स्वच्छ भारत
एक कदम स्वच्छता की ओर

Azadi Ka Amrit Mahotsav

G20 भारत 2023 INDIA
वसुधैव कुटुम्बकम्
ONE EARTH • ONE FAMILY • ONE FUTURE

KENDRIYA VIDYALAYA SANGATHAN
KOLKATA REGION

तत् त्वं पूषन् अपावृणु
केन्द्रीय विद्यालय संगठन

BIOLOGY STUDY MATERIAL
CLASS-XII

SESSION 2023-24

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Preface

It gives immense pleasure to present this support material for biology, designed specifically for the upcoming CBSE 12 board exams. This comprehensive guide has been crafted keeping in mind the varying needs and learning styles of students.

The primary objective of this support material is to provide you with a user-friendly and efficient resource that covers all aspects of the biology syllabus. We understand the importance of an exam-oriented approach, hence this material encompasses all types of questions that have been given in latest sample paper. From multiple-choice questions and assertion reason type questions to case study based questions, this guide includes a wide range of exercises to help you practice and familiarize yourself with the new questionnaire pattern.

To enhance your understanding and retention, this support material incorporates concise summaries of each chapter, serving as quick revision notes. Additionally, the inclusion of well-designed diagrams and illustrations aids in visual learning, enabling you to grasp complex concepts effortlessly.

Recognizing the diversity of students' abilities, this support material encompasses a balanced approach that caters to all types of learners. Whether you prefer a textual approach or a more visual one, this guide strives to facilitate your understanding of biology by presenting information in multiple formats.

I would like to extend my heartfelt gratitude to the team of content developers and moderators who dedicated their time and expertise to create this invaluable resource. I sincerely hope that this guide proves to be an indispensable tool in your examination preparation and helps you achieve exemplary results in your CBSE 12 board examination.

Wishing you the very best in your academic journey!

CBSE Curriculum for the Academic Year 2023-24

BIOLOGY (Code No. 044)
CLASS XII (2023-24)
(THEORY)

Time: 03 Hours **Max. Marks: 70**

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**

Unit-VI Reproduction

Chapter-2: 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-3: 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-4: 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-5: 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-6: 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-7: 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-8: 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-10: 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-11: Biotechnology - Principles and Processes

Genetic Engineering (Recombinant DNA Technology).

Chapter-12: 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-13: Organisms and Populations

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

Chapter-14: Ecosystem

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

Chapter-15: 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.

Question Paper Design (Theory) 2023-24 Class

XII

Biology (044)

Competencies	
Demonstrate Knowledge and Understanding	50%
Application of Knowledge / Concepts	30%
Analyse, Evaluate and Create	20%

Note:

- Typology of questions: VSA including MCQs, Assertion – Reasoning type questions;
- SA; LA- I; LA-II; Source-based/ Case-based/ Passage-based/ Integrated assessment questions.
- An internal choice of approximately 33% would be provided.

Suggestive verbs for various competencies

- **Demonstrate, Knowledge and Understanding**

  State, name, list, identify, define, suggest, describe, outline, summarize, etc.

- **Application of Knowledge/Concepts**

  Calculate, illustrate, show, adapt, explain, distinguish, etc.

- **Analyze, Evaluate and Create**

  Interpret, analyse, compare, contrast, examine, evaluate, discuss, construct, etc.

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CONTENTS

Good luck is when opportunity meets preparation, while bad luck is when lack of preparation meets reality.

CHAPTER :- 1

SEXUAL REPRODUCTION IN FLOWERING PLANTS

SUMMARY

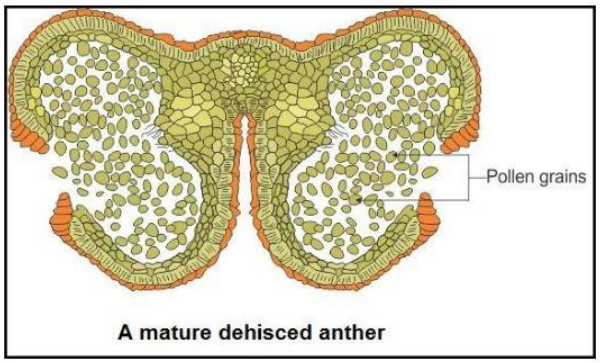
Flowers provide development of the pollen tube, germination of pollen, the formation of gametes and fertilization. The ovarian portion of the carpel is supplied into the fruit. The ovules are converted into seeds after fertilization. The gametophytes also develop inside the spores in case of heterosporous plants.Pollen grains represents the male gametophyte generation. The pollens have a two layered wall. The exine and inner intine. The pistil has three parts – the stigma, style and the ovary . Ovules are present in the ovary. The central tissue is the nucellus in which the archesporium differentiates. The megaspore mother cell divides meiotically and one of megaspores forms the embryosac.

KEY WORD

MICROSPORANGIA , SPOROGENOUS TISSUE, POLLEN MOTHER CELLS, MICROSPOROGENESIS, EXINE, INTINE, SPOROPOLLENIN, GERM PORES, GENERATIVE CELL,VEGETATIVE CELL, PLACENTA, FUNICLE, MEGASPORES, MICROPYLE, CHASMOGAMOUS,CLEISTOGAMY,GEITONOGAMY, XENOGAMY, PRIMARY ENDOSPERM CELL, PERISPERM,

CONCEPT MAP

IMPORTANT DIAGRAM ;-



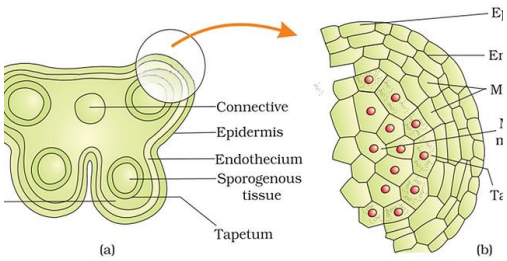


DIAGRAM OF MICROSPOROGENESIS

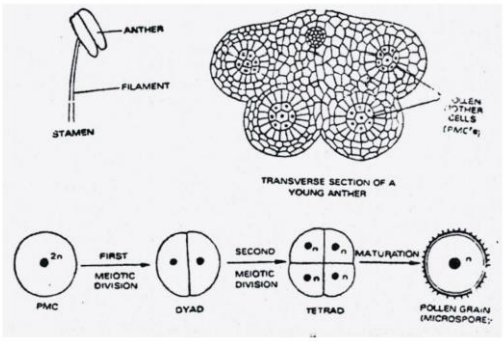
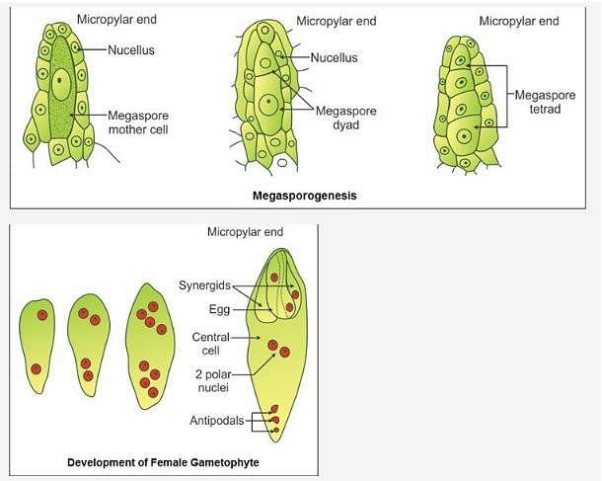


Figure: Microsporogenesis process.

DIAGRAM OFMEGASPOROGENESIS & DEVELOPMENT OF FEMALE GAMETOPHYTE



VERY SHORT ANSWER TYPE QUESTIONS. (one mark)

1. Write the function of coleoptile.
   A . it protect radicle of monocot.
   B . it protect root tip
   C. It Protects the plumule of the monocot embryo.
   D. None of these
2. Write the function of scutellum.

   A It protect and nourishment to the developing embryo. B.It protect plumule

   C. It protect radicle D. It provide only protection

3. Name the type of pollination in maize.

   A. Anemophily or wind pollination. B. Hydrophily

   C. Entomophily D. none of these

4. Name the type of flower which favours cross pollination.
   A. Cleistogamy B. geitonogamy C. Chasmogamy D. none of these
5. Name the type of pollination in self-incompatible plants.
   A. Xenogamy B..cleistogamy C.geitonogamy DChasmogamy.
6. How many nuclei are present in fully developed male gametophyte of flowering plants?
   A.One B.Two C. Three D. Four
7. Which nuclei fuse to give rise to endosperm?
   A.Polar nuclei of central cell which belong to the female gametophyte and the one male gametophyte. B. only polar nuclei
   C.only generative nuclei D.only vegetative nuclei.
8. What is the site of microsporogenesis ?
   A.Nucellus B.megasporangium C. Microsprangium or pollen sac of anther
   D. both A&B
9. What is the site of megasporogenesis ?

   A.Microsporangium . B. Nucellus tissue (megasporangium) present in ovule.

C.Tapetum D. none of these

10. What is nucellus ?
    A.It is mass of parenchymatous cell rich in reserve food material.
    B .It is mass of sclerenchymatous cell rich in reserve food material.
    C. It is mass of collenchymatous cell rich in reserve food material.
    D. None

11. Name the substance of which the intine and exine is made.

    A.Only cellulose B. only pectose C .sporopollenin

    D. cellulose &pectin and sporopollenin.

12. How many germ pore are there in pollen grains of monocot anddicot ?

    A.Both have same B. In monocot two and dicot has two

    C.In monocot one and dicot has three germ pore. D. both A&B

13. State the function of filiform apparatus.
    A.The filiform apparatus guides the egg apparatus into the synergid.
    B.The filiform apparatus guides the pollar nuclei into the central cell.
    C.The filiform apparatus guides the pollen tube into the synergid.
    D. none

14 . Write down examples of non - albuminous .

A.Pea B, groundnut C. both D. none

15 . How many meiotic divisions are required to produce 76 seeds in guava fruit ?

A.90 B. 93 C. 94. D. 95

*. 76 functional pollen will be formed by 76/4 = 19 meiotic divisions and 76 egg cells are produced by 76 meiotic divisions So total meiotic division required to produce 76 seeds 76+19 = 95.

<u>Assertion and reasoning type questions.</u>

In each of the following questions two statements are given, one is Assertion (A) and other is Reason (R) statements, mark the correct answer as-

(A) If both A and R are true and R is the correct explanation of A.

(B) If both A and R are true and R is not the correct explanation of A.

(C) If A is true but R is false. (D) If both A and R are false.

16..Assertion . Insect visit flower to gather honey.

Reason . Attraction to flowers prevents the insects from damaging other part of the plant.

17. Assertion . In some species of Asteraceae and poaceae seeds are formed without Fertilization.

Reason . Formation of fruit without fertilization is called parthenocarpy.

Answers MCQ

Q No	1	2	3	4	5	6	7	8	9
Ans	C	A	A	C	A	C	A	C	B
Q.No	10	11	12	13	14	15	16	17	
Ans	A	D	C	C	C	D*	C	B	

(Two marks questions)

Q.1. What are the component cells of the egg apparatus in an embryo sac?
A. An egg apparatus consists of:

- One egg cell
- Two synergids

Q.2. Which part of gynoecium determines the compatible nature of pollen grain?
A. Stigma

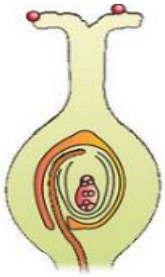
Q.3. What is common in the function performed by nucellus and cotyledon?
A. The cotyledons and nucellus both store reserve food material and does the work of providing nourishment- nucellus (embryo sac), cotyledons (embryo).

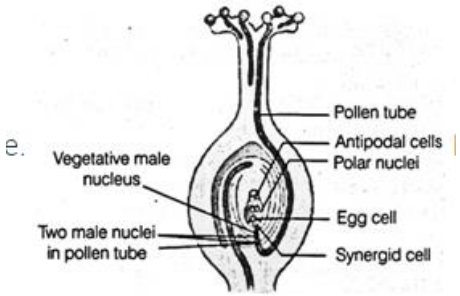
Q.4. Fill in the missing words:
Pollen mother cell → Pollen tetrad → Pollen grain → Vegetative cell, ___?____
A. Generative cell

Q.5. In the following events, indicate the stages where mitosis and meiosis occur (1,2,3).
Megaspore mother cell →(1)→Megaspores→(2)→Embryo sacs→(3)→Egg

A. 1- Meiosis 2- Mitosis 3- Meiosis

Q.6. Show the direction of the pollen tube from the pollen on the stigma to the embryo sac in the given diagram.





A.

Q.7. Which regions of pistil form fruits and seeds?
A.The **ovary** develops into a **fruit**. The **ovule** develops into the **seed**.

Q.8.During polyembryony, if one embryo is formed from synergids and the other from nucellus, state the one that is haploid and the one that is diploid.
A. Embryo developed from the synergid- haploid and Embryo developed from the nucellus- diploid.

Q.9. Is it possible that an unfertilized apomictic embryo sac gives rise to a diploid embryo? Give a reason in support of your answer.
A. Yes, an unfertilized apomictic embryo sac can give rise to a diploid embryo. If the

megaspore mother cell develops into an embryo sac without mitotic division, it will give rise to a diploid embryo.

Q.10. When a pollen grain is shed at the 3-celled stage, which three cells are found?
A. The following three cells are found at the three-celled stage:

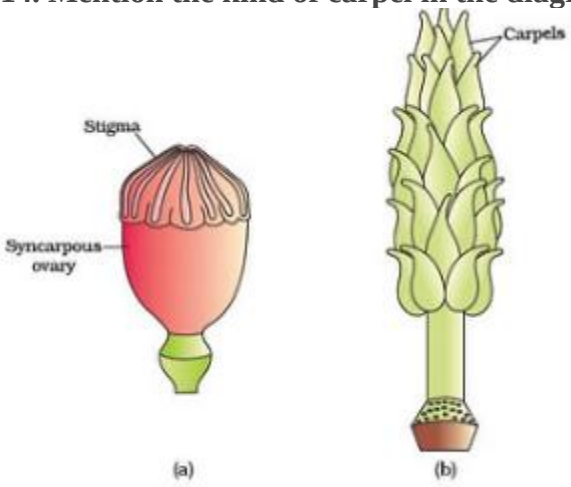
- One vegetative cell
- Two male gametes

Q.11. Define self-incompatibility. How do self-incompatible plants pollinate?
A. Self-incompatibility is a genetic mechanism in which the growth of the pollen tube in the pistil is inhibited which prevents self pollens from fertilizing the ovules. The self-incompatible plants pollinate by cross-pollination.

