form of catalyst
C. non-specific condition in laboratory, D. Purification of products.
2. A particular Vitamin which is important for growth and development and for good vision is incorporated into a cereal. The name of this vitamin and the cereal is
A. Vitamin A enriched barley, B. Vitamin A enriched golden rice
C. Vitamin B enriched golden wheat, D. Vitamin C enriched golden rice.
3. A biotechnological product human protein (a-1-antitrypsin) from transgenic animals is used to treat
A. Rheumatoid arthritisB. Alzheimer'sC. DementiaD. Emphysema
4. Transgenic animal is one which
A. has foreign gene.B. has changed the sexC. is hermaphroditeD. is imported from foreign land
5. The toxin from *Bacillus thuringiensis* contains
a)antibioticb)insecticidal proteinc)fungicidal proteind)bactericidal protein.
6. A nematode that infects the roots of tobacco plants and causes a great reduction in yield is
a)Meloidogyne incognitia b)Agrobacterium tumefaciens c)Bacillus thuringiensis d)Ascaris lumbricoides
7. Insulin from an animal source is discontinued in use because
A. it can be produced by anyoneB. it was expensive
C. it was against the ethical treatment of animalsD. it caused some patients to develop allergy
8. Mature insulin contains
a)A-peptide and C-peptide b)A-peptide and B-peptide c) B-peptide and C-peptide d) A-peptide, B-peptide, and C-peptide
9. To produce the required peptide chains of mature insulin, prepared two DNA sequences corresponding chains of human insulin are introduced
A. in plasmids of *E. coli* to produce insulin chains.
B. in plasmids of *Agrobacterium tumefaciens.*
C. in chromosomal DNA of *E. coli* to produce insulin chains
D. in chromosomal DNA of *E. coli* to produce insulin chains
10. In the first step towards gene therapy, certain cells of the patient are grown in a culture outside the body before they are subsequently returned to the patient's body. These cells are:
a)Red Blood Cells b) Germ cell c)Lymphocytes d) Adipose cells
11. Read the given names in the column A and match with the items of column B that best define the name. Each item can be used only once

Column A	Column B
i. *Agrobacterium tumefaciens*	(a)Control Cotton bollworm
ii. *Meloidogyne incognitia*	(b)Plasmid used to produce insulin chains

iii.	*Bacillus thuringiensis*	(c)A vector to introduce specific gene into host
iv.	*Escherichia coli*	(d) Tobacco infesting nematode

	i	ii	iii	iv
A.	(a)	(b)	(c)	(d)
B.	(c)	(d)	(a)	(b)
C.	(b)	(d)	(a)	(c)
D.	(c)	(d)	(b)	(a)

12. GM research and the safety of introducing GM-organisms for public services in India is validated by
    A. Genetic Engineering Approval Council
    B. Genetic Ethical Approval Council
    C. Genetic Engineering Approval Committee
    D. Genetic Ethical Approval Committee.
13. The use of bio-resources by multinational companies and other organisations without proper authorisation from the countries and people concerned without compensatory payment.
    a)Biopiracy b)Bioethics c)Bio-patent d)Biosafety
14. A probe which is a molecule used to locate homologous sequences in a mixture of DNA or RNA molecules could be- a)a ssRNA b)a ssDNA
    c)either ssRNA or ssDNA d)can be ssDNA but not ssRNA
15. In RNAi, genes are silenced using a)ssDNA b)dsDNA c)dsRNA d)ssRNA

ANSWERS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	B	D	A	B	A	D	B	A	C	B	C	A	C	C

Assertion Reason type Questions

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.

1. Assertion: The Green Revolution succeeded in tripling the food supply but yet it was not enough to meet the demands of the growing population.
   Reason: Agrochemicals were very expensive and it was not possible to increase the yield using Conventional breeding methods.
2. Assertion: RNAi takes place in all eukaryotic organisms as a method of cellular defence.
   Reason: RNAi silences specific mRNA of the pathogen through a complementary dsRNA and protects the plant.
3. Assertion : Synthetic oligo-nucleotide primers are used during annealing in a PCR.
   Reason : The primers bind to the double stranded DNA at their complementary regions.
4. Assertion: The clone having the mutated gene will not appear on the X ray film
   Reason: The probe will not be complementary with mutated genes.

5. Assertion: Milk produced by Rosie cow is a more balanced product than other cow's milk.
   Reason: Rosie Cow was inbred for many generations to obtain this characteristic.
   ANSWERS : 1A, 2A, 3B, 4A, 5C

Very short answer type questions.

1. Cry gene is extensively used in genetic engineering to develop transgenic plants like cotton. Name the source organism from which one can get the cry gene.
   Ans: Bacillus thuringiensis
2. Which organism badly affects the crop of tobacco.
   Ans: Nematode-Meloidogyne incognita

3. Human proinsulin has three polypeptide chains. Name all these chains and which chain is not present in mature insulin.
4. Ans: chain A, B and C. Chain C are not present in mature insulin.
5. Expand ELISA and mention the principle on which it is based.
   Ans: Enzyme-Linked Immuno-sorbent Assay It is based on antigen-antibody interaction
6. How human protein (α-1-antitrypsin) is used in the medical field.
   Ans: to treat emphysema
7. By giving one example clarify that GMOs enhance the nutritional value of food.
   Ans: Golden rice, i.e., Vitamin 'A' enriched rice.
8. Which vector is used to create a pest-resistant tobacco plant? Ans: Agrobacterium vectors
9. Specify one consequence of adenosine deaminase (ADA) deficiency.
   Ans: adenosine deaminase (ADA) is crucial for the immune system to function
10. Write any two roles of PCR in molecular diagnosis technique.
    Ans: HIV detection, identification of mutated gene.
11. 11. Name the insects which are controlled by cryIAc and cryIAb?
    Ans. Cotton Ballworm, Corn Borer.

Short answer type questions

1. How is a probe used in molecular diagnostics?
   Ans: A probe is a ss DNA or RNA used to search for its complementary sequence in a sample genome. By the process of hybridization and autoradiography, the probes can be identified.
2. What is biopiracy?
   Ans: use of bio-resources by multinational companies and other organisations without proper authorisation from the countries and people concerned without compensatory payment.
3. Developed nations are exploiting the bioresources of under-industrialised nations. Justify the statement with a suitable example.
   Ans: About 27 varieties of Basmati are grown in India. There is a reference to Basmati in ancient texts, folklore and poetry, as it has been for centuries. In 1997, an American company got patent rights on Basmati rice through the US Patent and Trademark Office. This allowed the company to sell a 'new' variety of Basmati, in the US and abroad.
4. Transgenic animals can be used in various ways. How could be a transgenic mouse helpful?
   81 Ans: Transgenic mice are developed for testing the safety of vaccines before they are used on humans. example: polio vaccine.
5. How crystal protein acts in Bt Cotton?
   Ans: Cry gene of Bacillus thuringiensis is introduced in the cotton plant to form insect resistant plant. When insects feed on the cotton plant the inactive crystal protein becomes active due to the alkaline pH in the midgut of insects. The protein creates pores in the midgut and ultimately insects die.
6. Give two examples of biological products obtained by using genetic engineering?
   Ans: human protein (α-1-antitrypsin) is used to treat emphysema. Rosie cow produced 2.4 g/ The milk contained the human alpha-lactalbumin and was nutritionally a more balanced product for human babies than natural cow-milk

Long answer questions

1. Plants bacteria, fungi and animals whose genes have been altered by manipulation are called Genetically Modified Organisms (GMO). GM plants have been useful in many ways. Give at least five examples in support of the statement.

Ans: • made crops more tolerant to abiotic stresses (cold, drought, salt, heat).
•reduced reliance on chemical pesticides (pest-resistant crops).
•helped to reduce post-harvest losses.
•increased efficiency of mineral usage by plants

•enhanced nutritional value of food, e.g., golden rice, i.e., Vitamin ‘A’ enriched rice

2. What are the advantages of insulin obtained from genetic engineering? Explain the process of its formation.

Ans: See the text given above.

3. What are transgenic animals? Enlist any four reasons for their production.

Ans: Transgenic animals or GMOs are those organisms whose genetic material has been altered by using genetic engineering techniques.

Reason of their production

- To study the effect of genes on normal physiology and development
- To study diseases like cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer’s
- To obtain biological products. E.g. human protein (α-1-antitrypsin)
- For study of Vaccine and chemical testing and safety

Competency-Based Questions

1. (a) What are transgenic animals?

(b) To produce transgenic animals, the gene of interest is introduced into embryonic stem cells. These stem cells are undifferentiated and the preferred target in the process of developing any transgenic animal. Give a reason why ?

Answer. (a) Animals that have had their DNA manipulated to possess and express an extra (foreign) gene are transgenic animals.

(b) Since embryonic stem cells are undifferentiated, they have the capability of forming all other cells of the body with their specialised functions and the inserted foreign gene.

2.(a) Give a reason why do Bt toxins are deadly for insects but not for plants producing them?

(b) Describe the steps in which Bt toxins act on insects.

Ans.See the text given above

3. Identify if the following statement is true or false. Between formation of the dsRNA and silencing of mRNA, the dsRNA needs to undergo an additional step. Justify if true, and rewrite the correct statement, if false.

Ans. True - Justification: Since dsRNA is double stranded, it cannot automatically bind to the mRNA. So the two strands must be separated so that a single stranded RNA is obtained which can bind to the single stranded mRNA, silencing it. [1 mark]

4. (a) What is a disadvantage of the traditional hybridisation procedure?

(b) How has rDNA technology overcome the disadvantage identified in (a)?

Ans.(a) Traditional hybridisation procedures very often lead to inclusion and multiplication of undesirable genes along with the desired genes.

(b) Using rDNA technology, only the desired gene can be introduced into an organism without introducing other undesirable gene.

5. Golden rice is a variety of rice that has been genetically modified to produce a compound called β-carotene, which gets converted to Vitamin A when metabolised in the human body. This was done by introducing the genes coding for three enzymes - 'psy' and 'LCYB' from daffodil and 'crtI' from the soil bacterium Erwinia uredovora. (a) With the help of a diagram, describe the process by which golden rice can be made. (b) Name the vector used in the process. (c) Give a reason why the vector identified in (b) should be used.

Ans.(a) Correct illustration of the process - drawing 3 genes of interest from 2 sources, inserting them into a plasmid cut with the same restriction enzyme, introducing the plasmid into rice embryos/cells - Step by step description of the process with correct terminology

(b) Ti plasmid (c) Ti plasmid can replicate well in the plant genome/Its genes can be expressed in the environment of the plant genome.

6. Explain why vectors that have restriction site/s within a marker gene are preferred, for recombinant DNA technology.

Ans. When a target gene gets inserted into a marker gene which has a restriction site, it inactivates the production of the marker - The absence of a characteristic that was coded for by the marker is useful in the detection of cells with the recombinant vectors. [Accept any other valid answer]

Case based questions

Read the following and answer the questions given below.

Case study 1

Read the following and answer any four questions: It's human nature, it seems, to resist change and fear the unknown. So, it is no surprise that genetic engineering of food and feed crops raised many doubts in the minds of many consumers. Farmers and agricultural scientists have been genetically engineering the foods we eat for centuries through breeding programs. In addition to traditional crossbreeding, agricultural scientists have used radiation and chemicals to induce gene mutations in edible crops in attempts to achieve desired characteristics. The fears of G.M.O.s are still theoretical, like the possibility that insertion of one or a few genes could have a negative impact on other desirable genes naturally present in the crop. But many positive instances of GMO have also been reported. Golden Rice, Iron rich Spinach, Bt-cotton are such examples. Ethical standards are required to evaluate the morality of all such genetic modification activities. GEAC makes all the decisions regarding the validity of GM research and the safety of introducing GMO's for public services.

(i) Farmers and agriculture Scientists are using:

a. Conventional breeding methods

b. Use of radiations and chemicals to induce gene mutations

c. Both (i) and (ii)

d. Recombinant DNA Techniques

(ii) Golden Rice is enriched in:

a. Carbs b. B-carotene c. Fats d. Minerals

(iii) GEAC stands for:

a. Genetic Engineering Approval Committeeb. Genetic Environment Approval Committee

c. Genetic Engineering Action Committee d. Genome Engineering Action Committee

(iv) Cultivation of Bt cotton has been much in the news. The prefix "Bt" means

a. Barium treated cotton seeds b. Carrying an endotoxin gene from Bacillus thuringiensis.

c. Produced by biotechnology method d.Bigger thread variety of cotton with tensile strength105

(v) Assertion: GMO'S have been useful in making crops tolerant to abiotic stresses, reduced reliance on chemical pesticides and to enhance nutritional value of food.

Reason: Genetic modification has been used to create tailor-made plants.

ANSWERS

Case study 1 (i) c (ii) b (iii)a (iv)b (v)b

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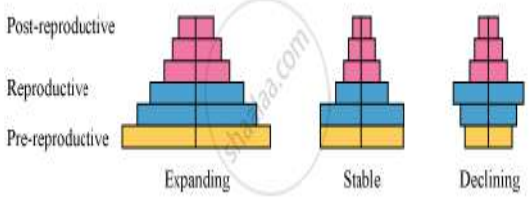
CHAPTER-11: ORGANISMS AND POPULATIONS

Population :A group of species— -livingin a well-defined geographical area, -share or compete for similar resources, -potentially interbreed In nature	**Example**s: All the cormorants (water birds) in a wetland, Rats in an abandoned dwelling, Teakwood trees in a forest tract, Bacteria in a culture plate and Lotus plants in a pond etc.

Population Attributes	**1.** Birth rates and death rates**2**.Sex ratio. **3**. Age distribution **4**. Population size (population density)

Birth rates per capitabirths	**Death rates** per capita deaths
For example- Original population of lotus plants in a pond= 20 New plants added through reproduction=08 So, birth rate= 8/20 = 0.4 offspring per lotus per year.	For example- Original population of fruit flies in a laboratory = 40 No. of flies died during a week,= 04 So, the death rate in the population during that period = 4/40 = 0.1 individuals per fruitflyper week.

Sex ratio : Percentage of male and female individuals in a population (e.g., 60 per cent of the population are females and 40 per cent males)	There are 2 common ways to express it: -Male to female ratio: Example: sex ratio of 105 means there are 105 males for every 100 females. -Female to Male ratio: Example: sex ratio of 95 means there are 95 females for every 100 males

Age distribution: Per cent individuals of a given age or age group in a population at any given time is called age distribution	**Age pyramid** structure that is obtained when per cent individuals of a given age / age group is plotted for the population at any given time, For human population, the age pyramids generally show age distribution of males and females in a diagram.	The shape of the pyramids reflects the growth status of the population - (a) Expanding /growing, - (b) stable - (c) declining. 

Population size (Population density= N): ----- Changes with time ----- Depends on various factors including food availability, predation pressure and adverse weather.	**Example**: <10 Siberian cranes at Bharatpur wetlands in any year -Millions of *Chlamydomonas*in a pond.

Population Growth			
The density of a population in a given habitat during a given period, fluctuates due to changes in 4 basic processes-			
1. Natality (B)	Growth increases (+)	3.Mortality (D)	Growth decreases (-)
2. Immigration (I)		4.Emigration (E)	

	Immigration (I) The number of individuals of the same species that have come from elsewhere. **+**	
Natality(B)+ The number of births	**POPULATION DENSITY (N)**	**- Mortality (D)** **-**The number of deaths
	- **Emigration (E)** The number of individuals of the population who left the habitat and gone elsewhere.	

So, if N is the population density at time t, then its density at time t +1 is-

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

Growth Models

Exponential growth: When resources (food and space) in the habitat are unlimited.

dN / dt = (b – d) × N Let (b–d) = r, then $dN/dt = rN$	N= Population Size b=birth rate d=death rate r= intrinsic rae of natural increase(Reproductive fitness)

The above equation describes the exponential or geometric growth pattern of a population and results in a **J-shaped curve** when we plot N in relation to time.
The integral form of the exponential growth equation is

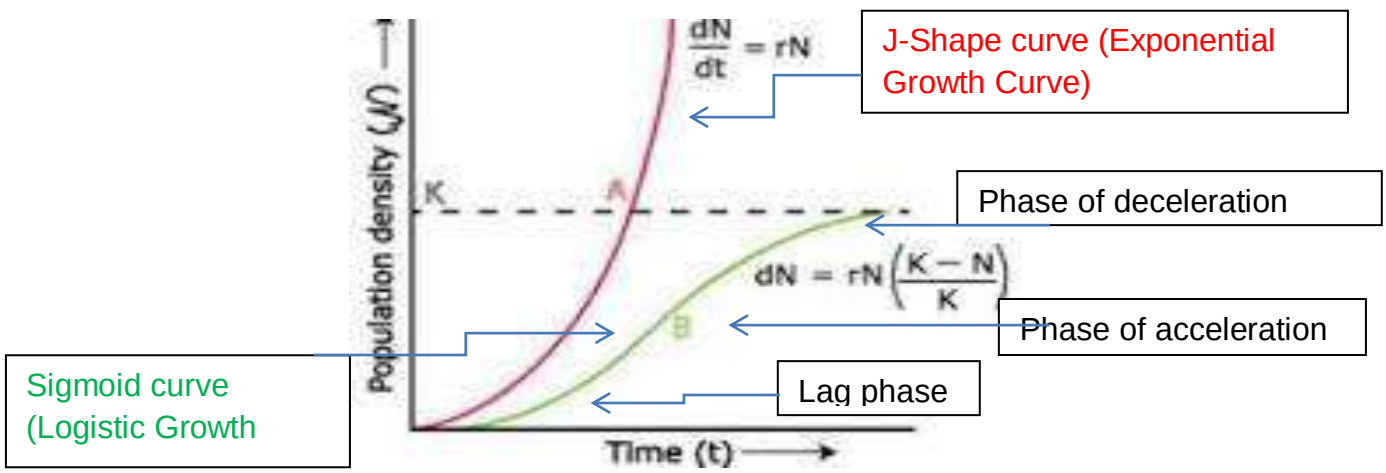
Nt= N0 ert	Where Nt= Population den after time t N0 = Population density at time zero r = intrinsic rate of natural increase (Reproductive fitness) e = the base of natural logarithms (2.71828)

Logistic growth: When resources (food and space) in the habitat are limited.

- Nature's **carrying capacity(K)** is described as the limitbeyond which no further growth is possible.
- A plot of N in relation to time (t) results in a sigmoid curve.
- This type of population growth is called**Verhulst-Pearl Logistic Growth** and is described by the following equation-

$$\frac{dN}{dt} = rN[K - N/K]$$

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



Population Interactions

Name of Interaction							
Mutualism		**Competition**		**Predation**		**Parasitism**	
Species A	Species B	Species A	Species B	Species A	Species B	Species A	Species B
+	+	–	–	+ Predator	- Prey	+ Parasite	- Host

Commensalism		**Amensalism**	
Species A +	Species B 0 (unaffected)	Species A –	Species B 0 (unaffected)

Predation

Role of Predators:

Predators act as 'conduits' for energy transfer	
They keep prey populations under control	
Predators also help in maintaining species diversity in a communityby reducing the intensity of competition among competing prey species (CBQ)	Example: When all the starfishPisaster of American Pacific coast were removed from an intertidal area, more than 10 species of invertebrates became extinct within a year, because of interspecific Competition)

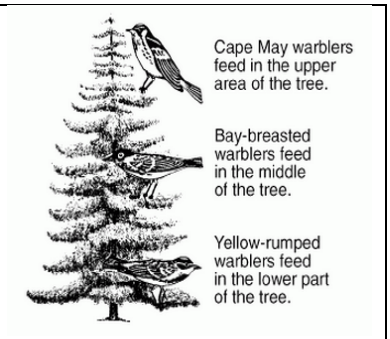
Defense mechanisms developed by prey:		**Defenses evolved by Plants (Morphological and chemical) against herbivores**:	
Some species of insects and frogs are cryptically-coloured (camouflaged) to avoid being detected easily by the predator.		Thorns (Acacia, Cactus) are the most common morphological means of defence.	

Poisonous preyare avoided by the predators The Monarch butterfly is highly distasteful to its predator (bird) because of a special chemical present in its body.	 	Calotropisproduces highly poisonous cardiac glycosides	

Competition:
Gause's '*Competitive Exclusion Principle*' It states that two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior one will be eliminated eventually. This may be true if resources are limiting, but not otherwise.

Evidences in support: 1.The **Abingdon tortoise** in Galapagos Islands (less browsing efficiency)-became extinct **Goats**(greater browsing efficiency)-survived~~Tortoise e~~xcluded / eliminated		
2. **Balanus**(the larger and competitively superior barnacle) dominates and excludes **Chathamalus**(the smaller barnacle) from that zone.(called **'competitive release')**	 larger superior barnacle	 Smaller barnacle chathamalus

Evidences not in support: 1.**Competition for the same resource b/w totally unrelated species** Visiting flamingoes and resident fishes compete for the zooplankton, their common food, in the lake.	

2. 'Resource partitioning mechanism'. Competition can be avoided b/w two species by different foraging patterns. 5 closely related species of warblers living on the same tree are able to avoid competition and **co-exist** due to differences in their foraging activities.		

Parasitism :		
Parasites involve <u>one or two intermediate hosts or vectors</u>	The human liver fluke parasite depends on two intermediate hosts (a snail and a fish)	The malarial parasite needs a vector (mosquito) to spread to other hosts.

Ecto parasites : Parasites that feed on the external surface of the host organism. The lice on humans and ticks on dogs, Copepods on marine fish. Cuscuta,a parasitic plant.			**Endo parasites :** (live inside the host body) Malarial parasite-plasmodium in human blood.
Brood parasitism: Parasitismin birds in which the <u>parasitic bird lays its eggs in the nest of its host and lets the host incubate them</u>.. Brood parasitism in action is seen in the movements of the **cuckoo (koel)** and the **crow** during the breeding season (spring to summer.			

Commensalism:

This is the interaction in which one species benefits and the other is neither harmed nor benefited.			
<u>An orchid growing as an *epiphyte* on a mango branch</u>, benefit while the mango tree	<u>Barnacles growing on the back of a whale</u> benefit while the whale does not derive any	<u>The cattle egret and grazing cattle</u> The cattle,when move, stir up and	<u>sea anemone and the clown fish</u> t The fish gets protection from

does not get any benefit.	apparent benefit.	flush out insects from the vegetation those egrets catch.	predators which stay away from the stinging tentacles of sea anemone.