Q.12. Which is a triploid tissue? How is the condition achieved in a fertilized ovule?
A. The endosperm is a triploid tissue in a fertilized ovule. Triple fusion, leading to the fusion of one male gamete and two haploid polar nuclei form the triploid tissue.

Q.13. Does apomixis require fertilization and pollination? Give reasons in support of your answer.
A. No, apomixis does not require pollination and fertilization. This is because apomixis is a form of asexual reproduction in which the female reproductive apparatus is used. The embryos can develop directly from the nucellus or synergids.

Q.14. Mention the kind of carpel in the diagram given below.



A.14.

- (a) Multicarpellary, the syncarpous pistil of *Papaver*
- (b) Multicarpellary, apocarpous gynoecium of *Michelia*

Q.15. How do aquatic plants undergo pollination?
A. A few aquatic plants have their flowers growing in the air. They are pollinated by the insects. Other plants that have their flowers submerged in water release their pollen in the water that drifts in the water and are caught by the feathery stigma of female flowers.

Q.16. Each pollen grain in the flowering plants produces male gametes. State the function of the male gametes.
A. One male gamete fuses with the nucleus of the egg cell, while the other male gamete

moves towards the two polar nuclei present in the central cell and fuses with it to form a triploid primary endosperm nucleus.

Q.17. List out the agents of pollination.

A. The pollinating agents are involved in transferring pollen grains from the male to the female part of the flower. Animals, birds, insects, wind and other biotic and abiotic agents are all examples of pollinating agents.

Q.18. What is pollination?

A.Pollination is a process of transferring pollen grains from the male anther of a flower to the flower's female part called the stigma. Pollination is the sexual mode of reproduction, which is carried out by all flowering plants of a plant kingdom.

Q.19.What are the stages of post-fertilization in plants?

A.In all flowering plants, the post-fertilization is a critical stage which occurs after the double fertilization and includes the series of steps:

1. Endosperm development. 2. Embryo improvement. 3. Development of ovule into a seed. 4. Development of ovary into a fruit.

Q.20.What are the male and female reproductive parts of a flower?

A.A flower plays a vital role in the reproduction process of a plant. Therefore, it is called the reproductive organ of plants.

The male reproductive parts of the flower include the stamen the filament and the anther, which are collectively termed the androecium.

The female reproductive parts of the flower include carpels, pistils, stigma, style and an ovary, which are collectively termed the gynoecium.

Q.21.What is cross-pollination?

A.Cross-Pollination is the complex type of pollination during which the pollen grains are transferred from the anther of one flower into the stigma of another flower. This type of pollination makes use of both biotic and abiotic agents like wind, water, insects, birds, animals, and other agents as pollinators.

Q.22.Define double fertilization.

A.In plants, double fertilization refers to the fusion of one female gametophyte with two male gametophytes. It is a complex process in all flowering plants.

Q.23.What are the main layers of a flower?

A.. There are different types of flowers in a plant kingdom. A few among them vary in colour, structure, shape, etc. However, all flowers have unique layers. The four main layers of a flower:

1. Calyx 2. Corolla 3. Androecium 4. Gynoecium

Q.24. Define Morphogenesis.

A.Morphogenesis is defined as a biological process which controls the growth, development in size, shape and structure and distribution of cells during the embryonic development of an organism.

Q.25. State the role of endothecium.

A. The endothecium protects the microsporangium and helps in the dehiscence of anther for the release of pollen grains.

Short Answer Type Questions (3 marks)

Q.1. How does a chasmogamous bisexual flower prevent self-pollination?
A. A chasmogamous bisexual flower prevents self-pollination in the following ways:

1. **Dichogamy:** In this strategy, the release of pollens and the receptivity of stigma are not synchronized. i.e in sunflower, the stigma becomes receptive long after the pollen release.
2. **Herkogamy:** In this, the male and female flowers are present at different locations. In this, the pollen of the flower cannot come in contact with the stigma of the same flower. For eg., *Hibiscus gloriosa*
3. **Self-sterility:** It is a mechanism in which the growth of the pollen tube in the pistil or the germination of pollen grains is inhibited. This prevents the fertilization of the ovules from the pollen of the same flower. For eg., Abolition.

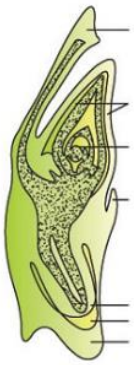
Q.2. Arrange them sequentially according to how they appear in the artificial hybridization programme.

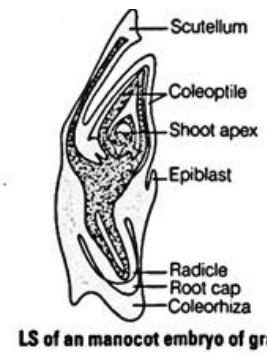
1. **Rebagging 2. Selection of parents 3. Bagging 4. Dusting the pollen on the stigma 5. Emasculation 6. Collection of pollen**

A. a) Selection of parents b) Emasculation c) Bagging d) Collection of pollen e) Dusting of pollen on the stigma f) Rebagging

Q.3. How do self-incompatibility restrict autogamy? How does pollination occur in such plants?
A. Self-incompatibility restricts autogamy by a mechanism known as self-sterility. This is a genetic mechanism in which the germination of pollen grains or the pollen tube growth in the pistil is inhibited which prevents the pollen from fertilizing the ovules. Such plants pollinate by the process of cross-pollination.

Q.4. Label the following diagram.





LS of an manocot embryo of grass

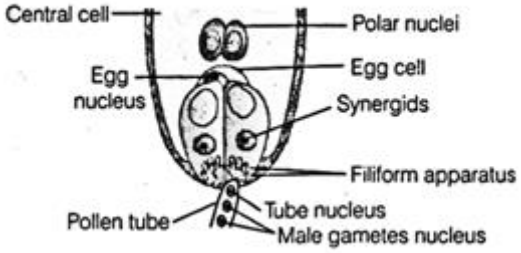
Q.5. Explain the term polyembryony. How is it exploited commercially?
A. When more than one embryo occurs in a seed, it is referred to as polyembryony. This can be seen in a few citrus fruits and mango varieties. Polyembryony plays a significant part in plant breeding and horticulture. These embryos give rise to virus-free plantlets and are healthy. Hybrid varieties of such plants and vegetables are being grown extensively. These varieties thus obtained are highly productive.

Q.6. Is there any difference between apomixis and parthenocarpy? Explain the benefits of each.
A. Yes, parthenocarpy is different from apomixis. In parthenocarpy, the fruit is produced without the fertilization of the female gamete. It is used for the production of fruits without seeds such as banana and grapes for commercial purposes. Apomixis is the process in which the seeds are produced without fertilization but the process occurs in the female reproductive tract of the plant. In this, the megaspore mother cell does not undergo meiosis. It is used for the commercial production of hybrid varieties and in the production of virus-free varieties.

Q.7. The zygote divides only after the division of the primary endosperm cell. Give reasons in support of the statement.
A. Zygote requires nourishment for its growth and division. This nourishment is provided by the primary endosperm cell. That is why the zygote divides only after the growth, food storage and division of the primary endosperm cell.

Q.8. Why is it that the generative cell of 2-celled pollen divides in a pollen tube and not of 3-celled pollen?
A. The generative cell divides to form two male gametes. In three-celled pollen, the generative cell divides into two gametes, therefore, no further division takes place in the pollen tube. However, in two-celled pollen, the generative cell moves down the pollen tube and divides to form two male gametes.

Q.9. Label the following parts in the diagram given below:
Male gametes, egg cell, polar nuclei, synergid, pollen tube.



A.

Q.10.Explain the events which occur after the process of fertilization in plants.

A. Fertilization is a vital process, which takes place in all sexually reproducing organisms. In all flowering plants, fertilization occurs after pollination and germination. After the process of fertilization, the following events occur:

1. The ovary becomes the fruit
2. The ovules become the seeds.

3. The other structures including the corolla, calyx, and other remaining parts of the androecium and gynoecium degenerate or fall off.

Long Answer Type Questions (5 marks)

Q.1. Explain the pollination occurring in the chasmogamous flowers.

A. The chasmogamous flowers are open with their anther and stigma exposed for pollination. In these flowers two types of pollinations take place:

Self-Pollination: Self-pollination occurs when both the anther and the stigma mature simultaneously and come in contact with each other.

Cross-Pollination: This type of pollination occurs in self-incompatible plants. In this, the anther and the stigma mature at different times so cannot come in contact with each other. Cross-pollination is of two types:

- **Geitonogamy**– When the pollen grains from the anther transfer to the stigma of a different flower in the same plant, it is known as geitonogamy.
- **Xenogamy**– When the pollen grains from the anther of a flower get transferred to the stigma of a flower in some other plant, it is known as xenogamy. This process carries genetically different pollen to the stigma.

Q.2. Describe the structure of the embryo sac of a mature angiosperm. Explain the role of synergids in it.

The cell walls of the 8 nucleate stage are organized in the form of a female gametophyte or embryo sac.

- Six out of the eight nuclei are surrounded by cell walls.
- The egg apparatus comprises two synergids and one egg cell.
- Three cells called the antipodals are present at the chalazal end.
- The central cell is formed by the fusion of two polar nuclei.
- On maturity, the embryo sac of the angiosperms consists of 8 nuclei and 7 cells.
- A single megaspore gives rise to the embryo sac, hence called monosporic embryo sac.

Role of Synergids

The synergids are responsible for the reproduction in an angiosperm. During fertilization, a pollen tube grows into one of the synergids. The tube ceases growth, ruptures and releases two sperm cells.

Q.3. How is it that the embryo sacs of some apomictic species look normal but contain diploid cells?

A. The offsprings produced by apomixis are genetically identical to the parent. In flowering plants apomixis is used to reproduce asexually through seeds. In a few species, the diploid egg cell does not undergo reduction division and forms an embryo without fertilization. In a few citrus species, the nucellar cells surrounding the embryo sac divide and give rise to an embryo. This takes place in the megaspore mother cell. It only undergoes mitosis and hence produces diploid cells in the embryo sac.

Q.4. What are the characteristics of wind, water and insect-pollinated flowers?

A. Characteristics of wind-pollinated flowers:

- These flowers are not brightly coloured.
- They possess no special odours or nectar.
- They are small and have no petals.

- Their stigma and stamens are exposed to air currents.
- The pollen is smooth, light can be blown easily by wind and are in large numbers.
- The stigma is feathery and can catch pollen from the wind.

Characteristics of water-pollinated flowers:

- They possess small male flowers that are not clearly visible.
- A large number of pollens are released in water that is caught by large, feathery stigma of female flowers.
- This pollen keeps floating on the water surface until they are caught by female flowers.

Characteristics of insect-pollinated flowers:

- They are large with bright-coloured petals to attract insects.
- The flowers have nectar and a pleasant fragrance.
- The pollen grains are sticky and can easily stick to the insect's body.

Q.5. Explain the structure of the pollen.

A. Pollen grains are microscopic structures that carry the male reproductive cells of a plant. It is a double-walled structure with a thin inner wall known as endospore composed of cellulose& pectin and a thick outer wall known as exospore, composed of sporopollenin.

The exospore protects the male genetic material during transportation from an anther to stigma. The waxes and proteins present on the pollen surface repel moisture and interact with the stigma.

Q.6.What are the functions of a flower?

A.The flowers are the reproductive organs of plants and are mainly involved in the reproduction process. The essential functions of flowers are mentioned below:

1. It provides the beauty of the plant. 2. Gametophytes developed in the flowers.
2. Helps in the development of fruit with a seed.
3. Involved in the union of male and female gametes.
4. It accommodates the sex organs of the plant.
5. Flowers provide nectar to certain birds and insects.
6. It protects the reproductive organs of a plant.
7. The flowers can produce diaspores without fertilization.
8. Flowers also promote the union of sperm and eggs from the same flower or different flowers.
9. It helps in pollination by attracting insects and other a

Q. 7 .Write down difference between microsporogenesis and megasporogenesis.

Ans.

It occurs inside microsporangia	It occurs inside the nucellus of ovule
There are many microspores mother cell in microsporangium.	There are is generally a single megaspore mother cell in a megasporangium.
The four microspores formed from single microspore mother cell are generally arrange in tetrahedral structure.	The four megaspores formed from a megaspore mother cell are arrange in the form of linear tetrad.
Four microspores are functional	One is functional while three are

	degenerated.
The microspores give rise to male gametophyte	The functional megaspore gives rise to female gametophyte.

1.CASE BASED QUESTION;-

Read the following and answer any Four questions I to v.

The pollen grains or microspores of male reproductive bodies of a flower and are contained in the pollen sac or microsporangia. Each pollen grain consist of a single microscopic cell, possessing two coat ; the exine and intine. The exine of a pollen grain is made of chemically stable material. Because of this ,pollen grains are often very well preserved for thousand of year in soil and sediment.

i. One of the most resistant biological material present in the exine of pollen grain is
A .Pectocellulose B. Sporopollenin C. Suberin D . Cellulose.

ii. The exine possesses one or more thin place known as
A. Raphe B. Germ pore C. Hilum D. Endothecium

iii. What is the function of germ pore ?
A . Emergence of radicle B . Absorption of water for seed
C. Initiation of pollen tube. D. All of these

iv . What is the key advantages to the plant for having such strong pollen

grain wall?

A. It protect the vital genetic material in the pollen grain.
B. It allow pollen to serve as a valuable Fossil record for the study of ancient plant.
C. It prevents the pollen tube from growing out before the pollen grain reaches the stigma.
D. All of the above.

v .The number of germ pore indicot and monocot respectively are

A . one &three B. three &two C. two& three D. three & one

Q No.	i	ii	iii	iv	v
Ans	B	B	C	D	D

2.Read the following and answer any four questions i to v.

Apomixis is a mode of reproduction which does not involve formation of zygote through gametic fusion .In plant , apomixis commonly mimics sexual reproduction but produces seeds without fertilisation . There are several method of apomictic development in seeds. The two common ones are recurrent .

(i) Apomixis is a type of reproduction in plants in which

A. Fertilization does not take place . B. male nucleus takes place in fertilization.

C. pollen fusion takes place D.generative nucleus take part in fertilization.

(ii) Which of the following statements is incorrect regarding recurrent agamospermy.

A. It is the formation of seed that has an embryo formed without meiosis and syngamy.

B. All the cell of embryo sac are diploid.

C. An embryo develop directly from diploid cell other than egg like that of Nucleus and integument. D None of these.

(iii) Adventive embryony is found in

A .Citrus B. Opuntia . C Apple D. Both a&b

(iv) Formation of embryo directly form diploid egg without fertilization is called

A . apospory B .diplospory C polyembryony D .amphimixis

(v) If any somatic cell of sporophyte produces gametophyte without reduction division ,it is called . (a)parthenogenesis (b) apogamy (c) apospory (d) Amphimixis.

Q No.	i	ii	iii	iv	v
Ans	A	A	D	B	A

CHAPTER :- 2 HUMAN REPRODUCTION

SUMMERY:

- Male and female reproductive organs differ in the structure, function and development
- **Male Reproductive System: Consist of**

a) Testes:

- ✓ A pair of testes are present in the scrotum outside the body, it helps in maintaining an optimal temperature for sperm formation
- ✓ There are two types of cells present in the internal lining of seminiferous tubules:
  (i)**Spermatogonia** are germ cells of males, thatform sperms.
  (ii) **Sertoli cells** provide nutrition to the germ cells.
- ✓ **Leydig's cells / interstitial cells:** Present in the interstitial spaces.They produce and secrete **androgens**.

b) Accessory ducts:

- ✓ There are accessory ducts present. Vasa efferentia, rete testis, epididymis and vas deferens.
- ✓ These ducts store and transport sperms from the testis to urethra.
- ✓ Ejaculatory duct that form by the Vas deferens along with a duct from seminal vesicles and opens into the urethra.

c) **Glands:** There are three glands,
(i) prostate gland, (ii) a pair of seminal vesicles (iii) Bulbourethral glands.

- The glands secrete seminal plasma. It is rich in certain enzymes, calcium, fructose and provides lubrication to the penis.
- **Spermatogenesis**
- Spermatogenesis starts at puberty.
- There is increased secretion of GnRHfrom the hypothalamus.
- **GnRH** stimulates the anterior pituitary to secrete LH and FSH.
- **LH** stimulates **Leydig's cells** to secrete **androgens**.
- This androgen hormone stimulates the process of spermatogenesis.
- **FSH** stimulates **Sertoli cells** to secrete factors, which help in the process of **spermiogenesis**
- **Stages of spermatogenesis:**

Spermatogonia (2n=46)

↓ Mitosis

Primary spermatocytes(2n=46)

↓ Meiosis-1

Secondary spermatocytes (n=23)

↓ Meiosis-II

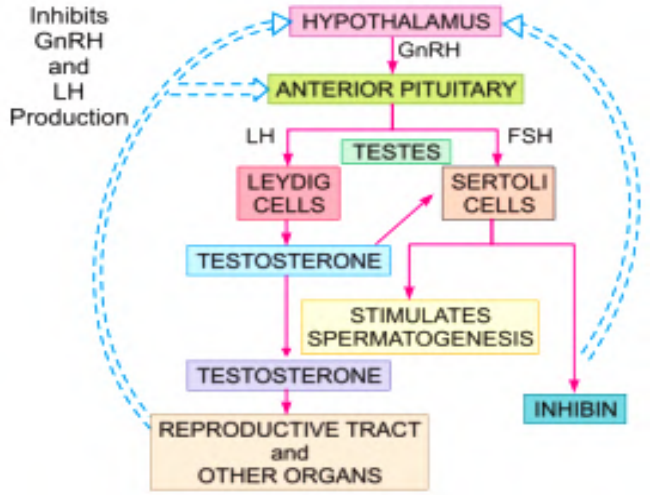
Spermatids (n=23)

Spermiogenesis ↓ Differentiaton

Spermatozoa

- **Spermiogenesis:** It is the process of formation of **sperms** from **spermatids**
- **Spermiation:** It is a process by which sperms are released from seminiferous tubules.

❖ Hormonal regulation in male reproductive system



❖ **Structure of Sperm:** Approx. 200-300 million sperms release per ejaculation. Consist of

- **Head:** contains acrosome which store sperm lysine that facilitate entry of sperm into the ovum.. It is contain nucleus (n).
- **Middle piece:** It has multiplemitochondria that provide energy for the movement of sperms.
- **Tail:** It providevigorous motility of sperms

Female Reproductive System

❖ **Structure: Consist of**

a) Ovaries: One pair of ovaries present. Oogenesis taken place within it.

b) Fallopian Tubes:

- ✓ A pair of fallopian tubes or oviducts (ampulla and isthmus) that connect ovaries to the uterus.
- ✓ **Infundibulum: It** is a funnel-shaped part of the fallopian tube.
- ✓ **Fimbriae (finger-like projections):** It is a terminal part of infundibulum, which collect the ovum.

c) Uterus : Inverted pear-shaped and site for embryonic development. The uterine wall is differentiated into three layers:

(i) **Perimetrium-** It is the outermost layer.
(ii) **Myometrium-** It is the middle layer of smooth muscles.
(iii) **Endometrium-** It is glandular and undergoes cyclic changes during the menstrual cycle.

d) Birth canal: The vagina and the cervical canal together form the birth canal.

e) External Genitalia: Mons pubis (fatty tissue), labia majora and labia minora (tissue folds) and clitoris form external female genitalia.

f) Mammary glands: A pair of breasts is present in females. They contain fat and mammary glands. Alveolar cells secrete milk.

Oogenesis

- ✓ Oogenesis is the formation of female gamete called the ovum.
- ✓ Oogenesis starts during embryonic development.
- ✓ About two million Oogonia are formed in the ovary of a foetus.
- ✓ **Stages of Oogenesis:**

Oogonia (2n=46)

↓ Mitosis

Primary oocytes(2n=46)

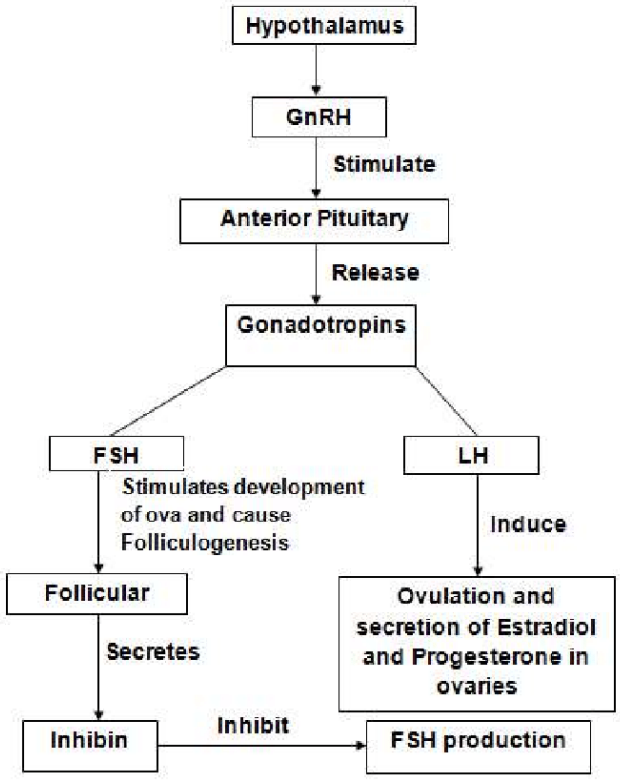
↓ Meiosis-1

Secondary Oocytes (n=23)

↓ Meiosis-II

Ovum (n=23)

❖ Hormonal regulation in female reproductive system



❖ Menstrual Cycle

- ✓ **Menarche-** First menstruation at puberty.
- ✓ **Duration** of the menstrual cycle is of 28/29 days.

- ✓ An ovum is released at the middle of each cycle (13^{th} to14^{th} day)
- ✓ **Menopause** is the stage at which the menstrual cycle ceases (45to 50 yrs

Phases of menstrual cycle:

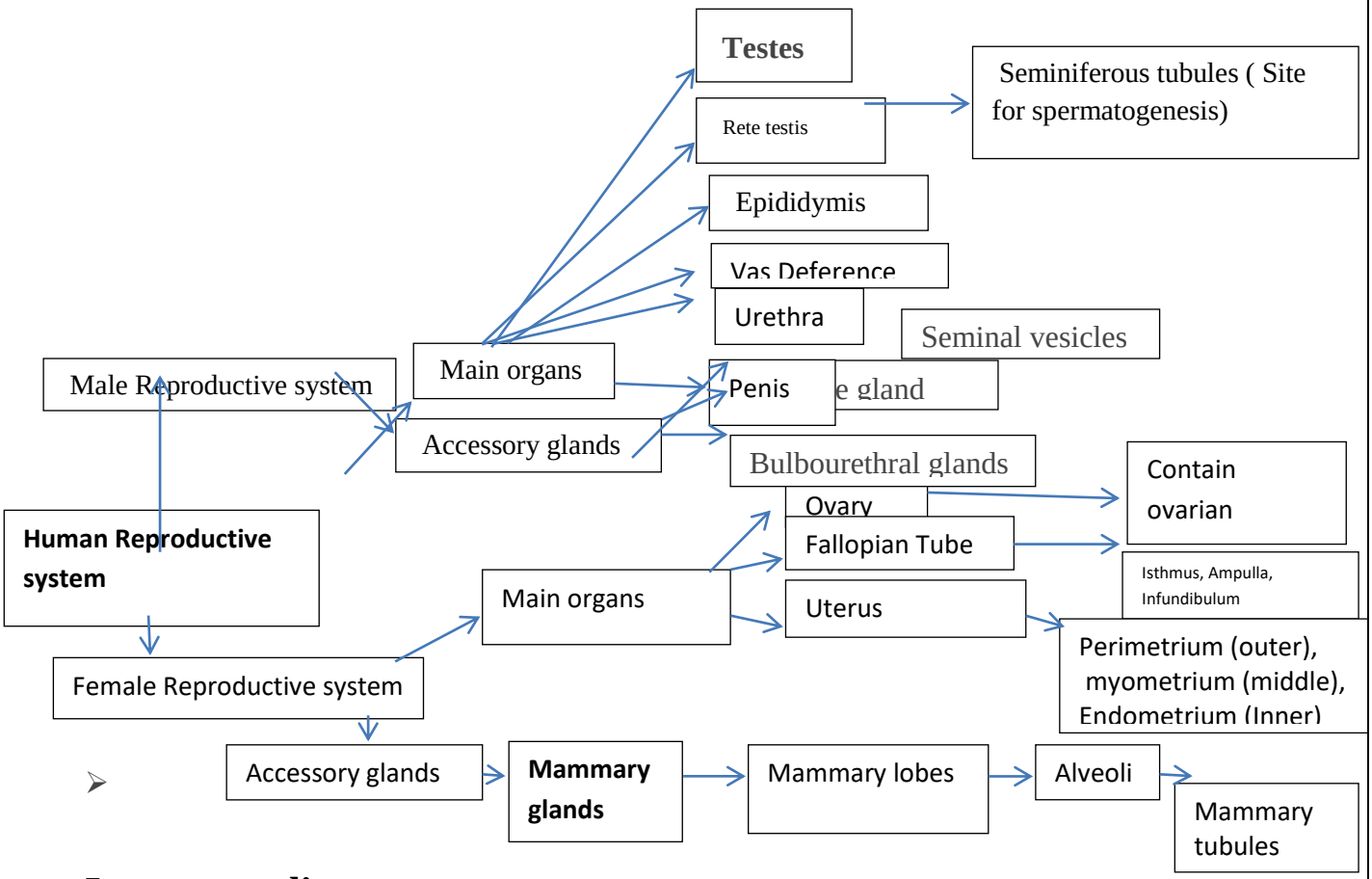
1. **Menstrual phase:** Last up to 3 to 4 days. Menstrual flowtakes place.
2. **Follicular phase/ Proliferative phase:** Development of Primary follicle into Graafian follicle. The endometrium also regenerates. Increases the release of FSH and LH from anterior pituitary.Stimulating follicular development.Increase the level of Estrogen at the midpoint.
3. **Luteal phase/Secretory phase**. **:** Corpus luteum is formed from the remaining part of the Graafian follicle. It secretes the hormone progesterone, which is required for the maintenance of the endometrium and for the implantation of the fertilised ovum.

- ❖ **Fertilization**
  - ✓ The fertilization takes place at the ampullary-isthmus junction of the fallopian tube
  - ✓ When one of the sperms comes in contact with the zonapellucida of the ovum, no more sperms can enter further due to changes induced in the membrane that can prevent polyspermy.
- ❖ **Implantation:** At the blastocyst stage it gets attached to the endometrium lining of the uterus. The trophoblastic layer and the endometrium together form the placenta whereas the inner cell mass gets differentiated into the embryo.The process is known as **implantation.**
- ❖ **Embryonic Development:**
  - ✓ After implantation, cells of the embryo start differentiating into outer ectoderm, inner endoderm and then the middle mesoderm. Different organs are developed from these layers.
- ❖ **Gestation period:** Human- 9 months
- ❖ **Foetal development:**
  - ✓ 1^{st} month- Formation of heart.
  - ✓ 2^{nd} month- Limbs and digits are formed
  - ✓ 3^{rd} month (first trimester)- all the major organs are developed and the foetus is recognizable as a human being.
  - ✓ 5^{th} month- Movement of foetus and hair on the head appear
  - ✓ Second trimester- eyelashes and eyelids develop, the body gets covered with fine hair
  - ✓ The third trimester- by the end of the third trimester, the child is fully developed and the body prepares for the delivery (parturition) of the infant
- ❖ **Parturition**
  - ✓ Fully develop foetus and placenta initiated the signal of parturition (foetal ejection reflex).
  - ✓ That leads mild uterine contractions.
  - ✓ This is followed by secretion of **oxytocin** from the pituitary gland.
  - ✓ Contractions become stronger and stronger as more oxytocin is secreted resulting in childbirth..
- ❖ **Lactation:** Increased secretion of prolactin from the pituitary gland induces milk production in the mammary glands.