Amensalism:

In amensalism, one species is harmed whereas the other is unaffected.		
Moulds: *Penicilliumnotatum*, a mould, produces an antibiotic, **penicillin**, which checks the growth of a variety of bacteria.	Bacteria: *streptomycesgriseus*, produce the antibiotic **streptomycin**, which inhibit the growth of many bacteria.	Plants : Walnut tree produces a substance **juglone** that inhibits the growth of seedlings including its own. Such chemicals are called **allomones** and the phenomenon is called allelopathy. Sunflower, sorghum and barley check the growth of weeds near them Ocimum sanctum (Tulsi) checks the growth of plants near it.

Mutualism:

This interaction confers benefits on both the interacting species	
Lichens Mutualistic relationship between a fungus and photosynthesizing algae or cyanobacteria.	The mycorrhizae Associations between fungi and the roots of higher plants

Plant-animal relationships: Pollinators and seed dispersers. 	Fig-wasp relationship: The wasp pollinates the fig inflorescence while searching for suitable egg-laying sites.
Orchids- bees relationship: ➢ Orchid *Ophrys*employs 'sexual deceit' to get pollination done by a species of bee. ➢ One petal of its flower bears resemblance to the female bee in size, colour and markings. ➢ The male bee is attracted and 'pseudocopulates' with the flower, ➢ When this same bee 'pseudocopulates' with another flower, it transfers pollen to it and thus, pollinates the flower. (**Note**: Co-evolution- If the female bee's colour patterns change even slightly for any reason during evolution, pollination success will be reduced unless the orchid flower co-evolves to maintain the resemblance of its petal to the female bee).	

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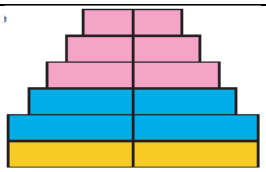
Practice Questions

MCQs:

1. What type of human population is represented by the following age pyramid?

Post- Reproductive	
Reproductive	
Pre-reproductive	

(a) Vanishing population (b) Stable population(c) Declining population (d) Expanding population

2. Cuscuta is an example of

(a) ectoparasitism (b) brood parasitims (c) predation (d) endo parasitims

3. Which of the following is the most accurate comment on Earth's carrying capacity (K)?

(a) K is smaller now than it was a thousand years ago.

(b) The human population is still a long way from K.
(c) Our technology has allowed us to keep increasing K.
(d) When it comes to humans, the concept of K is irrelevant.

4. When birth rate equals death rate,
(a) a population grows rapidly.
(b) the size of a population remains constant.
(c) density-dependent limiting factors do not affect the population.
(d) a population is in danger of extinction.

5. Which of the following forest plants controls the light conditions at the ground?
(a) Lianas and climbers (b) Shrubs (c) Tall trees (d) Herbs

6. If a population of 50 Paramecium present in a pool increases to 150 after an hour, what would be the growth rate of population?
(a) 50 per hour (b) 200 per hour (c) 5 per hour (d) 100 per hour

7. What would be the per cent growth or birth rate per individual per hour for the same population mentioned in the previous question?
a) 100 (b) 200 (c) 50 (d) 150

8. A population has more young individuals compared to the older individuals. What would be the status of the population after some years?
(a) It will decline (b) It will stabilize (c) It will increase (d) It will first decline and then stabilize

9. Amensalism is an association between two species where
(a) one species is harmed and other is benefitted
(b) one species is harmed and other is unaffected
(c) one species is benefitted and other is unaffected

10. The birth and death rates of four countries are given below. Which one will have the least population growth rate?
(a) M (b) N (c) O (d) P

Country	Birth rate/1000	Death rate/1000
M	15	5
N	25	10
O	35	18
P	48	41

Hint: 1. (b) 2. (a) 3. (c) 4. (b) 5. (c) 6. (d) 7. (b) 8. (c) 9. (b) 10. (d)

Assertion-Reason 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 : Predators are organisms which feed on other individuals.
Reason : Prey species have evolved various defenses to lessen the impact of predation.
2. Assertion : Population pyramid (graphically) depicts the rate at which population will grow in future.
Reason : A triangular population pyramid depicts population size is stable.
3. Assertion : Epiphytes growing on branches of the tree exhibit commensalism.
Reason : In commensalism on organism benefits from the association while the other has no effect.
4. Assertion : Verhulst-Pearl Logistic growth curve is sigmoid in nature.
Reason : A population growing in habitat with limited resources shows an initial lag phase, followed by acceleration and deceleration and finally an asymptote.

Hint: 1. (b) 2. (c) 3. (a) 4. (a)

Two Marks Questions:

1. When the population density at time t is N, write the population density at time t+1 in the equation using appropriate symbols.
2. Which curve would depict the population of a species of deer if there are no predators in the habitat? Why is it so?
3. Which one of the two curves is considered a more realistic one for most of the animal populations and why?
4. Predators in nature are said to be 'prudent'. Can you give reason why is it so?

Three Marks Questions:

1. "The size of a population for any species is not a static parameter.'' Justify the statement with specific reference to fluctuations in the population density of a region in a given period of time.

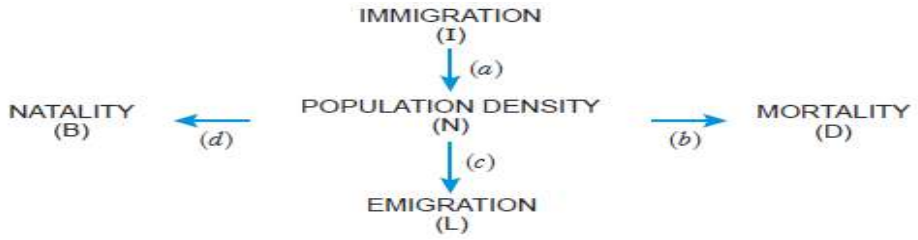
2. How can analysis of age pyramids for human population provide important inputs for long term planning strategies? Explain.

3. Predation is usually referred to as a detrimental association, then how can you explain their positive role in an ecosystem. Give any three ideas.

4. An ecologist studying an area with population A thriving on unlimited resources and showing exponential growth,introduced population B and C to the same area. What will be the effect on the growth pattern of population A, B and C when living together in the same habitat?

Long answer type Questions:

1.



(a) Which of the above represents the increase or decrease of population?

(b) If N is the population density at time t, then what would be its density at time (t+1)? Give the formula.

(c) In a barn there were 30 rats. 5 more rats enter the barn and 6 out of the total rats were eaten by the cats. If 8 rats were born during the time period under consideration and 7 rats left the barn, find out the resultant population at time (t+1).

(d) If a new habitat is just being colonized, out of the four factors affecting the population growth, which factor contributes the most?

Ans. (a) a and d represents increase of population and b and c represent decrease of population.
(b) $N_{t+1} = N_t + [(B + I) – (D + E)]$
(c) Here, $N_t = 30$; $I = 5$; $E = 7$; $D = 6$; $B = 8$
Putting the value in $N_{t+1} = N_t + [(B + I) – (D + E)]$
$N_{t+1} = 30 + [(8 + 5) – (6 + 7)]$
$= 30 + [13 – 13]$
$= 30 + 0$
$= 30$ rats
(d) Immigration contributes the most.

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CHAPTER 12.ECOSYSTEM

An ecosystem can be visualised as a functional unit of nature, where living organisms interact among themselves and also with the surrounding physical environment.

Ecosystem	Natural	Terrestrial	Forest, grassland and desert
		Aquatic	Pond, lake, wetland, river and estuary
	Man-made		Crop fields and an aquarium

ECOSYSTEM– STRUCTURE AND FUNCTION:

Ecosystem (A pond)	Structure	Biotic components	Autotrophic components	Phytoplankton , some algae, floating, submerged and marginal plants
			Heterotrophic components	Zooplankton, the free swimming and bottom dwelling forms
			The decomposers	Fungi, Bacteria and Flagellates
		Abiotic components	Water with all the dissolved inorganic and organic substances The rich soil deposit at the bottom of the pond. The solar input, the cycle of temperature, day-length and other climatic conditions.	
	Function	1. Productivity	Conversion of inorganic into organic material with the help of the radiant energy of the sun by the autotrophs and consumption of the autotrophs by heterotrophs.	
		2.Decomposition	Decomposition and mineralisation of the dead matter	
		3. Energy flow	There is unidirectional movement of energy towards the higher trophic levels and its dissipation and loss as heat to the environment	
		4. Nutrient cycling.	Release of minerals back to the system for reuse by the autotrophs.	

Ecosystem services:
The products of ecosystem processes are named as ecosystem services, for example, healthy forest ecosystems purify air and water, mitigate droughts and floods, cycle nutrients, generate fertile soils, provide wildlife habitat, maintain biodiversity, pollinate crops, provide storage site for carbon and also provide aesthetic, cultural and spiritual values.

1. Productivity:**Primary production**is defined as the amount ofbiomass or organic matter produced per unit area over a time period by plants during photosynthesis. It is expressed in terms of weight (gm–2) or energy (kcal m–2).
The rate of biomass production is called productivity. It is expressed in terms of $gm^{-2}yr^{-1}$or kcal $m^{-2}yr^{1.}$

Gross primary productivity: It is the rate of production of organic matterduring photosynthesis. A considerable amount of **GPP** is utilised by plantsin respiration. Gross primary productivity minus respiration losses (**R**),is the net primary productivity **(NPP)**.

Net primary productivity: is the available biomass for the consumption to heterotrophs (herbivores and decomposers).Primary productivity depends on the plant species inhabiting a particular area. It also depends on a variety of environmental factors, availability of nutrients and photosynthetic capacity of plants. Therefore, it varies in different types of ecosystems.

Secondary productivity: It is defined as the rate of formation of new organic matter byconsumers.

GPP – R = NPP

2. Decomposition: Breaking down complex organic matter into inorganic substances like carbon dioxide, water and nutrients by and the decomposers is called decomposition.

Detritus: The raw material for decomposition such as dead plant remains-leaves, bark, flowers and dead remains of animals, including fecal matter, is called detritus.

Decomposition is largely an oxygen-requiring process. The rate of decomposition is controlled hemical composition of detritus and climatic factors. In a particular climatic condition, decomposition rate is slower if detritus is rich in lignin and chitin, and quicker, if detritus is rich in nitrogen and water-soluble substances like sugars.

Temperature and soil moisture are the most important climatic factors that regulatedecomposition through their effects on the activities of soil microbes.Warm and moist environment favour decomposition whereas low temperature and anaerobiosis inhibit decomposition resulting in build up of organic materials.

Steps of decomposition

Fragmentation	Breaking down of detritus into smaller particles by the detritivores(e.g., earthworm) is called fragmentation.
Leaching	Leaching is a process of going down of water soluble inorganic nutrients into the soil horizon and getting precipitated there as unavailable salts.
Catabolism	Degradation of detritus by Bacterial and fungal enzymes into simpler inorganic substances is called as catabolism
Humification	Humificationleads to accumulation of humus (a dark colored amorphous substance that is highly resistant to microbial action and undergoes decompositionat an extremely slow rate). Being colloidal in nature it serves as a reservoir of nutrients.
Mineralization	Mineralization is the further degradation of humus by some microbes and release of inorganic nutrients into the soil.

When any organism dies it is converted to detritus or dead biomass that serves as an energy source for decomposers.

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.Decomposers secrete digestive enzymes that breakdown dead and waste materials into simple, inorganic materials, which are subsequently absorbed by them.