KEY WORDS:

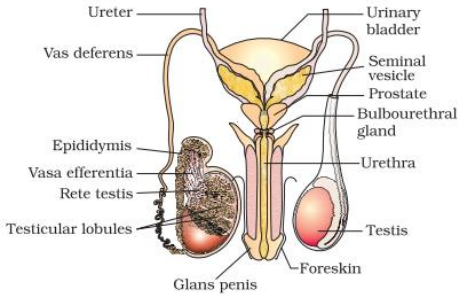
- **Morula:** It is anembryonic development stage having 8 to 16 blastomeres.
- **Blastocyst:** Embryonic developmental stage that formed due to the continuous mitotic division in zygote. This stage is is attached to the uterine wall.
- **Implantation:-** Attachment of blastocyst to the endometrium of the uterine wall
- **Gestation:-** Embryonic developmental stage (9 months in human)

- **Stem cells:** Some of the cells of inner cell mass act as **Stem cells**. They have the ability to develop into all types of tissues and are called pluripotent.
- **Placenta:** It is a temporary connection between the growing foetus and the mother.
- **Umbilical cord:**Connects the placenta to the foetus and transports nutrients.
- **Gestation period:** Period between implantation and birth of a baby. Inhuman gestation period is 9 months
- **Foetal ejection reflex**: It refers to the signals for parturition that originate from the fully developed foetus and the placenta
- **Parturition:-** Birth of a baby
- **Colostrum:** Initial milk produced by mother. Contain IgA antibody. Provide initial protection to the baby.
- **CONCEPT MAP**

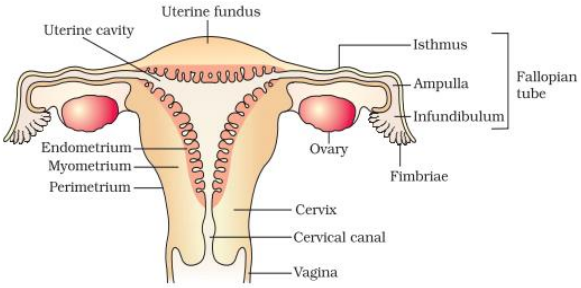


Important diagrams

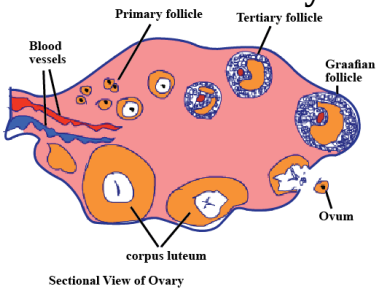
1. **Male reproductive system of human being.**



2. **Female reproductive system of human being**.

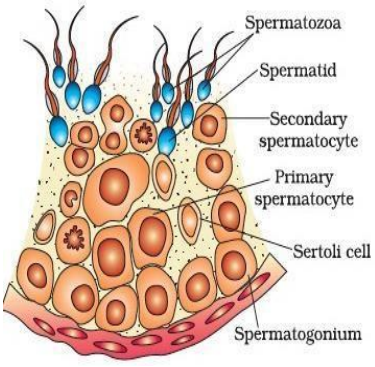


3. Sectional view of ovary

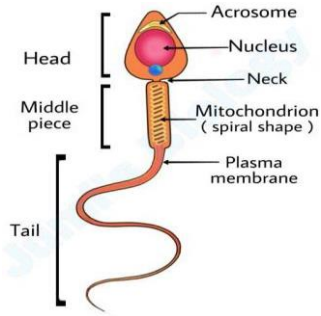


Sectional View of Ovary

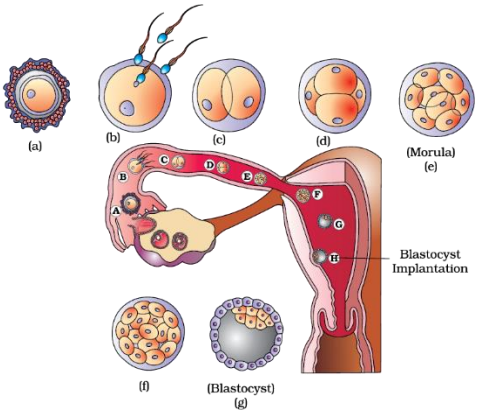
4. Sectional view of seminiferous tubules;



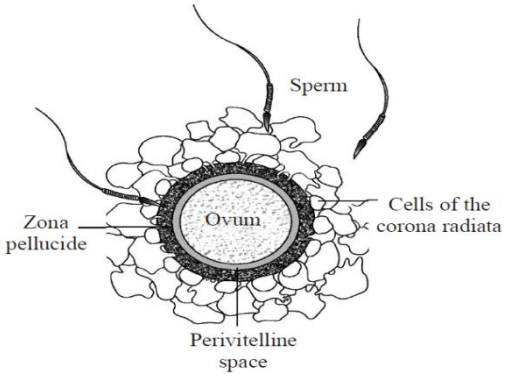
4.Structure of mature sperm



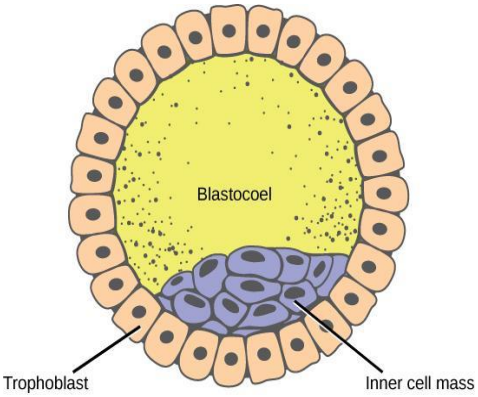
5. **Transport of ovum, fertilisation and passage of growing embryo through fallopian tube.**



6. **Labelled diagram of ovum surrounded by few sperms**



7. **T.S of Blastocyst;**



MCQ:

1. Testes descent into scrotum in human for :
   A. Fertilisation
   B. Spermatogenesis
   C. Development of sex organs
   D. Formation of sex hormones
2. Acrosome produces an enzymatic substance for dissolving egg coverings. It is called
   A. Hyaluronic acid
   B. Androgen
   C. Hyaluronidase
   D. Diastase
3. Antrum is a fluid filled cavity of
   A. Ovary
   B. Secondary follicle
   C. Graafian follicle
   D. Blastula
4. Seminal plasma of humans is rich in
   A. Galactose, certain enzymes and calcium
   B. Fructose, certain enzymes and calcium
   C. Fructose, certain enzymes but poor Calcium
   D. Fructose, certain enzymes but no calcium
5. The number of sperms produced from 100 primary spermatocytes are:
   A. 100 sperms
   B. 200 sperms
   C. 300 sperms
   D. 400 sperms
6. The number of eggs produced from 100 primary Oocytes are
   A. 100 eggs
   B. 200 eggs
   C. 300 eggs
   D. 400 eggs
7. Leydig's cell secretes hormone
   A. Gonadotropin
   B. Relaxin
   C. Inhibin
   D. Androgen
8. Spermatids are changed to spermatozoa through
   A. Spermatosis
   B. Spematogenesis
   C. Spermiogenesis
   D. Spermiation
9. Embryo at 8to 16celled stage called
   A. Blastomere
   B. Morula
   C. Blastula
   D. Gastrula
10. Leydig's cells are regulated by pituitary hormone
   A. LH
   B. FSH
   C. GnRH
   D. Prolactin
11. Which one of the following is not a male accessory gland?
   A. Seminal vesicle
   B. Mammary gland
   C. Prostate
   D. Bulbourethral gland
12. Which of the following hormone is not secreted by human placenta?
   A. hCG
   B. Estrogens
   C. hPL
   D. FSH
13. During parturition, the foetal ejection reflex triggers the release of
   A. GnRH from foetal hypothalamus
   B. Oxytocin from maternal pituitary.
   C. An increasing amount of estrogen from placenta
   D. An increasing amount of progesterone from placenta

14. What does a doctor inject to induce delivery of baby?

A. Progesteron
B. Estrogen
C. Inhibin
D. Oxytocin

15. The first movement of the foetus and appearance of hair on the head are usually observed during the month of

A. 3^{th} month of pregnancy
B. 4^{th} month of pregnancy
C. 5^{th} month of pregnancy
D. 7^{th} month of pregnancy

16. Layers of an ovum from outside to inside is

A. corona radiata, zonapellucida and vitelline membrane
B. zonapellucida, corona rodiata and vitelline membrane
C. vitelline membrane, zonapellucida and corona radiate
D. zonapellucida, vitelline membrane and corona radiata

17.In spermatogenesis, reduction division of chromosome occurs during conversion of

A. spermatogonia to primaryspermatocytes
B. primary spermatocytes to secondaryspermatocytes
C. secondary spermatocytes to spermatids
D. spermatids to sperms

18. Select the correct sequence of stages in spermatogenesis are:

A. spermatogonia → spermatid → spermatocyte → sperm
B. spermatocyte → spermatogonia → spermatid → sperm
C. spermatogonia → spermatocyte → spermatid → sperm
D. spermatid → spermatocyte → spermatogonia → sperm

ANSWER:

Q. Nos.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Answer	**B**	**C**	**C**	**B**	**D**	**A**	**D**	**C**	**B**	**A**
Qnos.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**		
Answer	**B**	**D**	**B**	**D**	**C**	**A**	**B**	**C**		

ASSERTION AND REASONING TYPE OF QUESTIONS WITHANSWERS

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.
B. If both Assertion and Reason are true but the Reason is not a correct explanation ofthe Assertion
C. If Assertion is true but the Reason is false.
D. If both Assertion and Reason are false

Q.No.1.
Assertion(A): In a Graafian follicle, the primary oocyte and the follicle cells may be regarded sibling cells.
Reason (R): Both arise from the same parent cell, the oogonium, by mitotic divisions

Q.No.2.
Assertion (A): Ovum retains most of the contents of the primary oocyte and is much larger than a spermatozoan.
Reason (R): Ovum needs energy to go about in search of a spermatozoon for fertilization.
Q.NO.3.
Assertion: In the testes, spermatogenesis occurs in the seminiferous tubules and testosterone secretion takes place in the interstitial cells.
Reason(R): Testosterone brings about growth and maturation of secondary sex organs and also development of accessory sex characters.
Q. No 4.
Assertion (**A):**A sperm sticks to an egg for fertilization.
Reason(R): Interaction of surface receptors, fertilizin on the egg and antifertilizen on the sperm head, makes them adhere together.

Q. No 5.
Assertion(A): At puberty only 60000 to 80000 primary follicles are left in both the ovaries
Reason(R): Large numbers of these follicles degenerate during the phase from birth to puberty.
Q No.6.
Assertion (A): Sperm formation continues even in old man but formation of ovum ceases in women around the age of 50 years.
Reason(R): The stoppage of menstrual cycle in female is termed as menopause.
Q. No 7.
Assertion(A): The primary follicles get surrounded by more layer of granulosa cells and a new theca called secondary follicles
Reason(R): These are characterized by the presence of fluid filled cavity called antrum.
Q. No 8.
Assertion (A): The regions outside the seminiferous tubules contain Sertoli cells.
Reason (R) :Sertoli cells synthesize and secrets androgens.
Q.NO.9
Assertion(A): .Infundibulum of fallopian tube is with finger –like fimbriae
Reason(R):Graafian follicle of ovary is with secondary Oocyte hanging in cavity called antrum

Q.No.10
Assertion (A):At puberty, human male does not develop secondary sexual characters.
Reason(R): Atpuberty, there is a decrease secretion of testosterone in male.
Q No. 11.
Assertion (A): The endometrium undergoes cyclical changes during the Menstrual cycle.
Reason (R): Myometrium contracts strongly during delivery of the baby.
Q No. 12.
Assertion (A): Only one sperm can fertilise an ovum.
Reason (R): The changes in the membrane of zonapellucida prevents polyspermy
Q NO.13.
Assertion (A): After implantation, finger like projections appears on the trophoblast called chorionic villi.
Reason (R) :Chorionic villi are surrounded by the uterine tissue and the maternal blood.
Q NO.14.
Assertion (A): Placenta is an endocrine tissue
Reason (R): It produces several hormones like hCG ,hPL , estrogens progestogen etc.

Q NO.15.
Assertion (A): The signals of parturition originate from fully developed foetusand placenta.
Reason (R): Oxytocin causes stronger uterine contractions which stimulates further secretion of oxytocin.
Q NO.16.
Assertion (A): The first movement of the foetus is usually observed during 5^{th} month of pregnancy.
Reason (R): By the end of first trimester the body is covered with fine eyelids and eyelashes are formed
Q NO.17.
Assertion(A): The bulbourethral gland is a male accessory gland.
Reason: Its secretion helps in the lubrication of the penis, thereby facilitating reproduction.
Q NO.18.
Assertion (A): Spermatogenesis starts at the age of puberty.
Reason (R)**:** There is a significant increase in level of gonadotropin releasing hormone at puberty.
Q NO.19.
Assertion (A): Each seminiferous tubule is lined on its inside by three type of cells.
Reason(R): These cells are male germ cells, Sertoli cells and Leydig's cells.
Q NO.20.
Assertion (A): The female external genitalia includemons pubis, labia majora and labia minora.
Reason(R): The glandular tissue of each breast is divided into 5-10 mammary lobes.

Q. nos.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Answer	**A**	**C**	**B**	**A**	**A**	**B**	**D**	**D**	**B**	**D**
Q. nos.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Answer	**B**	**A**	**B**	**A**	**A**	**C**	**A**	**A**	**D**	**C**

2. SHORT ANSWER TYPE-1 (2MARKS)

Q.No.1. Differentiate between gametogenesis in human males and females on the basis of

(a) Time of initiation of the process.
(b) Products formed at the end of the process.

Answer: (a) In male, initiation of Spermatogenesis takes place during puberty whereas in female, Oogenesis takes place at foetal life. (b) In male, four spermatozoa are produced from one spematogonium whereas in female, one ovum and two polar bodies are produced from one Oogonium.

Q.No.2. Why testes are located outside the abdominal cavity within a pouch? Also name that pouch.

Answer:
The process of spermatogenesis requires lower temperature (2 - 2.^{0}C) than the body and hence testes (site of spermatogenesis) are present outside the abdominal cavity. The pouch is known as the scrotum or scrotal sac.

Q.No.3.

(a) What is the total no of testicular lobule in human male reproductive system?
(b) Write the total number of seminiferous tubules in human male reproductive system.

Answer: (a) The total no of testicular lobule in human male reproductive system are500. as one testis contain 250 in number. (b) The total number of seminiferous tubules 500 to 1500 in number as one lobule contain 01 to 03 tubules.

Q.No.4. .Write location and function of each

(a) Leydig,s cells (b) Sertoli cells

Answer: (a)Leydig cells located in Interstitial space and function : Leydig's cells can synthesise and secrete the male testicular hormones called androgen.

(b) Sertoli cells located in seminiferous tubules and function is to provide nutrition to the germ cells.

Q.No.5. Write function of

(a) Endometrium (b) Myometrium

Ans: (a) Myometrium: The highly muscular middle layer. This is what expands during pregnancy and contracts to push your baby out.

(b) Endometrium: The inner layer or lining of your uterus (uterine lining). This layer of your uterus is shed during your menstrual cycle.

Q.No.6. How is the tertiary follicles characterised? (b) What is LH surge?

Answer: (a) The secondary follicle soon transforms into a tertiary follicle, which is characterised by a fluid filled cavity, called as antrum. The theca layer is fibrous and is organised into an inner theca interna and an outer theca externa.

(b) An LH surge is a rapid increase in luteinizing hormone levels during mid-cycle which induces rupture of Graafian follicle and there by the release of ovum.

Q.No.7. Why all copulations do not lead to fertilisation and pregnancy?

Answer: Fertilisation can only occur if the ovum and sperms are transported simultaneously to the ampullary-isthmic junction and ovum is released only once a month. This is the reason why all copulations do not lead to fertilisation and pregnancy.