3.Energy Flow:

Sun is the only source of energy for all ecosystems on Earth except for the deep sea hydro-thermal ecosystem. Of the incident solar radiation less than 50 per cent of it is photosynthetically active radiation (PAR)

Plants capture only 2-10% of the PAR and fix Sun's radiant energy to make food from simple inorganic materials.

The green plants are called **producers**. (Herbaceous and woody plants, phytoplankton,algae and higher plants)

All animals depend on plants (directly or indirectly) for their food needs. They are hence called consumers and also heterotrophs. If they feed on the producers, they are called **primary consumers or herbivores**

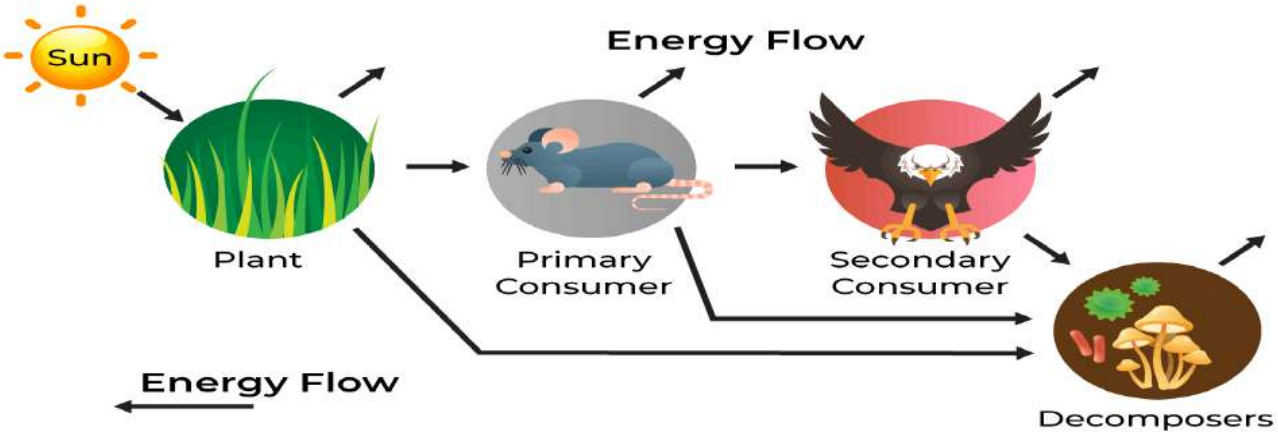
The animals that eat other animals which in turn eat the plants or their produce are called **secondary consumers or primary carnivores**

The consumers that feed on primary carnivores / secondary consumers are labeled **tertiary consumers or secondary carnivores**.

Solar energy captured by plants flows through different organisms of an ecosystem. (**Unidirectionalflow of energy from the Sun to producers and then to consumers**)

Energy flow through different trophic levels in a food chain

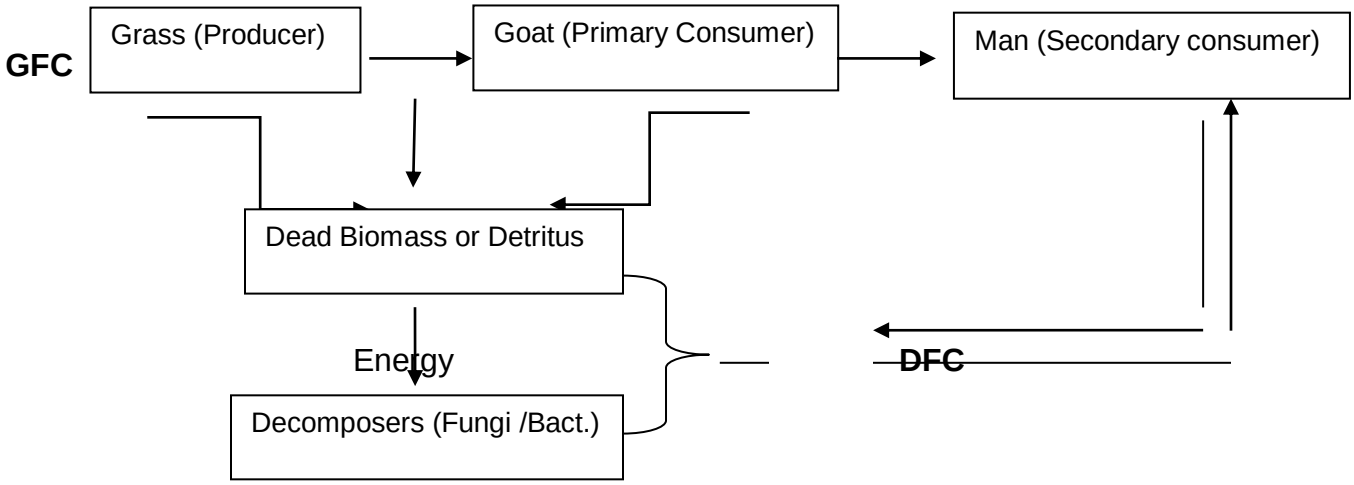
Transfer of energy follows **10 per cent law** in the grazing food chain – **only 10 % of the energy** is transferred to each trophic level from the lower trophic level.



A trophic level represents a specific place occupied by the organisms in the food chainbased on their feeding relationships with other organisms i.e. the source of their nutrition or food. Producers belong to the first trophic level, herbivores (primary consumer) to thesecond and carnivores (secondary consumer) to the third.The important point to note is that the amount of energy decreases at successive trophic levels.

Standing crop: Each trophic level has a certain mass of living material at a particular time called as the standing crop. The standing crop is measured as the mass of living organisms (biomass) or the number in a unit area. The biomass of a species is expressed in terms of fresh or dry weight.

Grazing and Detritus Food Chain (GFC and DFC) relationship:



- ✓ 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 interconnections of food chains make it a **food web.**

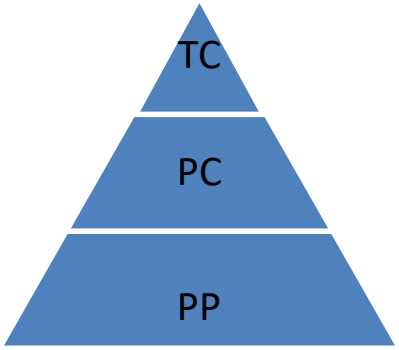
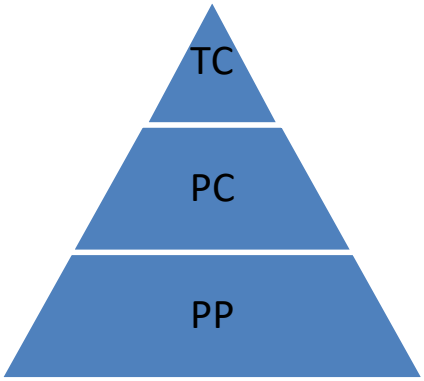
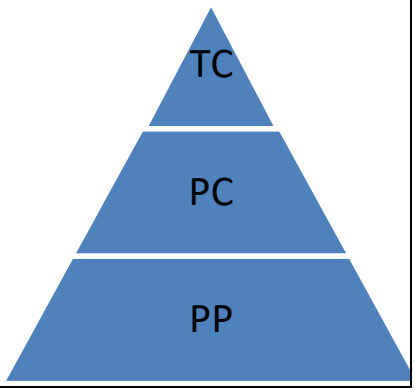
Ecological pyramids:

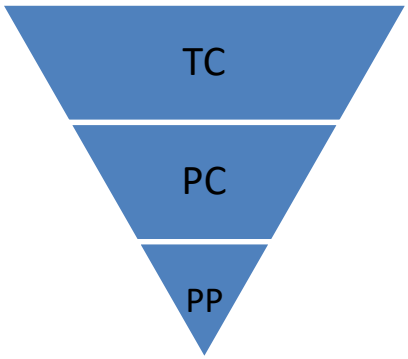
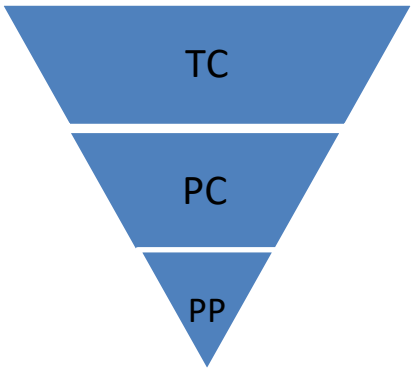
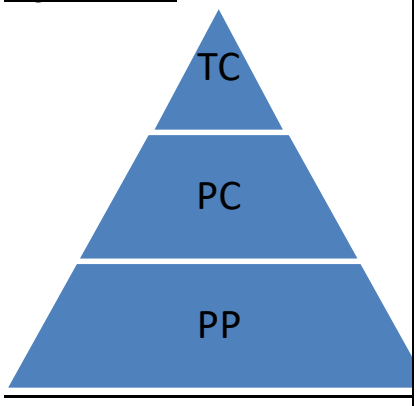
Ecological pyramids are the shapes that represent the food or energy relationship between organismsat different trophic levels. This, relationship is expressed in terms of number, biomass or energy.
The base of each pyramid represents the producers or the first trophic level while the apex represents tertiary or top level consumer.

The three types of ecological pyramids that are usually studied are -----
(a) Pyramid of number
(b) Pyramid of biomass
(c) Pyramid of energy.

Pyramid of energy **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.

Limitationsof ecological pyramids:
1. It does not take into account the same species belonging to two or more trophic levels.
2. It assumes a simple food chain, something that almost never exists in nature
3. It does not accommodate a food web.
4. Saprophytes are not given any place even though they play a vital role in the ecosystem.

Pyramid of Number	**Pyramid of Biomass**	**Pyramid of Energy**
Generally upright	Generally upright	Always upright
Producers are more in number than the herbivores, and herbivores are more in number than the carnivores. 	Producers are more in biomass than the herbivores, and herbivores are more in biomass than the carnivores. 	Producers are more in energy than the herbivores, and herbivores are more in energy than the carnivores. 

Exception : A big tree on which a number of insects feed, small birds feeding on insects as also the number of larger birds eating the smaller. 	**Exception :**The pyramid of biomass in sea is generally inverted because the biomass of fishes far exceeds that of phytoplankton. 	**No exception:** Energy at a lower trophic level is <u>always more than at a higher level.</u> 

Practice Questions

Multiple Choice Questions (MCQs)

1. Which of the following is an example of a terrestrial ecosystem?
   a) Pond b) Lake c) Forest d) River
2. In an ecosystem, energy flow is:
   a) Cyclic b) Multidirectional c) Bidirectional d) Unidirectional
3. The rate of biomass production is called:
   a) Decomposition b) Productivity c) Stratification d) Mineralization
4. Primary consumers in an aquatic ecosystem are typically:
   a) Zooplankton b) Phytoplankton c) Algae d) Fungi

5. Humus is: a) Fully decomposed organic matter
   b) Partially decomposed organic matter
   c) Inorganic matter
   d) Fresh plant material
6. The pyramid of energy is always: a) Upright b) Inverted c) Irregular d) Horizontal
7. Which factor does NOT affect primary productivity? a) Plant species b) Solar radiation
   c) Soil pH d) Altitude
8. The process by which water-soluble nutrients are carried away from the soil is called:

   a) Fragmentation b) Leaching c) Catabolism d) Humification

Assertion-Reason Type Questions

9. Assertion: Decomposition is faster in a warm and moist environment. Reason: Warm and moist conditions favor microbial activity.
10. Assertion: The pyramid of biomass in the ocean is generally inverted. Reason: The biomass of phytoplankton is lower than that of the fish.
11. Assertion: In a food web, energy transfer efficiency is about 10%. Reason: Energy is lost as heat at each trophic level.
12. Assertion: The net primary productivity (NPP) is always higher than the gross primary productivity (GPP). Reason: NPP includes respiration losses.

13. Assertion: Detritivores are essential for nutrient cycling. Reason: They break down organic matter into simpler inorganic substances.

Short Answer Questions (2 marks each)

14. Evaluate the implications of the 10% law for the structure of food webs.
15. Assess the impact of human activities such as deforestation on the decomposition process.
16. Develop a model to demonstrate the process of decomposition in a laboratory setting
17. Explain why energy flow in an ecosystem is unidirectional.
18. Using a food chain of your choice, illustrate how energy is transferred from one trophic level to the next.
19. Discuss the reasons for the decrease in energy as it moves through the trophic levels.
20. What is primary productivity and how is it measured?
21. Explain why the pyramid of energy is always upright.
22. How does energy flow through an ecosystem according to the laws of thermodynamics?
23. What are the major differences between the grazing food chain (GFC) and the detritus food chain (DFC)?

Case Based Question (4 Marks)

Case Study: A forest ecosystem was studied to understand the structure and function of different components. It was observed that the forest had a variety of plant species (producers), herbivores (primary consumers), and carnivores (secondary and tertiary consumers). Decomposers like fungi and bacteria were also abundant.

Questions:

1. Describe the roles of producers, consumers, and decomposers in this forest ecosystem.
2. Explain how energy flows through the trophic levels in this forest ecosystem.
3. Discuss how the structure of this forest ecosystem contributes to its overall stability.
4. Based on the given information, what type of ecological pyramid (numbers, biomass, or energy) would best represent this forest ecosystem? Justify your answer.

24. A pond ecosystem is observed with the following components: phytoplankton, zooplankton, small fish, and bacteria. Explain the energy flow and nutrient cycling within this pond ecosystem, and discuss how each component contributes to these processes.

Long Answer Questions (5 marks each)

25. Describe the steps involved in decomposition and discuss the factors affecting the rate of decomposition.

26. Explain the structure and function of an ecosystem using a forest as an example.

27. Compare and contrast gross primary productivity (GPP) and net primary productivity (NPP). How do environmental factors influence these measures?

28. Discuss the different types of ecological pyramids and their significance in understanding ecosystem dynamics.

CHAPTER-13: BIODIVERSITY AND ITS CONSERVATION

Syllabus (2025-26)
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.

Main Points:

Biodiversity: Presence of different kinds of organisms in Biosphere is called Biodiversity.

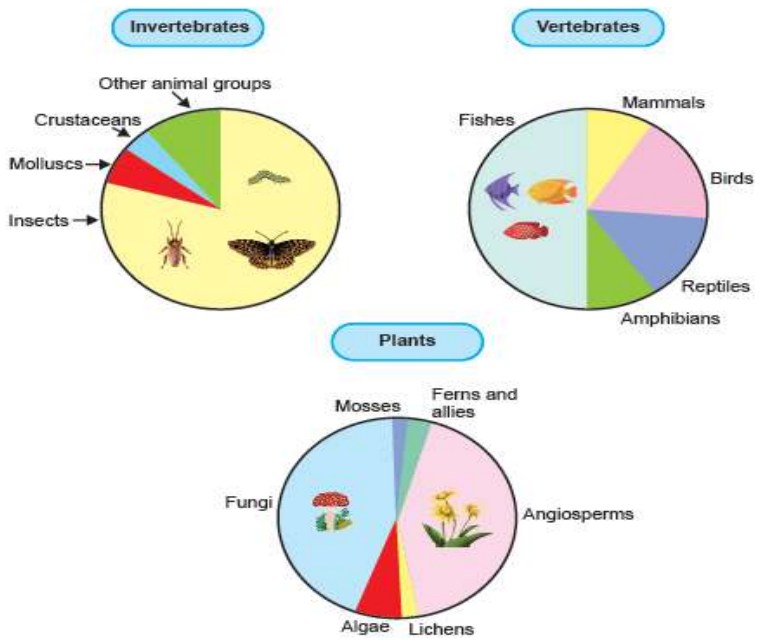
Types:

Genetic Diversity: Diversity at genetic Level in a single species is called genetic diversity.
Example: 50000 strains of rice in India.*Rauwolfiavomitoria*has genetic variants for reserpine.

Species Diversity: Diversity at Species level is called Species diversity.
Example: There are more species of Amphibians in Western Ghat than in Eastern Ghat.

Ecological Diversity: Ecosystem level diversity i.e. presence of different kind of ecosystems in an Area is called Ecosystem Diversity.
Example: In India Desert, Wetland, Mangroove, Alpine etc ecosystems are present.

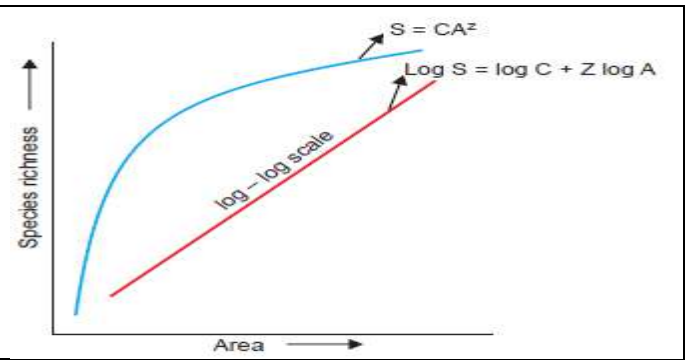
How many species are on earth?
As per Robert May Total Global species Diversity is & 7 million.
Out of these slightly more than 1.5 million species are described till date as per IUCN (International Union for Nature & Natural Resources) 2004.



Patterns of Biodiversity:

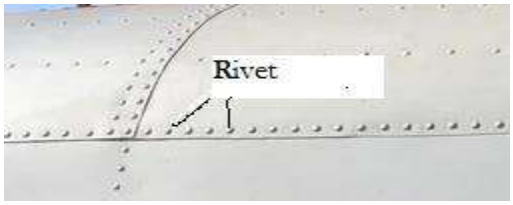
Latitudinal Gradient: The species diversity generally decreases as we move from equator towards pole. This are called latitudinal Gradient. **Example:** Near equator Colombia 1400 species of birds>New York 41◦ N 105 species of birds>Green Land 71◦ 56 species of birds.	**Species Area Relationship:** As per **Alexander Van Humboldt** Within a region the species richness increases with increasing explored area up to a limit. There after it does not increase. **When** it is shown in graph rectangular hyperbola is obtained.

Graph showing relationship between species richness & area--

The equation showing species area relationship is- **log S=log C+Z log A** Where- S=Species Richness, A=Area, Z=Slope of the line (regression coefficient) C=Y intercept Generally value of Z is 0.1to 0.2 but for very large area say continent Z is 0.6 to 1.2 irrespective of taxonomic group of the area.	

<u>Importance of Species Diversity to the Ecosystem:</u>

- **David Tilman** foundthat plots with more species showed less year to year variation in total bio mass.This gives stability to community.
- **<u>Rivet Popper Hypothesis</u>** <u>by</u> **<u>Paul Ehrlich:</u>**
- Paul Ehrlich Hypothesized that if we consider Airplane as Ecosystem & thousands of Rivets as Species joining the parts of plane.
- If rivets are taken away by every passenger (species extinct) then in starting it will not affect the flight safety (proper functioning of Ecosystem) but if it is more & more than plane becomes weak & flight safety becomes very dangerous & plane may crash.
- Also if very critical rivet is removed (Key Species is lost) viz. rivet of wings then more serious threat to flight safety will occur & plane will collapse (Ecosystem may collapse).



Rivets in Airplane

Loss of biodiversity:

Causes of Biodiversity Loss (Evil Quartet):

1. Habitat loss & Fragmentation
2. Overexploitation
3. Alien species Invasion
4. Co-Extinction

Examples-

1. Habitat loss & Fragmentation-Amazon rain forest being removed for soya bean cultivation & grassland making for beef cattle.

2. Overexploitation: In last 500 years**Stellar's Cow, Passenger pigeon got** extinct.

3. Alien species Invasion: Nile Perch Introduced in Lake Victoria resulted in extinction of more than 200 species of indigenous Cichlid fish in East Africa.

4. Co-Extinction: Extinction of a host fish leads in to extinction of parasite species based on it.

Biodiversity Conservation:

Narrowly utilitarian View–	Broadly utilitarian View-	Ethical Reason:
Biodiversity conservation due to direct economic benefits from nature like food,fibre, medicine, fire wood, industrial products etc.	Biodiversity conservation due to indirect benefits through ecosystem services. **Example**-Production of Oxygen by plants viz. Amazon rain forest contributes 20% of total Oxygen in atmosphere. Pollination done by pollinators & aesthetic pleasures obtained from watching flowers, natural scenery etc.	We need to realize that every species in the word has importance in nature. So if it is not of any economic importance even that it is our moral duty to conserve them so that they can be passed to future generations in good order.

How Do We Conserve Biodiversity?

***In situ* conservation**	***Ex situ* Conservation**
When we conserve and protect the whole ecosystem, its biodiversity at all levels is protected This approach is called *in situ* (on site) conservation. **Example**: we save the entire forest to save the tiger. (14 biospheric reserve,90 national parks,448 wild life sanctuaries, Hot spots ,Sacred grooves.)	When 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. Then it is called ***Ex-situ (off site)* Conservation.** **Example:** Zoological Parks, Botanical Gardens, Wild life safari parks, cryopreservation of gametes etc

- **Biodiversity Hot Spots:**'Biodiversity hotspots 'are the regions with very high levels ofspeciesrichnessand high degree of endemism.
- Total 34 biodiversity hot spots are in world.
- 03 of these hotspots – **Western Ghats and Sri Lanka, Indo-Burma** and**Himalaya**cover our country's exceptionally high biodiversity regions.Although all the biodiversity hotspots put together cover less than2 % of the earth's land area, the number of species they collectively bear is very high.(their protection can reduce 30% extinction).

Sacred grooves: In many cultures, tracts of forestwere set aside, and all the trees and wildlife within were venerated and given total protection. These are called sacred groves.
Example: Khasi and Jaintia Hills in Meghalaya, Aravalli Hills of Rajasthan, Western Ghat regions of Karnataka and Maharashtra and the Sarguja, Chanda and Bastar areasof Madhya Pradesh.

Earth summit:

- The Earth Summit' held in Rio de Janeiro in 1992,
- Aim was to take appropriate measures for conservation of biodiversity and sustainable utilization of its benefits.
- Later on the World Summit on Sustainable Development held in 2002in Johannesburg, South Africa, 190 countries pledged their commitmentto achieve goal by 2010.

Most recently Earth Summit was held in Stockholm in SWEDEN IN JUNE 2022.

Ramsar Site:

- A Ramsar site is a wetland site designated to be of international importance under the Ramsar Convention
- It is also known as "The Convention on Wetlands", an international environmental treaty signed on 2 February 1971 in Ramsar, Iran, under the auspices of UNESCO.

- Ramsar sites are home of many plant & animal species. So that these are conserved.
- There are 2400 Ramsar sites in the world.
- There are 89 Ramsar Sites in India.