Q.No.8. Whatare the events taking place in the ovary and uterus during follicular phase of the menstrual cycle?

Ans: Ovarian events: Follicle stimulating hormone (FSH) secreted by the anterior pituitary stimulates the maturation of one ovarian follicles to release ovum during ovulation. Remnants of Ovarian follicles in turn secrete estrogen.

Uterine Events: Uterine changes during follicular phase involves the following: Estrogen stimulates the proliferation of endometrium of the uterine wall includes extensive vascularization and more secretory.

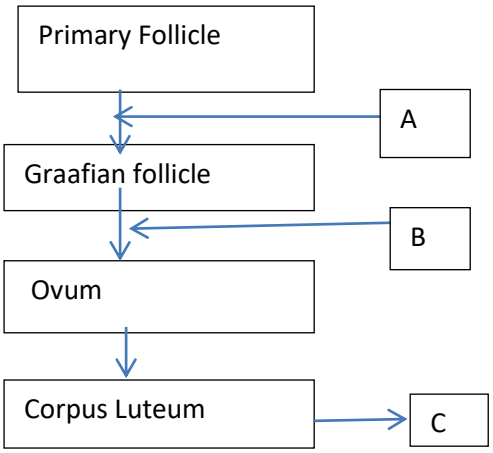
Q.No.9. Write any two differences between oogenesis and spermatogenesis?

Spermatogenesis	Oogenesis
The production of sperms from Spermatogonia is known as spermatogenesis	The production of eggs from Oogonia is known as oogenesis
Occurs inside the seminiferous tubules of testes	Occurs inside the ovary
All stages are completed in testes	The major part of oogenesis occurs inside the ovary. The last few stages occur in the oviduct.
At the end of the process one spematogonium produces four spermatozoa	At the end of the process one Oogonium produces one ovum.

Q.No.10. Study the flow chart and answer the following:

(a) Identify the hormones 'A', 'B' and 'C'.

(b) What is the role of 'C'?



Answer:

(a) The hormones 'A' is FSH , 'B' is LH and 'C' is Progesterone**.**

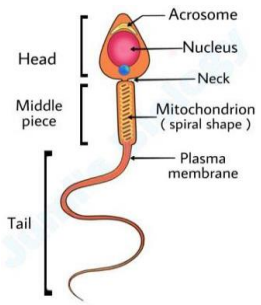
(b) The role of Progesterone is to maintain pregnancy throughout the gestation period.

SHORT ANSWER TYPE-11 (3marks)

Q. No.1. (a) Draw a labelled diagram of a human sperm.

(b) Which part of the sperm provides energy for its movement?

Answer: (a)



(b) Middle piece as more number of mitochondria are present.

Q. No.2. (a) What is the function of acrosome?

(b) What is the function of mitochondria of human sperm ?

Answer: (a) Acrosome contains hydrolytic enzymes helps to break down outer layers of ovum. (b) Mitochondria helps sperm mobility in the female reproductive tract.

Q. No.2.

(a) Where do the signals for parturition originate in humans?
(b) Placenta acts as an endocrine gland. Justify.

Answer: (a) The signals for parturition originate from a fully developed foetus and placenta which induce mild uterine contraction. This triggers the release of oxytocin (birth hormone) from the maternal pituitary gland.
(b) The placenta can also act as an endocrine gland but only during pregnancy and produces some hormones like human chorionic gonadotropin (hCG), human placental lactogen (hPL),estrogen, progesterone, etc.

.**Q.No.3.** (a) Name the structural and functional unit between developing embryo and maternal body. (b) How is it connected to the embryo?
Answer: (a) Placenta (b) Formation of the placenta involves the following steps:
(i) After implantation, finger-like projections appear on the trophoblast called chorionic villi.
(ii) Chorionic villi are surrounded by the uterine tissue and the maternal blood.
(iii)The chorionic villi and endometrium tissue become interdigited with each other and jointly form a structural and functional unit between the developing embryo and maternal body called the placenta.

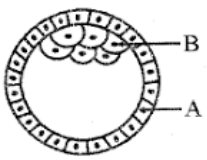
Q.No.4 (a) Explain the role of ovarian hormones in inducing changes in the uterus during menstrual cycle. (b) What triggers release of oxytocin at the time of parturition?
Answer:

(a)In the uterus, estrogen helps proliferate endometrial cells in the follicular phase of the menstrual cycle, thickening the endometrial lining in preparation for pregnancy.

Progesterone is essential for maintenance of the endometrium. Such an endometrium.is necessary for implantation of the fertilised ovum and other events of pregnancy.

(b)The signals for parturition, originates from the developed in foetus and placenta.

Q.No.5. Study the diagram given below and answer the following questions.

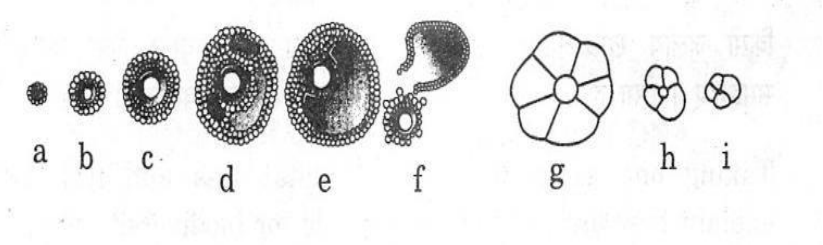


(a)Name the stage of human embryoin the figure represents.
(b)Identify 'A' and 'B'.in the figure and mention their functions.
(c)Where are the stem cells located in the embryo?

Answer: (a) The name of the stage is Blastocyst (b) 'A' is trophoblast layer and 'B'.is inner cell mass. (c) The trophoblast layer gets attached to endometrium to form placenta and inner cell mass to form embryo proper. (d) Inner cell mass.

CASE BASED QUESTIONS:

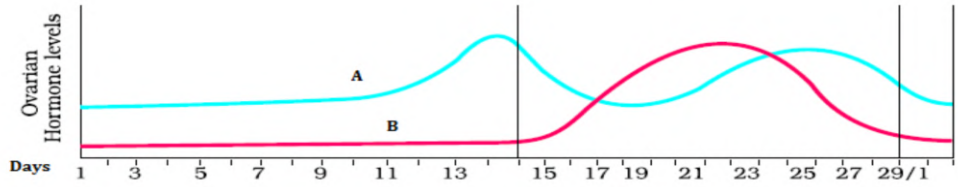
1. Study the diagram bellow and answer the following questions:



(i) Identify 'c' and 'e'
(ii) Name and state the function of 'g'
(iii) Write one difference between'c'and'd'.
(iv)Name the pituitaryhormones causes the above mentioned events.
ANSWER:

(i) 'c,is secondary follicle and 'e' is Graafian follicle.
(ii) 'g' is Corpus luteum. It produce progesterone and maintain pregnancy if egg is not fertilised.
(iii) One difference:
In Secondary follicle,fluid filled antrum is absent but in Tertiary follicle fluid filled Antrum is present.
(iv) Pituitary hormones are FSH and LH. FSH induces follicular development and LH induces ovulation.

CASE BASED : 2



Read the graph given above and correlate the uterine events that take place according to the hormonal levels on
(i)Identify 'A' and 'B'.
(ii) Specify the source of the hormone marked in the diagram.
(iii) Give reason why A peaks before B.
(iv) Compare the role of A and B.
(v) Under which condition will the level of B continue to remain high on the 28th day?

Answer:

(i) A is Estrogen and B is Progesterone
(ii) Estrogen secretes from ovarian follicles and Progesterone secretes from corpus luteum**.**

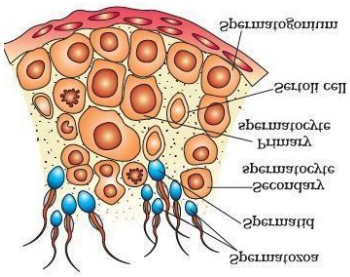
(iii) As follicular phase takes place before luteal phase.
During the follicular phase of the cycle the secretion of estrogen peaks due to the developing follicles which release the hormone. Progesterone is produced during the later stages of the cycle from the corpus luteum.

(iv) Estrogenenhances and maintains the mucous membrane that lines the uterus.Whereasprogesterone prepares the endometrium for the potential pregnancy after ovulation. It also triggers the lining to thicken to accept a fertilized egg.

(v) If an egg is fertilized by sperm and conception occurs then secretion of progesterone remaincontinues as it is needed for thickening of endometrium lining.

CASE BASED:3

Observe the given diagram and answer the following questions.



(i)Which cell among them is known as nurse cell?

(a) Primary spermatocyte (c) Spermatid

(b) Spermatogonium (d) Sertoli cell

(ii)Which hormone of pituitary gland regulates Sertoli cells?

(a) LH (c) GH

(b) FSH (d) Prolactin

(iii) The process of spermatogenesis is induced by

(a) TSH (b) ACTH (c) MSH (d) Androgens

(iv) The correct sequence of cell stage in spermatogenesis is

(a) spermatocyte → spermatids → spermatogonia → spermatozoa

(b) spermatogonia → spermatids → spermatocyte → spermatozoa

(c) spermatocytes → spermatogonia → spermatid → spermatozoa

(d) spermatogonia → spermatocytes→ spermatids → spermatozoa

(V) The number of sperm produced from 100 Secondary spermatocytes are:

(a) 100 sperms (c) 300 sperms

(b) 200 sperms (d) 400 sperms

ANSWER:

(i) (d) Sertoli cell

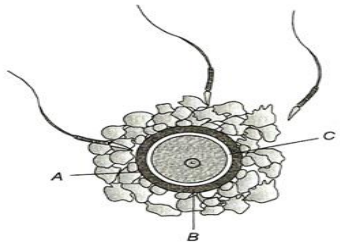
(ii) (b) FSH

(iii) (d) Androgens

(iv) (d) spermatogonia → spermatocytes→ spermatids → spermatozoa

(v) (a) 100 sperms

CASE BASED:4
Study the illustration given and answer the questions that follow:



(*i*) Identify 'a'.
(*ii*) Name and state the function of 'c'.
(*iii*) Identify 'b'.
(iv). Explain the role of hormones in the formation and release of 'a'.
ANSWER
(i). Ovum (ii) Zona pellucida .Itprevents polyspermy (iii). Perivitelline space
(iv).FSH,estrogen helps in development of ovarian follicles which in turn formation of oogonium into secondary oocyte (Ovum) and LH surge releases ovum during ovulation.

LONG ANSWER TYPE QUESTIONS: (5MARKS)

Q No.1. (a) Write the specific location and functions of the following cells in human males.
(i) Leydig's cells (ii)Sertoli cells (iii) Primary spermatocyte
(b) Explain the role of two accessory glands in human male reproductive system.

ANSWER: (a)

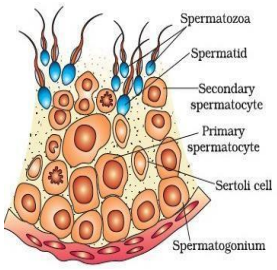
(i) Leydig's cellslocated in interstitial space and produce androgens.
(ii) Sertoli cells located inside the seminiferous tubules and it nurture the sperms.
(iii) Primary spermatocyte located inside the seminiferous tubules and it undergoes meiotic division to formed sperm.

(a) Male accessory glands are seminal vesicles, prostate glands, and bulbourethral glands. These glands secrete fluids called seminal plasma. The sperms get dispersed in the fluid which makes their transportation into the female body easier.

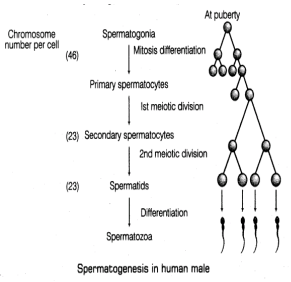
Q No.2.
(a) Draw a diagrammatic labelled sectional view of a seminiferous tubule of a human 9

(b) Describe in sequence the process of spermatogenesis in humans.

ANSWER: (a)



(b)



Q No..3.
(a) When and how does placenta develop in human female?
(b) How is placenta connected to the embryo?
(c) Write the functions of placenta other than endocrine gland. .

ANSWER:

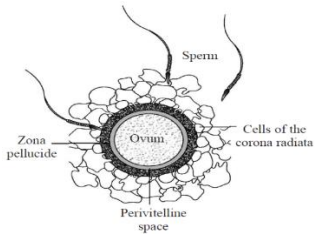
(a) The placenta begins to form after a fertilized egg implants in your uterus around seven to 10 days after conception. Chorionic villi are surrounded by the uterine tissue and the maternal blood. The chorionic villi and uterine tissue become interdigitated with each other and jointly form a structural and functional unit between the developing embryo and maternal body called the placenta.

(b)Through umbilical cord

(c)The placenta is an organ that develops in the uterus during pregnancy. This structure provides oxygen and nutrients to a growing baby. It also removes waste products from the baby's blood. The placenta attaches to the wall of the uterus, and the baby's umbilical cord arises from it.

Q No.4.
.(a) Draw a labelled diagram of ovum surrounded by few sperms.
(b) Differentiate between gametogenesis in human males and females on the basis of:
(i) Time of initiation of the process.
(ii) Products formed at the end of the process.