Questions:

Multiple Choice Questions 1 Marks

1	Which one of these is example of In situ conservation of Biodiversity? (a)Zoological Park (b) Botanical Garden (**c**) Wildlife Sanctuaries (d) None of these
2	A species is confined to a particular site only .So the species may be termed as- (a)Epidemic (b) Cosmopolitan (c) Indigenous(**d**) Endemic
3	Colombia, New York, & Greenland are situated near equator, 41◦N &71◦ N latitude respectively. Find correct option for number of bird species- (a)71,105,1400 (**b**) 1400,105,71 (c) 1400,71,105 (d) 105,71,1400
4	IUCN(2004) Red Data Book has list of - (a)Biospheric reserves (b) Hot spots (c) Ramsar sites (**d**) Endangered species
5	A road was newly made across a dense forest such that forest got divided in three parts. Which one is true evil Quartet for this case - (**a**)Habitat fragmentation (b) Overexploitation (c) Co-extinction(d) Alien species invasion
6	Keystone species are required to be protected Because these- (a) are capable of surviving in harsh environmental condition (b) have become rare due to overexploitation (**c**) play very crucial role in supporting other species (d) indicate certain mineral in the soil.
7	Which of the following is not a cause for loss of biodiversity? (a) Destruction of habitat (b) Invasion by alien species (**c**) Keeping animals in zoological parks (d) Over-exploitation of natural resources
8	The term biodiversity hotspot refers to – (a) Areas with high species diversity (b) Areas with low speed diversity (c) Regions only with endangered species(**d**) Areas that are easy to access
9	Which of the following is a threatened species in India? (**a**) Bengal Tiger (b) House Sparrow (c) Pigeon (d) Frog
10	Match the animals given in column I with their location in column II. Column-I Column-II A. Dodo (i) Africa B. Quagga (ii) Russia C. Thylacine (iii) Mauritius D. Stellar's sea cow (iv) Australia Choose the correct match from the following (a) A-(i), B-(iii), C-(ii), D-(iv) (b) A-(iv),B-(iii), C-(i), D-(ii) (c) A-(iii), B-(i), C-(ii), D-(iv) (**d**) A-(iii), B-(i), C-(iv), D-(ii)
	Assertion Reason Questions:
	In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices. (A) Assertion and reason both are correct statements and reason is correct explanation for assertion.

	(B) Assertion and reason both are correct statements but reason is not correct explanation for assertion. (C) Assertion is correct statement but reason is wrong statement. (D) Assertion is wrong statement but reason is correct statement.
1.	**Assertion:** Biodiversity is declining at an accelerated rate. **Reason:**Exotic species cause extinction of endemic species.
2.	**Assertion:** The general value of z in species area relationship equation is is 0.6 to 1.5. **Reason:**Z represents the slope of line.
3.	**Assertion :** IUCN maintains the red list of threatened species to assess Conservation of different species. **Reason:** The species which are on the verge of extinction are called the threatened species.

Ans:1B, 2D, 3B

Short answer type 2 marks Questions

1 **What is IUCN red list? Give any two uses of this list.**

Ans. IUCN red list is a catalogue of species which are facing the risk of extinction.
The two uses of this list are:
(*i*) It provides authentic information about threatened species.
(*ii*) It is Identification and documentation of endangered species and so helps in taking protective measures for them.

2 **What are two criteria to decide a Hot Spot?**

Ans: The two criteria to decide a hot spot are-
(1) High species richness
(2) Endemic species

3 **Justify that on invasion of an exotic species indigenous species get affected & they may be extinct.**

Ans: Invasion of exotic species affects badly to indigenous species. For example When Nile perch an exotic fish was introduced in the Lake Victoria in East Africa then 200 indigenous Cichlid Fish become extinct.

4 **Differentiate between in situ & ex situ conservation of biodiversity.**

Ans:

***In situ* conservation**	***Ex situ* Conservation**
When we conserve and protect the whole ecosystem, its biodiversity at all levels is protected This approach is called *in situ* (on site) conservation. **Example**: we save the entire forest to save the tiger. (14 biospheric reserve,90 national parks,448 wild life sanctuaries, Hot spots ,Sacred grooves.) .	When 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. Then it is called ***Ex-situ (off site)* Conservation.** **Example:** Zoological Parks, Botanical Gardens, Wild life safari parks, cryopreservation of gametes etc

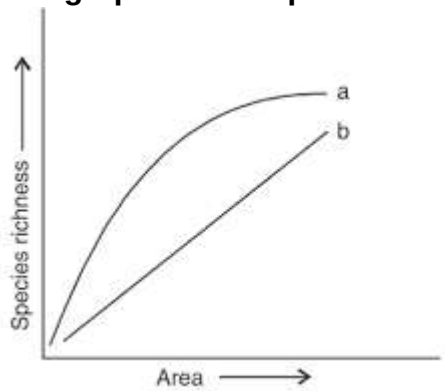
5 **Which region/biome in the world is considered as the 'Lungs of the planet'? Give two reasons for its degradation.**

Ans. The Amazon rain forests are considered as the lungs of the planet as they contribute 20% of total Oxygen of atmosphere. They are cut and cleared for cultivation of soya beans. Some part has been converted into grass lands for raising beef cattle.

Short answer 3 marks Questions:

1 **Who considered ecosystem analogous to an airplane**? **What component of ecosystem was considered analogous to rivets? What was the term given to this hypothesis?**
Ans. Paul Ehrlich considered ecosystem analogous to airplane. Species of an ecosystem was considered analogous to the rivets. The term given to this hypothesis was rivet popper hypothesis. This hypothesis states that in an airplane (ecosystem) all parts are joined together using thousands of rivet (species). If every passenger travelling in it starts popping a rivet to take home (causing a species to become extinct), it may not affect flight safety (proper functioning of the ecosystem) in starting but if more and more rivets are removed, then plane becomes dangerously weak . Which rivet is removed is also important for example loss of rivets on the wings (key species) is more serious threatto flight safety than loss of few rivets on the seats or windows inside the plane.

2 **The graph shows species-area relationship:**



If b denotes the relationship on log scale-
(i) Describe a and b.
(ii) How is slope represented? Give the normal range of slope.

Ans: (i) "a" represents the graph between species richness & Area. It's equation is-
$S = CA^Z$

Where S = species Richness ,C= Y- intercept, Z= Slope of line

"b" represents relationship on logarithmic scale. Equation for this is –

log S=log C+Z log A

Where-

S=Species Richness, A=Area,
Z=Slope of the line (regression coefficient)
C=Y intercept

(ii) Slope is represented by Z. Generally value of Z is 0.1to 0.2 but for very large area say continent Z is 0.6 to 1.2 irrespective of taxonomic group of the area.

Long answer type 5 Marks Questions
(*a*) Taking one example each of habitat loss and fragmentation, explain how are the two responsible for biodiversity loss.
(*b*) Explain two different ways of biodiversity conservation.
Ans: (a) Habitat loss and fragmentation: This is the most important cause for animals and plants to be extinct. The most dramatic. Oncecovering more than 14 per cent of the earth's land surface, theserain forests now cover no more than 6 per cent. They are beingdestroyed fast.

Example: The Amazon rain forest (also called 'lungs of the planet')harbouringprobably millions of species is being cut and clearedfor cultivating soya beans or for conversion to grasslands for raisingbeef cattle.

When largehabitats are broken up into small fragments due to various human activities (**for Example making Roads through dense forest**), mammals and birds requiring large territories and certainanimals with migratory habits are badly affected, leading topopulation declines.

(b) The two different ways of biodiversity conservation are-

***In situ* conservation:**

When we conserve and protect the whole ecosystem, its biodiversity at all levels is protected. This approach is called *in situ* (on site) conservation.

Example: We save the entire forest to save the tiger.viz. Kanha Tiger reserve in Madhya Pradesh.

(There are14 biospheric reserve,90 national parks,448 wild life sanctuaries, Hot spots ,Sacred grooves for this.)

***Ex situ* Conservation:**

When 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. Then it is called ***Ex-situ (off site)* Conservation.**

Example: Zoological Parks, Botanical Gardens, Wild life safari parks, cryopreservation of gametes etc

(*a*) Why should we conserve biodiversity? How can we do it?

(*b*) Explain the importance of biodiversity hotspots and sacred groves.

Ans.(a) We should conserve the biodiversity because of the following reasons-

Narrowly utilitarian View–Biodiversity conservation due to direct economic benefits from nature like food, fibre, medicine, fire wood, industrial products etc.

Broadly utilitarian View-Biodiversity conservation due to indirect benefits through ecosystem services. **Example**-Production of Oxygen by plants viz. Amazon rain forest contributes 20% of total Oxygen in atmosphere. Pollination done by pollinators & aesthetic pleasures obtained from watching flowers, natural scenery etc.

Ethical Reason: We need to realize that every species in the word has importance in nature. So if it is not of any economic importance even that it is our moral duty to conserve them so that they can be passed to future generations in good order.

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AISSCE EXAMINATION 2024-2025
CLASS –XII BIOLOGY (044)
2023-24

Maximum Marks: 70 **Time: 3 hours**

General Instructions:
1. All questions are compulsory.
2. The question paper has five sections and 33 questions.
3. All questions are compulsory. Section–A has 16 questions of 1 mark each; Section–B has 5 questions of 2 marks each; Section– C has 7 questions of 3 marks each; Section– D has 2 case-based questions of 4 marks each; and Section–E has 3 questions of 5 marks each.
4. There is no overall choice. However, internal choices have been provided in some questions. A student has to attempt only one of the alternatives in such questions.
5. Wherever necessary, neat and properly labeled diagrams should be drawn.

SECTION-A

1. In which of the following plants are both male and female flowers born on the same plant and the mode of pollination can be geitonogamy or xenogamy ?
(A)Papaya (B)DatePalm(C)Maize(D)Spinach
2. Which one of the following hormones is secreted by the human placenta that helps in the maintenance of pregnancy ?
A) Relaxin(B)Human ChorionicGonadotropin(C)Oxytocin(D)Human Placental Lactogen
3. The periodic abstinence by a couple for family planning should be from:
Day 5 to 10 of menstrual cycle
Day 13 to 15 of menstrual cycle
Day10to17ofmenstrual cycle
Day16to20ofmenstru
Day 10 to 17 of menstrual cycle
Day16to20ofmenstrualcycle
Select the incorrect match from the following:
4. Human KaryotypeCharacters
45+XX – Broad palm with characteristic palm crease
44+XXY – Overall feminine development
44+XO – Sterile females as ovaries are rudimentary
44+XY – Normal male
5. You know that there are twenty different types of naturally occurring amino acids and four different types of bases in the DNA. A combination of 3 such bases code for a specific amino acid. If instead there are 96 different amino acids and 12 different bases in the DNA, then the minimum number of combination of bases required to form a codon is :
(A) 6 (B)8 (C)2 (D)4
6. The type of bond represented by the dotted line'– – – – –'in a schematic polynucleotide chain is :

(A) Hydrogen bond (B) Peptide bond

(C) N-glycosidic linkage (D) Phosphodiester bond

7. In which of the following conditions/diseases is there a substantial increase in the activity of mast cells observed in the human body?
(A) Typhoid (B) Allergy
(B) Ascariasis (D) AIDS
8. Lactobacillus that sets milk into curd is categorised as :
(A) Cyanobacteria (B) Archaebacteria
(C) Chemosynthetic bacteria (D) Heterotrophic bacteria
9. Which one of the following transgenic animals is being used to test the safety of the polio vaccine ?
(A) Sheep (B) Goat(C) Pig (D) Mice
10. Restriction Endonuclease–Hind II always cuts DNA molecules at a particular point by

recognising a specific sequence of :

(A)Six base pairs (B) Four base pairs

(C) Seven base pairs (D) Three base pairs

11. The improved trait that is found in the genetically modified transgenic crop –Golden rice is :
A)High lysine content ,B)Insect resistant ,C)High protein content ,D)High vitamin-A content

12. The rate of formation of new organic matter by consumers, and the biomass available for consumption of herbivores as well as decomposers are referred to as :
(A) Gross primary productivity and Net primary productivity
(B) Net primary productivity and Secondary productivity
(C)Secondary productivity and Net primary productivity
(D)Secondary productivity and Gross primary productivity

For Questions number 13 to 16 ,two statements are given one labeled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questi~~ons~~ 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 notthe correct explanation of the Assertion(A).
(C) Assertion(A)istrue, butReason(R)isfalse.
(D) Assertion(A)is false ,but Reason (R) is true.

13. **Assertion (A)** : The laws of our country permit legal adoption and it is as yet, one of the best methods for childless couples looking for parenthood.
Reason (R): Emotional, religious and social factors are no deterrentsto the legal adoption of orphaned and destitute children in India.

14. **Assertion (A):** Linked genes do not show dihybrid F_2 ratio 9 :3:3:1.
Reason(R): Linked genes donot undergo independent assortment.

15. **Assertion (A)** : Agrobacterium tumefaciens is a pathogen of several monocot plants.
Reason (R) :It is able to deliver a piece of DNA known as 'T-DNA' to transform normal plant cells into a tumor.

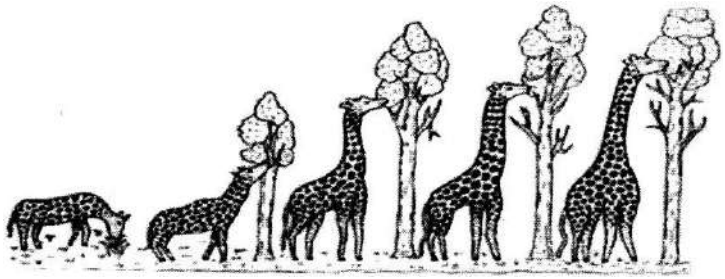
16. **Assertion (A**) :Indian Government has set up an organisation known as GEAC to decide the validity of GM research.
Reason (R) :Genetic modification of organisms has no effect when such organisms are introduced in the ecosystem.

SECTION-B

17. Identify A,B,C and D in the table given below:

Terms	Part of the plant it represents
Pericarp	'A'
'B'	Cotyledon in seed of grass family
Embryonal axis	'C'
'D'	Remains of nucellus in a seed

18. Observe the picture given below.Name the naturalist and write the explanation given by him that evolution of life forms had occurred on the basis of this example.



19. Write the basic steps followed in the Assisted Reproductive Technologies (ART) programme to help childless couples.Why is it also known as test tube baby programme?

20. (a) A farmer while working on his farm was bitten by a poisonous snake. He was rushed to a nearby health centre where the doctor gave him an injection to save his life.

(i) What did the doctor inject and why?

(ii) Name the kind of immunity provided by this injection.

OR

(b)Why do organic farmers not recommend complete eradication of Insect pests? Explain giving reason.

21. Study the diagram of a pyramid of biomass given below.Name the two standing crops that

'A' [redacted]

ould be occupying leve 'A' and 'B' in it.Name This type of pyramid and the ecosystem in which it is found.

SECTION-C

22. Explain the mode of action of contraceptive pills taken by human females. Mention the schedule to be followed for effective outcome.

23. (a)Name and write two characteristics of the type of DNA that forms the basis of DNA fingerprinting technique.

(b)Mention any two applications of this technique.

24. (a)Explainthesignificanceoftheexperimentcarriedoutby S.L. Miller. Name the scientists whose hypothesis prompted him to carry out this experiment.

(b) How does meteorite analysis favour this hypothesis.

25. Identify A,B,C,D,E and F in the table given below:

Name of Human Disease	Causative Organism	Symptoms
Pneumonia	Streptococcus	'A'
Typhoid	'B'	High fever, weakness, headache, stomach pain
CommonCold	Rhino virus	'C'
Ringworm	'D'	Dryscaly lesionson bodyparts,redness, itching
Ascariasis	Ascaris	'E'
'F'	Entamoeba histolytica	Constipation,cramps, stools with mucous and blood clots

26. In a family, the father, the daughter and the son are colourblind,whereas the mother has normal vision. Do you think the son and the daughter have inherited the disease from their father ? Work out a crossto justify your answer.

27. (a)(i)What are transgenic animals?

(ii)Name the first transgenic cow and state its importance.

OR

(b)(i)Explain the convention for naming EcoRI.

(ii)With the help of an illustration only, show the action of EcoRI on a DNA Polynucleotide.

28. (a)Explain how it is ensured that the orchid Ophrys is pollinated by a specific species of bee.

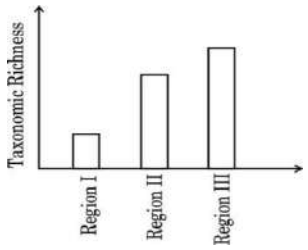
(b)Describe co-evolution with the help of this example.

SECTION-D

Questions No. 29 and 30 are case-based questions.Each questionhas 3 sub-questions with internal choice in one sub-question.

Read the following passage and answer the questions that follow.

29. Total land area whereas its share of the global species diversity is an impressive 8·1 per cent . However,in these estimates of species, prokaryotes do not figure anywhere.
Biologists are always keen on collecting data with respect to species diversity observed in different regions of the world. The data collected based on the survey conducted for species richness of groups of mammals in three different regions of the world is shown in the bar graph given below :

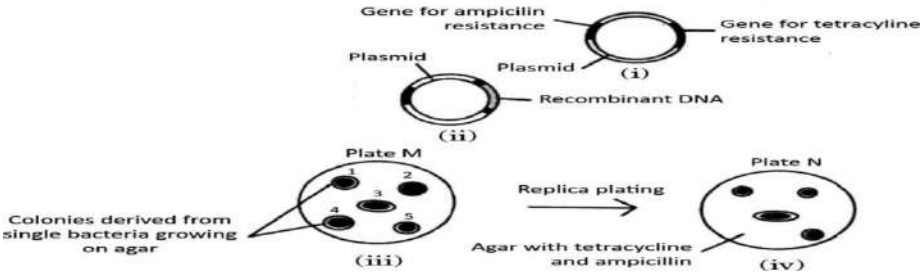


(a)Why is the species richness maximum in Region III in the bar graph ?

OR

(a) Why is the species richness minimum in Region I in the bar graph ?
(b) Plants and animals do not have uniform diversity in the world but show rather uneven distribution. Mention what this kind of diversity is referred to as?
(c) Why is it that prokaryotes do not have an estimated number of their species diversity as seen in plants and animals ? Explain.

30. Study the diagram given below that shows the steps involved in the procedure of selecting transformed bacteria and answer the questions that follow :



(a) Identify the colony that has got transformed. Justify your answer.
(b) What are the sites in a plasmid called where ampicillin and tetracycline resistance genes are inserted ? State their role in genetic engineeri

(c) Name two enzymes playing an important role in genetic engineering.

OR

(c)State the role of β-galactosidase in insertional inactivation
.

SECTION-E

31. (a) (i)Explainthe developmentofmalegametophyteinan angiosperm.
(ii)Draw a labeled diagram of a three-celled male gametophyte.

OR

(b)(i)Draw a diagrammatic sectional view of ovary of human female and label the following (1) Bloodvessels(2) Primaryfollicle(3)Tertiaryfollicle(4)Ovum
(ii)At which stage of life are primary follicles formed in a human female?
(iii)Explain the events (both hormonal and structural) that occur at the time of ovulation till the onset of the next menstrual cycle.

32.(a)Stability, as one ofthe properties of genetic material, was very evident in one of the very early experiments in genetics. Name the scientist and describe his experiment.State the conclusion he arrivedat.

OR

(b) At all pea plant bearing violet flowers with unknown genotype is given. Find the genotype by working out different crosses only by selfing the plants. Write the genotypic and phenotypic ratios of each cross shown by you.

33. (a) (i) Name and explain the property present in normal cells but is lost in cancer cells.

(ii) All normalhumancellshave genes thatmaybecome cancerous under certain conditions. Name them and explain how.

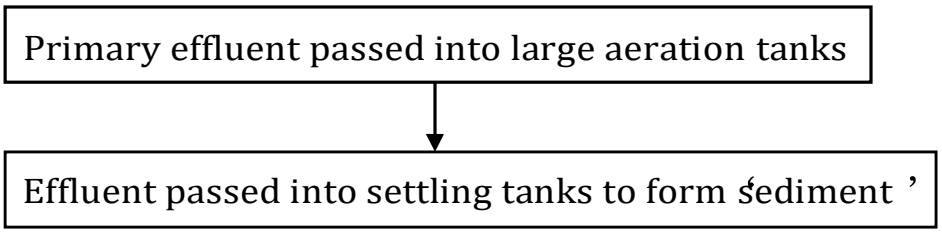
(iii) State the role of the following techniques in detection and diagnosis of cancer :

1. Biopsy and Histopathology
2. Magnetic Resonance Imaging

OR

(b) Large quantities of sewage are generated every day in cities as well as in towns and are treated in Sewage Treatment Plants (STPs) to make them less polluting. Given below is the flow diagram of stages of STP.

Study the flow diagram and answer the questions that follow



(i) 1. Why is primary effluent passed into large aeration tanks ?

2. What is the 'sediment' formed,referred to as? Mention its significance.

3. Explain the final step in the settling tank before the treated effluent is released into water bodies.

(ii) Name any two organisms commonly used as biofertilisers, belonging to different kingdoms. Write how each one acts asa biofertiliser.

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AISSCE EXAMINATION 2024-2025

CLASS –XII BIOLOGY (044)

Maximum Marks: 70 **Time: 3 hours**

General Instructions:

1. All questions are compulsory.

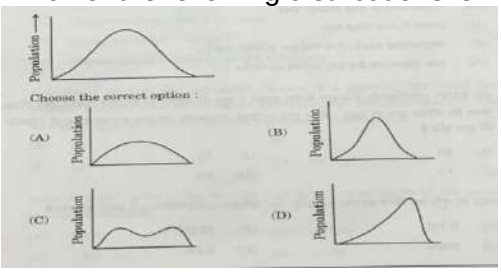
2. The question paper has five sections and 33 questions.

3. All questions are compulsory. Section–A has 16 questions of 1 mark each; Section–B has 5 questions of 2 marks each; Section– C has 7 questions of 3 marks each; Section– D has 2 case-based questions of 4 marks each; and Section–E has 3 questions of 5 marks each.

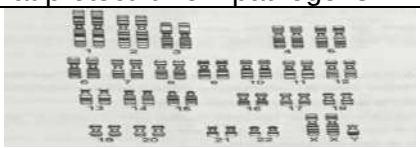
4. There is no overall choice. However, internal choices have been provided in some questions. A student has to attempt only one of the alternatives in such questions.