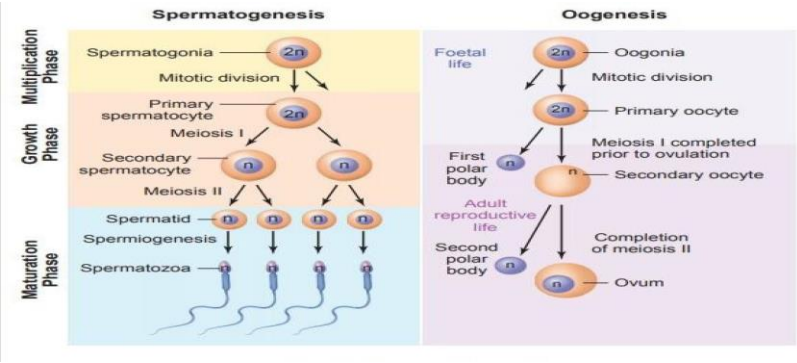
Answer; (a)



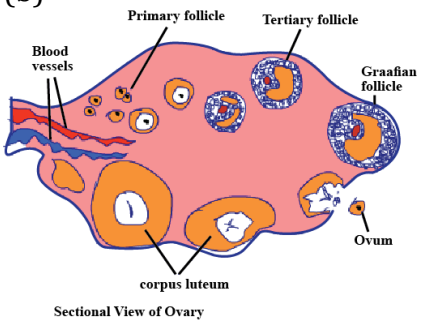
(b)

S**permatogenesis**	**Oogenesis**
Initiated at puberty	Initiated at foetal life
At the end of the process one spematogonium produced four spermatozoa	At the end of the process one ovum. produced from one oogonium

Q. No.5. (*a*) How is 'oogenesis' markedly different from 'spermatogenesis' with respect to the growth till puberty in the humans?
(*b*) Draw a sectional view of human ovary and label the different follicular stages, ovum and corpus luteum
Answer: (a)

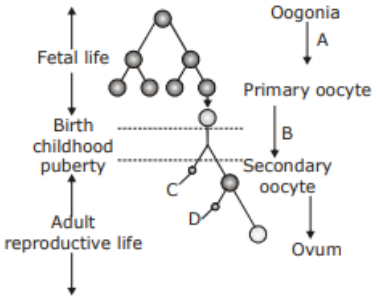


(b)



Sectional View of Ovary

Q. No.6.. (a) Give a schematic representation of oogenesis in human female indicating the chromosomal number at each step. Mention at what stage of female life each phase occurs.
(b) Explain the role of ovarian hormones in inducing changes in the uterus during menstrual cycle.
Answer: (a)



Oogonia (2n) , Primary oocyte (2n), Secondary oocyte (n) ,Ovum (n)

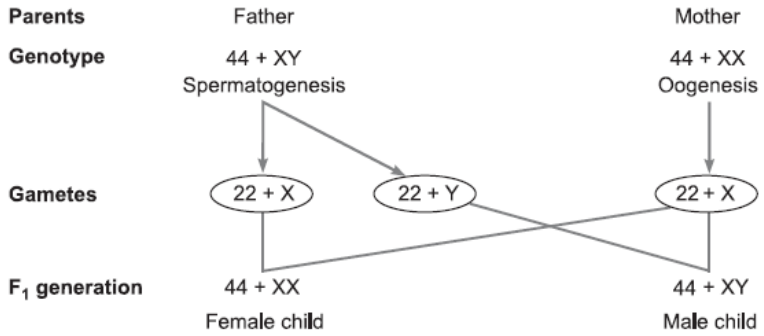
N = 23 chromosome.

(b) In the uterus, estrogen helps proliferate endometrial cells in the follicular phase of the menstrual cycle, thickening the endometrial lining in preparation for pregnancy.

Progesterone is essential for maintenance of the endometrium. Such an endometrium is necessary for implantation of the fertilised ovum and other events of pregnancy.

Q. No.7. (*a*) Explain sex determination in humans.
(*b*) How do human males with 'XXY' abnormality suffer?

Answer:
(*a*) By the process of spermatogenesis, males produce two types of sperms—50% carrying X-chromosome and 50% carrying Y-chromosome. However, females produce only one type of ovum carrying X-chromosome. If the sperm carrying X-chromosome fertilises the ovum, the zygote will develop into a female (XX) and if the sperm carrying Y-chromosome fertilises the ovum, the zygote develops into a male (XY).



(b) The XXY individual suffers from Klinefelter's syndrome

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CHAPTER 4. REPRODUCTIVE HEALTH

Abbreviation

IUCD	Intra Uterine Contraceptive Device	RTI	Reproductive Tract Infection
RCH	Reproductive and Child Health care	PID	Pelvic Inflammatory Disease
STD	Sexually Transmitted Disease	ART	Assisted Reproductive Technologies
HIV	human Immuno deficiency virus	IVF	In Vitro Fertilisation
AIDS	Acquired immuno deficiency syndrome	ZIFT	Zygote Intra Fallopian Transfer
CDRI	Central Drug ResearchInstitute	AI	Artificial insemination
MMR	Maternal Mortality Rate	IUI	Interna uterine insemination
IMR	Infant mortality rate	ET	Embryo transfer
MTP	Medical Termination ofPregnancy	IUT	intra uterine transfer
VD	Venereal Disease	ICSI	Intra Cytoplasmic Sperm Injection

SUMMARY

Reproductive health means a total well-being in all aspects of reproduction, i.e., physical, emotional, behavioural and social.

RCH PROGRAMME-REPRODUCTIVE AND CHILD HEALTH CARE PROGRAMME

i)creating awareness among people about various reproduction related aspects.

(ii) Providing facilities and support for building up a reproductively healthy society.

AMNIOCENTESIS- Foetal sex determination method for analysing chromosomal pattern by collecting cells from the amniotic fluid. It is used to find out any genetic disorder in the developing foetus.

MMR-MATERNAL MORTALITY RATE
IMR-INFANT MORTALITY RATE
BIRTH CONTROL METHODS
CONTRACEPTION
IDEAL CONTRACEPTIVE:
1) cheap 2) readily available
3) no side effects 4) effect should be reversible.

METHODS OF BIRTH CONTROL
(i) NATURAL METHODS -These are natural methods that work on the principle of avoiding the meeting of ovum and sperm.
(a) PERIODIC ABSTINANCE- is a method in which a couple avoids or abstains from coitus from day 10–17 of the menstrual cycle, when ovulation is expected to occur.

(b) COITUS INTERRUPTUS- or withdrawal is a method in which male partner withdraws his penis from the vagina just before ejaculation, so as to avoid insemination.

(c) LACTATIONAL AMENORRHEA- is based on the principle that during the period of lactation after parturition, ovulation does not occur.

(ii) BARRIER METHODS - These methods prevent the contact of sperm and ovum with the help of barriers. Such methods are available for both males and females.

(a) CONDOMS -are barriers made of thin rubber/latex sheath used to cover the penis in the male or vagina and cervix in females. It prevents the deposition of ejaculated semen into the vagina of the female. Additionally prevents STDs

(b) DIAPHRAGMS, CERVICAL CAPS are the barriers made of rubber that are inserted into the female reproductive tract to cover the cervix during coitus. They prevent the entry of sperms through cervix. They are reusable.

(c) Spermicidal creams, jellies and foams are usually used along with these barriers to increase contraceptive efficiency.

(iii) IUDs – INTRA UTERINE DEVICES PLACED IN UTERUS

(a) NON-MEDICATED: (Lippe's loop)- Increase phagocytosis of sperms within the uterus.

(b) COPPER RELEASING: (CuT, Cu7, Multiload 375)- Cu ions released supresses sperm motility and fertilising capacity of the sperms.

(c) HORMONE RELEASING -(LNG 20, Progestasert) -makes uterus unsuitable for implantation and the cervix hostile to the sperms.

ORAL CONTRACEPTION PILLS – Combination of estrogen and progestogen. May be taken daily, weekly or monthly. Inhibits ovulation. inhibits implantation. alter the quality of cervical mucus to stop or retards entry of sperms.

SAHELI- (DEVELOPMENT BY CDRI) – CENTRAL DRUG RESEARCH INSTITUTE LUCKNOW.A Non-steroidal preparation.

SKIN IMPLANT- Progestogens or progestogen–estrogen combination can also be used by females as injections or implants under the skin.

STERILIZATION (Surgical methods)

i)VASECTOMY-removing a portion of Vas deferens or tied up through a small incision.

II) TUBECTOMY- removing a portion of fallopian tube or tied up through a small incision.

MTP -(MEDICAL TERMINATION OF PREGNANCY) --Abortion by voluntary termination of pregnancy Uses – i) unwanted pregnancies can be stopped ii) helps in minimising population iii) in cases where pregnancy is harmful for mother. Safe up to 12 weeks.

STD'S / VENEREAL DISEASES (VD) / REPRODUCTIVE TRACT INFECTION /SILENT INFECTION

VIRAL DISEASES – HEPATITIS-B, AIDS, GENITAL HERPES. No cure available.

BACTERIAL OR PROTOZOAN- (gonorrhoea, syphilis, chlamydiasis, trichomoniasis) Early symptoms: Itching, fluid discharge, slight pain and swellings in the genital region. Complications due to chronic

STDs: Pelvic inflammatory diseases (PID), abortions, still births, ectopic pregnancies, infertility, or even cancer of the reproductive tract. On early detection completely curable. Earlier minor symptoms are shown, which become crucial for the spread of the diseases.

INFERTILITY AND TREATMENT Couples not able to conceive baby after 2/3 years of marriage.

TREATMENT- ART (ASSISTED REPRODUCTIVE TECHNOLOGIES)

1. TEST TUBE BABY PROGRAMMES–

(a) IN VITRO FERTILISATION (IVF)-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.

(b) ZYGOTE INTRA FALLOPIAN TRANSFER OR ZIFT -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).

(c) INTRA UTERINE TRANSFER OR IUT- if embryo with more than 8 blastomeres is transferred into the uterus (process is called intra uterine transfer or IUT).

2. 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.

3. INTRA CYTOPLASMIC SPERM INJECTION (ICSI)- It is a procedure to form an embryo in the laboratory by directly injecting the sperm into an ovum. The embryo is later transferred by ZIFT or IUT.

4. ARTIFICIAL INSEMINATION (AI)- 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.

MULTIPLE CHOICE QUESTIONS

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 is a barrier method of contraception?

a) diaphragms b) periodic abstinence c) Lactational amenorrhea d) Withdrawal method

3) In Vasectomy the part that is tied up is :

(a) Vasa deferens (b) Vasa efferentia (c) Epididymis (d) Fallopian tube

4) A doctor advises an infertile male to undergo Artificial insemination to correct his infertility-

(a) The male has low sperm count (b) Syphilis (c) Gonorrhoea (d) None of these

5)Which of the following have been found to be very effective as emergency contraceptive as they could be used to avoid possible pregnancy due to rape if given within 72 hours?

A. Administration of progestogens B. Progestogen-estrogen combination

C. IUDs inserted within 72 hours of coitus

(a) A only (b) B only (c) A & B only (d) A, B & C

6) Population explosion in recent years is due to?

(a) Decline in Maternal mortality rate (b) Decline in Infant mortality rate

(c) Increased number of people in reproductive age (d) All of the above

7) Which is the correct surgical procedure as a contraceptive method is

(a) Ovariectomy (b) Hysterectomy (c) Vasectomy (d) Castration.

8) Choose the odd one out

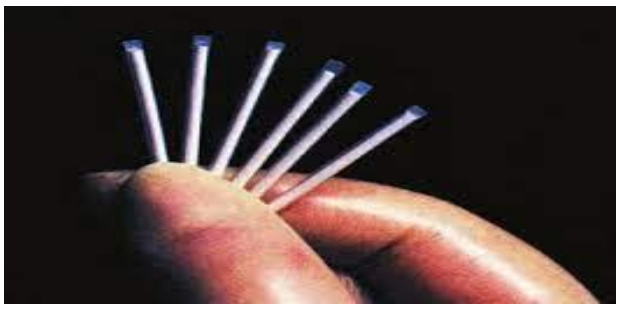
a) Multiload 375 b) CuT c) Tubectomy d) Cu7

9) GIFT is recommended for those female-

a) Who cannot retain the foetus inside uterus
(b) Whose cervical canal is too narrow to allow passage for the sperms
(c) Who cannot provide suitable environment for fertilisation
(d) Who cannot produce an ovum but can provide suitable environment for development
10) Lactational Amenorrhea is related to-

a) Temporary method of contraception
(b) Permanent method of contraception
(c) Absence of menstruation
(d) Onset of menstruation

11) Choose the correct statement for given figure



(a) Hormone containing device inserted in uterus for providing long term conception
(b) These contain non-steroidal preparation and are effective for 3 years
(c) These are one of the devices having levonorgestrel and are effective for 5 years
(d) Chemical contraceptives which kill the sperms by disrupting their membrane in vagina
12) Cu ions released from copper- releasing IUD‘s.

(a) Suppress sperm motility (b) Prevent ovulation

(c) Make uterus unsuitable for implantation (d) Kills sperms.

13) Which days are considered as most fertile period in the menstrual cycle?

(a) 5 to 10 days (b) 10 to 17 days (c) 17 to 23 days (d) 23 to 28 days

14) An ideal contraceptive should be

(a) user friendly (b) Reversible (c) Both (a) and (b) (d) Decreased sexual drive

15) Which of the following STDs are not curable?

(a) Genital herpes, hepatitis-B, HIV infection (b) Chlamydiasis, syphilis, genital warts

(c) HIV, gonorrhoea, trichomoniasis (d) Gonorrhoea, trichomoniasis, hepatitis-B

QUESTION NO	CORRECT OPTION	QUESTION NO	CORRECT OPTION	QUESTION NO	CORRECT OPTION
1	B	6	d	11	c
2	A	7	c	12	a
3	A	8	c	13	b
4	A	9	d	14	c
5	D	10	a	15	a

ASSERTION AND REASONING QUESTIONS

In the following questions a statement of Assertion(A) is followed by a statement of Reason. (R)

If both Assertion and Reason are true and Reason is the correct explanation of the Assertion, then mark (a)

If both Assertion and Reason are true and the Reason is not the correct explanation, then mark (b)

If Assertion is true and Reason is False, then mark (c)

If Assertion is false and Reason is true, then mark (d)

1) Assertion: Lactational amenorrhea is a natural method of contraception.
   Reason: Ovulation does not take place during the period of intense lactation following child birth.
2) Assertion(A): Infertility can occur in both males and females.
   Reason(R): Infertile couples can have children with the help of ARTS.
3) Assertion: Hormone releasing IUD‘s make the uterus unsuitable for implantation and the cervix hostile to sperms.
   Reason: IUD prevent the contact of sperm and ovum.
4) Assertion: Reproductive and Child Healthcare Programmes is for reproduction related areas.

Reason: It deals with creating awareness among various reproductions related aspects.

5) Assertion: Introduction of sex education in schools should be encouraged.
Reason: This will encourage children to believe in myths about sex related aspects

6) Assertion: Vasectomy and tubectomy are reversible methods of birth control.
Reason: MTP is safe during trimester.

7) Assertion: Rapid decline in death rate, MMR and IMR have led to a staggering rise in population. Reason: Such an alarming growth rate has led to an absolute scarcity of even the most basic requirements i.e food and shelter.

8) Assertion: Diseases that are transmitted through sexual contact are collectively called STDs

Reason: STDs cannot be prevented by avoiding unknown and multiple partners

. 9) ASSERTION: IUDs are an ideal and most widely used contraceptive method for the women in India. REASON: their male partners are free to take decisions about delaying of pregnancy and or space children for a period of few years.

10) Assertion: Artificial Insemination is the technique in which semen is collected from the male partner and artificially introduced either into the vagina or into the uterus.

Reason: It is effectively used in infertility cases where male partner is unable to inseminate the female partner or have very low sperm counts in ejaculations.

11) ASSERTION: Sex education has been included in the school curriculum.
REASONING: Sex education in schools may help in eliminating many queries that arise in young students.

12) Assertion: Hepatitis-B is also considered a sexually transmitted disease. Reason: It can be spread by sexual contact.