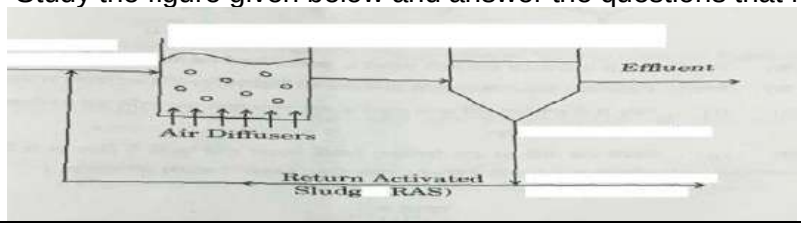
5. Wherever necessary, neat and properly labeled diagrams should be drawn.

	Section-A	
Q1	What are minisatellites? (A) 10-40 bp sized small sequences within the genes. (B) Short coding repetitive sequences region on the eukaryotic genome. (C) Short non-coding repetitive sequences forming a large portion of eukaryotic genome. (D) Regions of coding strand of DNA.	1M
Q2	The incorrect statement regarding PCR is- (A) Two sets of primers are required during polymerisation (B) The process of replication is repeated multiple times to produce one billion copies	1M

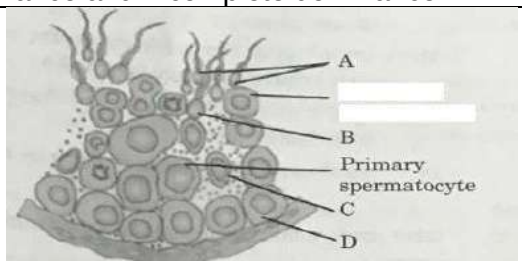
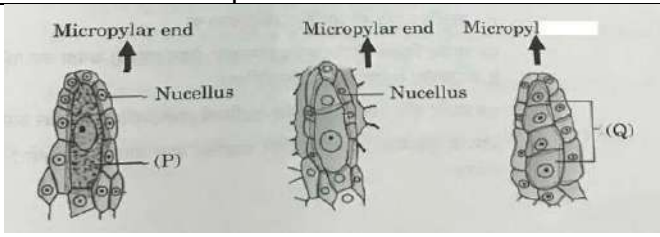
	(C) Thermostable DNA polymerase is used for extension of primers. (D) Annealing is required to separate both the strands of template DNA.	
Q3	3 .The following information is about drugs and tobacco. Select the correct statement from the options given below. (A) Cocaine is given to patients after surgery as it stimulates recovery. (B) Chewing tobacco lowers blood pressure and heart rate. (C) Barbiturates when given to criminals makes them tell the truth. (D) Morphine is often given to persons who have undergone surgery as a painkiller.	1M
Q4	Given below are the events that are observed in an artificial hybridisation programme. Arrange them in the correct sequential order and select the correct option. (i) Re-bagging (ii) Selection of parents (iii) Bagging (iv) Dusting the pollens on stigma (A) (ii), (iii), (v), (vi), (iv), (i) (B) (ii), (v), (iii), (vi), (iv), (i) (C) (v), (ii), (iii), (vi), (i), (iv) (D) (ii), ((vi), (iv), (v), (i)	1M
Q5	Which of the following conditions correctly describes the manner of determining the sex in the given options? (A) Homozygous sex chromosomes (ZZ) determine female sex in birds. (B) XO type of chromosomes determines male sex in grasshoppers. (C) XO condition in humans determines female sex. (D) Homozygous sex chromosomes (XX) produce male in Drosophila.	1M
Q6	Choose the option that correctly describes the gynoecium of Michelia: (A) Multicarpellary, Apocarpous (B) Bicarpellary, Apocarpous (C) Multicarpellary, Syncarpous (D) Bicarpellary, Syncarpous	1M
Q7	The given graph shows the range of variation among population members, for a trait determined by multiple genes. If this population is subjected to disruptive selection for several generations, which of the following distributions is most likely to result?  Choose the correct option: (A) (B) (C) (D)	1M
Q8	Which one of the following immune system components does not correctly match with its respective role? (A) Interferons Secreted by virus-infected cells and protect non-infected cells from further viral infection. (B) Macrophages Mucus-secreting cells that trap microbes entering into the body. C) B-Lymphocytes-Produce antibodies in response to pathogens to fight with them. (D) IgA Present in colostrum in early days of lactation to protect infants from diseases.	1M
Q9	Which one of the following is not the product of transgenic experiments? (A) Pest-resistant crop variety (B) High nutritional value in grain (C) Drought-resistant crops (D) Production of insulin by rDNA technique	1M
Q10	A biologist studied the population of rats in a granary. He found the average natality was 280, average mortality was 200, immigration was 40 and emigration was 50. The net increase in population is: (A) 80 (C) 10 (B) 70 (D) 90	1M
Q11	India has only 2-4% of the world's land area but its share of the global species diversity is: (A) 81% (B) 12.9% (C) 7-3% (D) 5-1%	1M
Q12	Out of the following, select the correct match: (A) Transgenic cow milk - Human beta-lactalbumin protein(B) ELISA-Antigen antibody interaction(C) Corn Borer - Cry II Ab gene (D) Cotton plant - *Meloidegyne Incognitia*	1M

	For Questions number 13 to 16, 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.	
Q13	Assertion (A): Swiss cheese is characterized by large holes due to CO_2 production. Reason (R): It is ripened by growing specific fungi.	1M
Q14	Assertion (A): Replication of DNA takes place in S phase of the cell cycle. Reason (R): DNA replication and cell division cycle should be highly coordinated.	1M
Q15	Assertion (A): A male individual always inherits haemophilia from his mother. Reason (R): The gene for haemophilia lies on X-chromosome.	1M
Q16	Assertion (A): Apiece of DNA inserted into an alien organism generally dores not replicate, if not inserted into a chromosome. Reason (R): Chromosome have specific sequences called ori region , where DNA replication is initiated	1M
	Section-B	
Q17	(a) Name the Indian crop variety for which, in 1997, an American company got patent rights through the US Patent and Trademark Office. This is considered a case of Biopiracy. Justify. OR (b) State two purposes for which the Indian Government has set up GEAC (Genetic Engineering Approval Committee).	2M

Q18	(a) "A fully developed foetus initiates its delivery from the mother's womb." Explain. OR (b) Give reasons for the following: (i) Why can a woman generally not conceive a child after 50 years of age? (ii) Polar bodies are formed during oogenesis and not during spermatogenesis.	2M
Q19	A few stages and their respective time period in the evolutionary history of human beings are mentioned in the flowchart given below: Primates walking like gorillas and chimpanzees existed. 15 mya — Primates walking like gorillas and chimpanzees existed. (a) 3-4 mya — Man-like primates walked in Eastern Africa. Fossils of their bones were discovered (b) 1-5 mya — This ancestor lived in the East African grasslands and ate fruits. (c) 1-5 mya — This hominid had a brain size of 900 cc and probably ate meat. (d) Based on the above information, answer the following questions: (a) Name one primate about 15 mya. (b) Name one place where fossils of primates were discovered in Eastern Africa. (c) Name the ancestor that lived in the East African grasslands about 2 mya. (d) Name the hominid that was found around 1-5 mya.	2M
Q20	(a) How does a human body respond when vaccine is introduced into it? It is said that vaccinations are a must for a healthy society. Justify. OR (b) Humans have innate immunity for protection against pathogens that may enter the gut along with food. What are the two barriers in our body that protect it from pathogens?	2M
Q21	(a) Identify the disorder. (b) Write the symptoms of the disorder. (c) Give reason for such a disorder 	2M

	Section-C	
Q22	A village health worker was taking a session with women. She tells them that one has to be careful while using oral pills as a method of birth control. Wrong usage can actually promote conception. (a) Analyse the above statement and compare the merits and demerits of using oral pills and surgical methods of birth control. (b) Village women are confused as to how a thin metallic copper loop can provide protection against pregnancy. Explain the mode of action of IUDs. Give two points.	3M
Q23	(a) "The process of evolution of different species in a given geographical area start from a point and literally radiates to other geographical areas. Explain it with an example. (b) Cite an example where more than one adaptive radiation has occurred in an isolated geographical area. Name the type of evolution your example depicts.	3M
Q24	A segment of DNA, TTG AGG GGG ATG was translated into an oligopeptide with the amino acids, Lysine - Serine - Proline - Tyrosine. (a) Write the codons in correct sequence for the four amino acids. (b) If first adenine in DNA is substituted by guanine, what will be the sequence of amino acids in the new oligopeptide? (c) Write the anticodons for these amino acids.	3M
Q25	A person is suffering from high grade fever. Which symptoms will help to identify if he/she is suffering from Typhoid, Pneumonia or Malaria?	3M
Q26	(a) Why are transgenic animals so called? (b) With the help of an example each, explain the role of transgenic animals in the following: (i) Vaccine safety (ii) Biological products	3M
Q27	(a) Mention any two advantages of micro propagation techniques. (b) Write in brief how the process is carried out in the laboratory. (c) Name any two important food plants grown commercially by this method.	3M
Q28	Name the type of food chains responsible for the flow of larger fraction of energy in an aquatic ecosystem and a terrestrial ecosystem, respectively. Mention any two differences between the two food chains.	3M
	Section-D 2X4=8 M	
Q29	Study the figure given below and answer the questions that follow.  	

	(a) Identify the figure and state its importance. (b) Why is air diffused into the aerator tank? Explain. (c) What changes take place in the settling tank? OR (c) How is BOD related to organic matter present in the water?	1M 1 2 2
Q30	 (a) Give the scientific terms for the processes taking place in Figures A and B respectively. (b) Mention two conditions necessary for the process occurring in Figure B. (c) (i) State one advantage and one disadvantage of the process occurring in Figure B.	 1M 1

	OR (c) (ii) Name one plant where, in some flowers only, the process in Figure B takes place and give the reason responsible for it.	2 2
	Section-E	
31	Write the features a molecule should have to act as a genetic material. In the light of the above features, evaluate and justify the suitability of the molecule that is preferred as an ideal genetic material. OR (b) Differentiate between the following: (i) Polygenic Inheritance and Pleiotropy (ii) Dominance, Codominance and Incomplete dominance	5M
32	 (i) Label A, B, C and D in the figure. (ii) What will be the number of chromosomes in secondary spermatocyte and spermatid respectively? (iii) Explain the terms - Spermiogenesis and Spermiation. OR (b) Study the figures given below showing initial stages in the formation of female gametophyte and answer the questions that follow.	5M
	 I. What kind of division does cell (P) undergoes to form (Q)? II. How many (Q) cells from the embryo sac? What name is given to such kind of development? III. How many free nuclear mitotic divisions will the functional megaspore undergo to form the embryosac? IV. Describe the structure of a mature female gametophyte.	
Q33	(i) How does alien species invasion cause a decline in biodiversity? Explain. How have the following contributed to biodiversity loss? a. Nile Perch b. *Lantana* and *Eichhornia* c. *Clarias gariepinus* (ii) Why have certain regions been declared as biodiversity hotspots by environmentalists of the world? Name any two such regions in India. **OR** Write an equation for Verhulst-Pearl Logistic Growth Curve where: N -Population density at time t', r - Intrinsic rate of natural increase (ii) Draw a graph for a population whose density has reached carrying capacity. (iii) Draw a growth curve where resources are non-limiting to growth of population. (iv) Which growth curve is considered more realistic and why? Explain.	5M

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