13) Assertion(A): A surgical method of contraception is sterilisation.
Reason(R): Sterilisation blocks gamete transport and thereby prevents conception.

14) Assertion: IUT is the transfer of embryo with more than 8 blastomeres into the uterus.
Reason: IUT is a very popular method of forming embryos in vitro.

15) Assertion: Syphilis, Gonorrhoea and AIDS are some common STDs.
Reason: STDs are transmitted through sexual intercourse.

QUESTION NO	CORRECT OPTION	QUESTION NO	CORRECT OPTION	QUESTION NO	CORRECT OPTION
1	A	6	d	11	a
2	C	7	a	12	a
3	B	8	c	13	a
4	A	9	c	14	b
5	C	10	a	15	a

VERY SHORT ANSWER QUESTIONS (1 mark)

1) Give the full form of ICSI?

2) Suggest the name of 2 STDs caused by bacterial infection.

3) Name any 2 natural methods of birth control that you are aware of.

4) Mention any 2 common causes of infertility in males.

5) Suggest any two methods of ARTs which can be used for males with low sperm count.

6) Government of India has raised the marriageable age of female to 18 years and of males to 21 years. Suggest any two more measures adopted by Government for the purpose.

7) Give one reason to justify statutory ban on amniocentesis.

8) A doctor has observed the chromosomal disorders in developing foetus and advised the couple to undergo abortion. Suggest the technique by which doctor observed the chromosomal disorders.

9) Reproductive health refers only to healthy reproductive functions. Comment.

10) The present population growth rate in India is alarming. Suggest ways to check it.

11) Indiscriminate diagnostic practices, using X-rays, etc., should be avoided. Give one reason.

12) Why is tubectomy considered a contraceptive method?

13) In case of an infertile couple, the male partner can inseminate normally but the mobility of sperms is below 40 percent. Which kind of ART is suitable in this situation to form an embryo in the laboratory conditions, without involving a donor?

14) A woman‘s husband is infertile. So, the lady has decided to have baby by taking sperms from sperm bank. Which technique will you suggest for her pregnancy?

15) What technique would you suggest for correcting infertility caused due to very low sperm counts of a male partner?

ANSWERS

1) Intra cytoplasmic sperm injection.

2) Syphilis and gonorrhoea.

3) Periodic Abstinence, Lactational amenorrhea

4) Smoking and Alcoholism can be attributed to low sperm count.

5) Artificial Insemination and ICSI and be done in cases of Infertility with low sperm count.

6) (i) Incentives given to couples with small families. (ii) Media publicity through posters of happy couples with two children (Hum Do Humare Do).

7) Statutory ban on amniocentesis prevents female foeticide.

8) Amniocentesis.

9) Reproductive health refers to the total well-being in all aspects of reproduction, i.e., physical, behavioural, psychological and social.

10) (i) By increasing marriageable age. (ii) By promoting use of birth control measures.

11) These practices act as carcinogens which convert normal cells to neoplastic cells by harmful mutations or chromosomal aberration.

12) Tubectomy involves cutting a piece of the fallopian tube and tying its ends. This way, the sperms are not able to reach the egg so fertilisation cannot take place. Thus, it acts as a contraceptive method.

13) Intra Cytoplasmic Sperm Injection 14) Intra cytoplasmic sperm injection (ICSI)

15) Artificial insemination.

SHORT ANSWER TYPE (2marks)

1) Comment on the RCH programme of the government to improve the reproductive health of the people.

2) What is amniocentesis? Why has the government imposed a statutory ban in spite of its importance in the medical field?

3) Describe the lactational amenorrhea method of birth control.

4) Name an oral pill used as a contraceptive by human females. Explain how it prevents pregnancy.

5) Why is medical termination of pregnancy (MTP) carried out?

6) At the time of Independence, the population of India was 350 million, which exploded to over 1 billion by May 2000. List any two reasons for this rise in population and any two steps taken by the government to check this population explosion.

7) The alarming population growth is leading to scarcity of basic requirements. Suggest with reasons, any two population control measures other than contraception to address the situation.

8) A couple is eager to know the sex of their unborn child. What diagnostic technique will you suggest? What social abuse is associated with the application of this technique?

9) Why is _Saheli considered to be an improved form of oral contraceptive for human female?

10) How do copper and hormone releasing IUDs act as contraceptives? Explain.

11) All reproductive tract infections (RTIs) are STDs but all STDs are not RTIs. Justify with example.

12) A couple where both husband and wife are producing functional gametes, but the wife is still unable to conceive, is seeking medical aid. Describe any one method that you can suggest to this couple to become happy parents.

13) An infertile couple is advised to adopt test-tube baby programme. Describe two principle procedures adopted for such technologies.

14) The process of GIFT involves the transfer of female gamete to the fallopian tube. Can gametes be transferred to the uterus to achieve the same result? Explain.

15) How can childless couples be helped by the following assisted reproductive technologies:

(a) GIFT? (b) Intracytoplasmic Sperm Injection.

ANSWERS

1) The basic aims of the RCH programmes are creating public awareness regarding reproduction related aspects population growth and providing facilities to build up a healthy society with added emphasis on the health of mother and child.

2) Amniocentesis is a procedure to test for the presence of certain genetic disorders like Down syndrome, haemophilia etc. Now a days people are using it for foetal sex determination test based on the chromosomal pattern in cells extracted from the amniotic fluid, surrounding the developing embryo. Amniocentesis is used for sex determination, which most people go for, to kill female foetus. Therefore, it has been banned.

3) Lactational amenorrhea is based on the principle that during the period of intense lactation after parturition, menstrual cycle or ovulation does not occur.

4) _Saheli is an oral pill used as a contraceptive by females. Oral pills inhibit ovulation and implantation, as well as, alter the quality of cervical mucus to prevent or retard entry of sperms. Thus, fertilisation and further pregnancy is prevented.

5) MTP is carried out to get rid of unwanted pregnancies. It is also essential when the foetus is suffering from an incurable disease or when continuation of the pregnancy could be harmful or even fatal to the mother and/or foetus or terminate pregnancy in rape cases

6) Two reasons for increase in population are:

(i) A rapid decline in death rate, maternal mortality rate and infant mortality rate.

(ii) Increase in number of people in reproducible age.

Two steps for checking population explosion:

(i) Statutory raising of marriageable age of the females to 18 years and males to 21 years.
(ii) (ii) Incentives given to couples with small families.

7) Following are the population control measures other than contraception:

(a) Advertisements in the media to generate awareness about advantages of small families.

(b) Statutory raising of marriageable age of the female to 18 years and that of males to 21 years, to delay the number of births.

(c) Incentives given to couples with small families, to motivate others to comply. (Any two)

8) Amniocentesis is the suggested diagnostic technique which when applied helps in sex determination of the foetus and may lead to social abuse like female foeticides.

9) Saheli contains a non-steroidal preparation and is a once-a-week pill, with high contraceptive value and very less side-effects. Therefore, it is considered an improved form of contraceptive pills.

10) The copper releasing IUDs release Cu ions, which suppress sperm motility and the fertilising capacity of sperms. The hormone releasing IUDs make the uterus unsuitable for implantation and the cervix hostile to the sperms.

11) Among the common STDs, hepatitis-B and AIDS are not infections of the reproductive organs though their mode of transmission could be through sexual contact also. All other diseases like gonorrhoea, syphilis, genital herpes, are transmitted through sexual contact and are also infections of the reproductive tract.

12) Methods: IVF/ZIFT/AI.

13) (i) IVF/In vitro fertilisation: It is the fertilisation of gametes outside the body in almost similar conditions as that in the body.

(ii) ET/Embryo transfer: Embryos formed by fusion of gametes is transferred into reproductive tract or uterus.

14) The uterine environment is not congenial for the survival of the gamete. If directly transferred to the uterus, they will undergo degeneration or could be phagocytosed and hence viable zygote would not be formed.

15) (a) GIFT (Gamete Intra Fallopian Transfer): 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.

(b) Intracytoplasmic Sperm Injection (ICSI): It is a process in which an embryo is formed in the laboratory, in which a sperm is directly injected into the ovum.

SA–II (3 marks)

1) What are the consequences of population explosion?

2) If implementation of better techniques and new strategies are required to provide more efficient care and assistance to people, then why is there a statutory ban on amniocentesis? Write the use of this technique and give reason to justify the ban.

3) (a) List any four characteristics of an ideal contraceptive. (b) Name two intrauterine contraceptive devices that affect the motility of sperms.

4) A woman has certain queries as listed below, before starting with contraceptive pills. Answer them. (a) What do contraceptive pills contain and how do they act as contraceptives? (b) What schedule should be followed for taking these pills?

5) (a) Name and explain the mode of action of any two types of IUDs. (b) List the advantages of using _Saheli‘ as a contraceptive.

6) 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.

7) (a) Expand IUD. (b) Why is hormone releasing IUD considered a good contraceptive to space children?

8) Name three incurable sexually transmitted diseases and their causative organisms.

9) Within what age group sexually transmitted diseases (STDs) are reported to be very high. Mention three practices to avoid them.

10) Suggest and explain any three Assisted Reproductive Technologies (ART) to an infertile couple.

11) Explain the zygote intra-fallopian transfer technique (ZIFT). How is intra-uterine transfer technique (IUT) different from it?

12) How are Assisted Reproductive Technologies helpful to humans? How are ZIFT and GIFT different from intra-uterine transfers? Explain.

13) Briefly explain IVF and ET. What are the conditions in which these methods are advised?

14) Expand the following and explain any one of them. (a) IVF (b) ZIFT (c) IUI (d) MTP.

15) Explain any three contraceptive devices that can be used by women for their family planning.

ANSWERS

1) Following are the consequences of population explosion:

(i) It is causing an absolute scarcity of the basic requirements, i.e., food, clothing, fuel and shelter.

(ii) There is greater demand for fossil fuels (oil, gas and coal). (iii) Eco-degradation.

2) There is a statutory ban on amniocentesis to legally check female foeticide. This sex determination technique has been misused to eliminate girl child before birth. This technique is also used to detect the abnormal chromosomes or any genetic disorder. The ban is justified to prevent female foeticide which could lead to change in sex ratio of the population.

3) (a) The ideal contraceptive should be (i) user-friendly, (ii) effective and easily available, (iii) not interfering with the sexual drive, (iv) reversible with no or least side effects.

(b) CuT, Cu7 and Multiload 375 affect motility of sperms.

4) (a) Contraceptive pills contain progestogen or progestogen-estrogen combination. They act by either of the following way:

(i) Inhibit ovulation (ii) inhibit implantation (iii) alter quality of cervical mucus to prevent or retard entry of sperms.

(b) 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).

5) (a) Any two types of IUD like Copper T and LippesLoop .

(b) Advantages of Saheli:

(i) It is non-steroidal (ii) It is taken only once a week (iii) It has high contraceptive value (iv) It has less side effects.

6) 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 oral pill.

7) (a) IUD—Intra uterine devices. (b) Hormone releasing IUDs are considered a good contraceptive because (i) they make the uterus unsuitable for implantation.

(ii) they increase the phagocytosis of sperms within uterus and the Cu ions released, suppress sperm motility and the fertilising capacity of sperms.

8) Sexually transmitted disease Causal agent

(i) Hepatitis-B, Hepatitis-B virus (ii) Genital herpes, Herpes simplex virus

(iii) AIDS, HIV (Human Immunodeficiency Virus).

9) 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.

10) Explain any three ART like IVF, ICSI and GIFT .

11) Zygote intra fallopian transfer technique (ZIFT) is a technique of in vitro fertilisation wherein the zygote or early embryo having up to 8 blastomeres is transferred into the fallopian tube to complete its further development. Intra uterine transfer (IUT) technique is different from ZIFT as the embryos with more than 8 blastomeres are transferred into the uterus in IUT.

12) The infertile couples could be assisted to have children through certain special techniques known as assisted reproductive technologies (ART). ZIFT: The zygote or early embryo with up to 8 blastomeres is transferred into the fallopian tube. This is called zygote intra fallopian transfer (ZIFT). 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. Intra-uterine transfer (IUT) refers to the introduction of embryo with more than 8 blastomeres into the uterus of a female to complete its further development.

13) IVF refers to in vitro fertilisation and ET refers to embryo transfer. Gametes from the male and female are collected hygienically and induced to fuse in the laboratory set up under simulated conditions. The zygote formed is collected and is introduced into the uterine of a host or surrogate mother at an appropriate time. Early embryos (up to 8 cell) are generally transferred to the fallopian tube whereas embryos with more than 8 cells are transferred to the uterus.

14) IVF — In-vitro Fertilisation ZIFT — Zygote Intra Fallopian Transfer IUI — Intra-Uterine Insemination MTP — Medical Termination of Pregnancy.

15) Copper releasing IUDs—suppress sperm motility/ fertilizing capacity of sperms Hormone releasing IUDs—make uterus unsuitable for implantation/cervix hostile to sperms (Female)

Condoms—provide physical barrier and prevent meeting of sperm and ovum.

Oral pills—inhibit ovulation and implantation/alter quality of cervical mucus and prevent entry of sperms.

LONG ANSWER QUESTIONS (5 marks)

1) STDs are a threat to reproductive health. Describe any two such diseases and suggest preventive measures.

2) Name and explain the surgical method advised to human males and females as a means of birth control. Mention its one advantage and one disadvantage.

3) A large number of married couples the world over are childless. It is shocking to know that in India the female partner is often blamed for the couple being childless.

(a) Why in your opinion the female partner is often blamed for such situations in India?
(b) State any two reasons responsible for the cause of infertility.
(c) Suggest a technique that can help the couple to have a child where the problem is with the male partner.

4) A village health worker was taking a session with women. She tells the women that one has to be very careful while using oral pills as method of birth control. Wrong usage can actually promote conception.

(a) Analyse the statement and compare the merits and demerits of using oral pills and surgical methods of birth control.
(b) Village women were confused as to how a thin metallic copper loop can provide protection against pregnancy. Justify the use, explaining the mode of action of IUDs.

ANSWERS

1) Explain and mention about the causal organism mode of infection and harmful effects of any two STDs like Syphilis and Gonorrhoea.
2)Explain Vasectomy and Tubectomy in details. Advantage : It is the permanent and most effective method of preventing conception as it blocks transport of gametes. Disadvantage: The process of surgical method is irreversible.
3) (a) Female partner is often blamed due to following reasons:
(i) Social mind set (ii) Inequality of sexes (iii) Lack of awareness/male dominated society.
(iv) Awareness is to be created that abnormality can occur in both male and females and infertility issues with suitable examples
(v) Mutual respect towards both the partners in case of the problem and to find the remedy from medical experts
(vi) Educate them to find the reason and not believe in superstitions.
(b) Infertility is caused due to physical abnormality in reproductive system, congenital, immunological or psychological problems. (c) Artificial Insemination.
4) (a) Contraceptive pills-

Merits-
1. Pills are effective with lesser side effects and well accepted by females.
2. Reversible method.
Demerits-
1. If not taken on right days they can promote conception. 2. Can have side effects if taken for a long time.
Surgical methods-
Merits-
1. Surgical intervention block gamete transport. 2. Highly effective.
Demerits-
1. Not reversible. 2. Can affect health of a person if performed in unhygienic condition.
(b) Mode of action of IUDs
(i) Increased phagocytosis of sperms within the uterus.
(ii) Cu++ released suppresses sperm motility.
(iii) Hormone releasing IUDs make uterus unsuitable for implantation

CASE BASED QUESTIONS

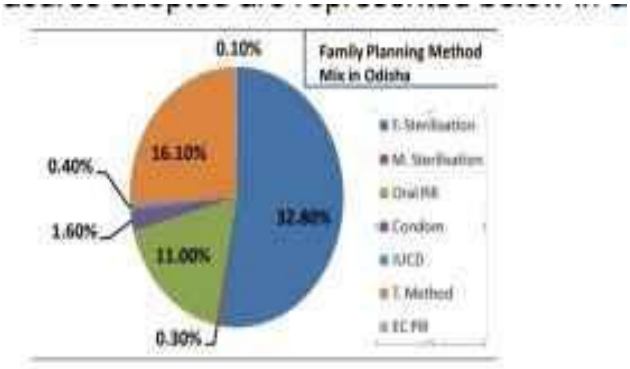
The so-called test tube babies are produced by the technique of "in vitro fertilisation" . It is a form of assisted reproductive technologies (ART). The steps of ART include:

(i) Administration of gonadotropins or Clomiphene Citrate to the woman.
(ii) Aspiration of several ova (sec. oocytes) by laparoscopy.
(iii) Collection of the sperm from the husband/donor semen.
(iv) Incubation of ovum and the sperm together in special media and environment

i)What will be the reason behind using the above technique?
ii) From which part, the ovum (sec. oocytes) are aspirated using Laproscopy?
OR
ii)Why Gonadotropins are administered to the woman in above technique?
iii)Why woman is administered with progesterone before the implantation of the embryo?

Answer:
i)The reason behind using this technique is there may be inadequate mobility of spermatozoa or there may be obstruction of the uterine tube. (ii) Graaffian follicle. OR (ii) Growth of corpus Luteum. (iii) To make the endometrium of uterus receptive

Population in Odisha is 42 million where youth constitute one fifth of it. The unmet need of family planning is 19%. Modern contraceptive prevalence rate in Odisha is 46.3% . The different contraceptive measures adopted are represented below in a pie chart.



Answer the following question based on your concept on Reproductive health and the above mentioned pie chart.

Q1. From the pie chart write which family planning method is most popular in Odisha?

Q2. How can the use of condoms be advocated?

Q3. Why there is prevalence of female sterilisation over male sterilisation?

Q4. How can as an aware citizen you motivate the young couple to adopt the family planning methods?

Answer: 1.- The female sterilisation method is most popular in Odisha.

2.By creating awareness among the people that,it don't have

i) any side effects ii) gives privacy to the user iii)don't need medical assistance

3. i)Still there is a belief in society that female are more responsible for reproduction related problems.

ii) Male are not going for sterilisation because of social stigma.

4.- i) By briefing them the benefit of small family.

ii) By creating awareness among them regarding the family planning methods and it's benefits.

I) Read the passage given below and answer the following questions.
Foetal abnormalities like Down‘s syndrome, Cystic fibrosis etc. are detected by a technique called Amniocentesis. It is performed in between 16 to 20 weeks of pregnancy. Amniotic fluid is taken to study the chromosomal pattern of the developing embryo. The fluid contains cells from the foetal tissues. Amnion surrounds the foetal cells that contain amniotic fluid. The foetal cells and foetal DNAs taken to examine and identify the chromosomal abnormalities and detect certain genetic abnormalities. It can also be used to determine the sex of the infant. Now days it has been responsible for female foeticide in want of a male child in most of the ignorant families.

1) Amniocentesis can be used for –

(a) Determination of chromosomal abnormalities (b) Detection of genetic disorders

(c) Detection of the sex of the infant (d)All of the above.

2) Which of the following option is true regarding amniotic fluid?

(a) It is the fluid enclosed in the amniotic sac (b) It is a fluid surrounding the foetus

(c) It is a fluid containing cells from the foetal tissue (d)All of the above

3) Amniocentesis has been banned as it has promoted:

(a) Foeticide (b) Female foeticide (c) Homicide (d)male foeticide

4) Amniocentesis is prenatal diagnostic technique:

(a) of detection of foetal abnormalities (b) of detection of parental abnormalities

(c) of detection of pregnancy abnormalities (d) of detection of placental abnormalities

II) Read the passage given below and answer the following questions.

Assisted Reproductive Technology (ART) refers to treatment and procedures that aim to achieve Pregnancy. These complex procedures may be an option for people who have already gone through various infertility treatment options but who still have not achieved pregnancy. The main type of ART is In Vitro Fertilisation (IVF), IVF involves extracting a women egg, fertilising the eggs in the laboratory and then transferring the resulting embryos into the woman's uterus through the cervix. ART success rates vary in the context of patient and treatment characteristics, such as age, infertility diagnosis, number of embryos transferred, type of ART procedure, use of techniques such as ICSI and history of previous births, miscarriages and ART cycles.

5) A woman whose womb is used as a substitute for the biological mother to nurse the embryo is called

(a) Interrogate mother (b) Surrogate mother (c) Both (a) and (b) (d) None of these

6) The stage of cells at which it is transferred into the uterus after induced fertilisation of ova in the laboratory is (a) embryo at 4 blastomeres stage.

(b) Embryo at 2 blastomeres stage. (c) Morula (d) Zygote

7) Artificial reproductive techniques are not always applicable because.

(a) it is an expensive technique, hence only few people can afford it.

(b) it is not possible in women with damaged uterine wall.

(c) it has raised ethical, legal and moral concerns

(d) All of the above

8) Assertion(A): Both ZIFT and IUT are embryo transfer techniques.

Reason(R): In both ZIFT and IUT, the number of cells in zygote is same.

(a) If both A and R are true and R is the 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 and R is true

CORRECT OPTIONS

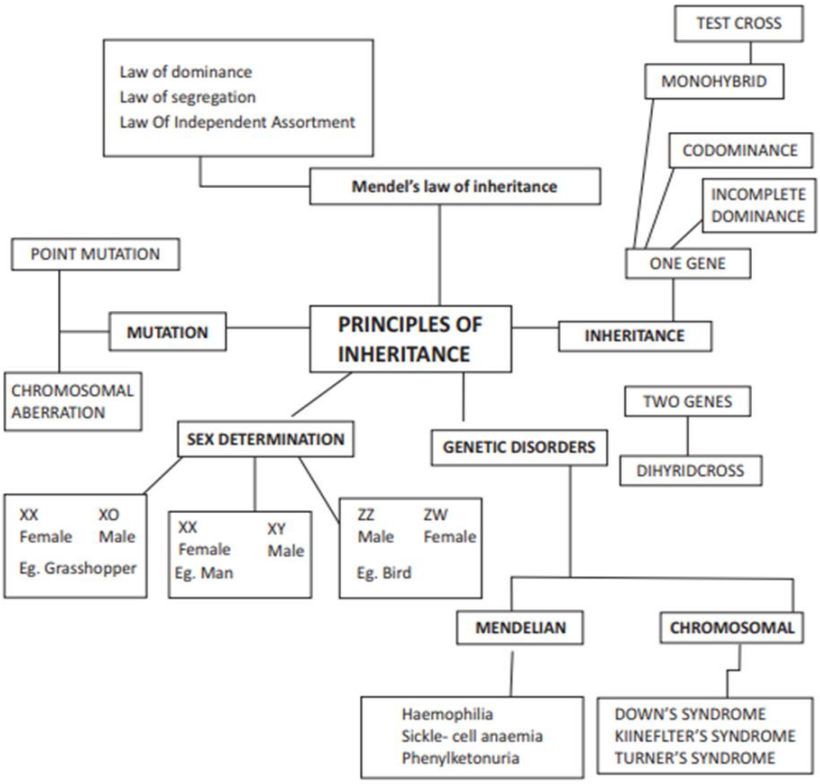
QUESTION	CORRECT OPTION	QUESTION	CORRECT OPTION
1	D	5	b
2	D	6	c
3	B	7	a
4	A	8	c

CHAPTER: 4 Principles of Inheritance and Variation

IMPORTANT TERMINOLOGIES

SL. NO.	TERMS	DEFINITION
1.	Character	The feature of an individual like hair colour, flower colour, height etc.
2.	Trait	The variant of the character-black or brown hair colour
3.	Gene	A gene is an ordered sequence of nucleotides locted in a particular position on a particular chromosome that encodes a specific function product. It is the fundamental physical and funtional unit of heredity.
4.	Allele	The Alternative forms of a gene on the same locus (the position on the chromosome) is called as alleles.
5.	Genotype	The genetic constitution of an organism.
6.	Phenotype	Observable characteristics of an organism, produced by the organism's genotype
7.	Homozygous	An individual with both identical alleles at one locus (Position)
8.	Heterozygous	An indidual with different alleles at one locus (Position)
9.	Dominant	The trait expressed in the heterozygote or in F1 Generation is called dominant.
10.	Recessive	The trait that remains hidden in the heterozygote is called Recessive. It is expressed only in homozygous condition.
11.	Monohybrid Inheritance	It is the study of inheritance of a single characteristic. This involves the inheritance of two alleles of a single gene.
12.	Dihybrid Inheritance	It is the study of inheritance of a two characteristic. This involves the inheritance of four alleles of a two genes.
13.	Back Cross	Cross between a hybrid and its any parent.
14.	Test Cross	Crossing of an organism with its homozygous recessive parent. It is a cross to know whether an individual is homozygous or heterozygous for dominant character.
15.	Selfing	It is the process of fertilization with pollen or male gametes of the same individual.
16.	Hybrid	The organism produced after crossing of two genetically different individual is called hybrid.
17.	Incomplete dominance	A form of Gene interaction in which both alleles of a gene at a locus are partially expressed, often resulting in an intermediate or different phenotype
18.	Codominance	a type of inheritance in which different alleles of the same gene are expressed separately to yield different traits in an individual
19.	Multiple Allele	A set of three , four , or more alleles , which has arisen as a result of mutation of normal gene and which occupy the same locus in the homologous chromosome.
20.	Pleiotropy	Pleiotropy is defined as the expression of multiple traits by a single gene.

CONCEPT MAP



CONTRASTING TRAITS IN PEA (STUDIED BY MENDEL)

S. No.	Character	Dominant	Recessive
1	Stem height	Tall	Dwarf
2	Flower colour	Violet	White
3	Flower position	Axial	Terminal
4	Pod shape	Inflated	Constricted
5	Pod colour	Green	Yellow
6	Seed shape	Round	Wrinkled
7	Seed colour	Yellow	Green

MONOHYBRID CROSS

Mendel's experiment of the Monohybrid Cross

Parental Generation (P_1)

Phenotype: Tall Dwarf

Genotype: T T t t

Gametes: T t

First Filial Generation (F_1)

Tt

Phenotype: Tall

Parental Generation (P_2) Selfing in F_1

Phenotype: Tall Tall

Genotype: Tt Tt

Gametes: T and t T and t

Second Filial Generation (F_2)

Male gamete / Female gamete	T	t
T	TT (Tall)	Tt (Tall)
t	Tt (Tall)	tt (Dwarf)

DIHYBRID CROSS

Phenotype of parents → Yellow Round × Green Wrinkled

Genotype → YYRR yyrr

Gametes → (YR) (yr)

F_1 generation → YyRr (Yellow round)

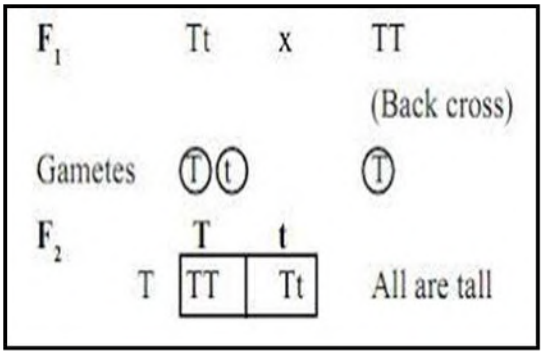
Selfing of F_1 generation → YyRr × YyRr

Gametes → (YR) (Yr) (yR) (yr) (YR) (Yr) (yR) (yr)

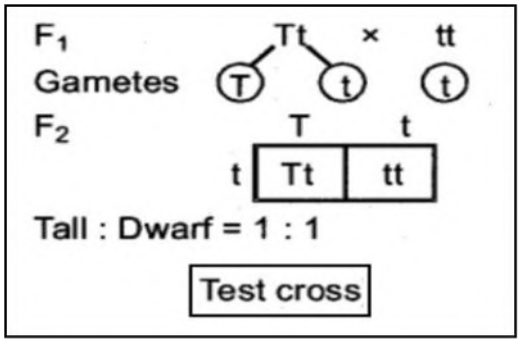
F_2 generation →

♀ \ ♂	YR	Yr	yR	yr
YR	YYRR Yellow round	YYRr Yellow round	YyRR Yellow round	YyRr Yellow round
Yr	YYRr Yellow round	YYrr Yellow wrinkled	YyRr Yellow round	Yyrr Yellow wrinkled
yR	YyRR Yellow round	YyRr Yellow round	yyRR Green round	yyRr Green round
yr	YyRr Yellow round	Yyrr Yellow wrinkled	yyRr Green round	yyrr Green wrinkled

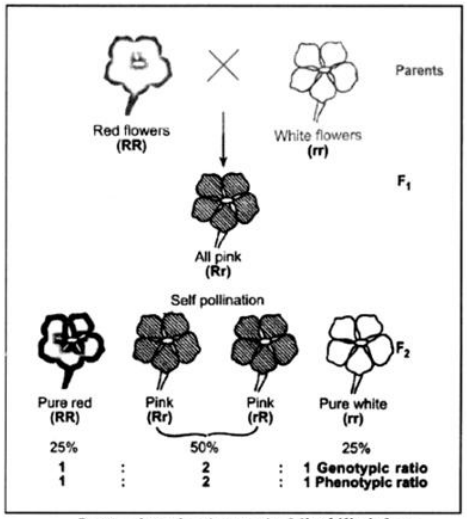
BACK CROSS



TEST CROSS



INCOMPLETE DOMINANCE

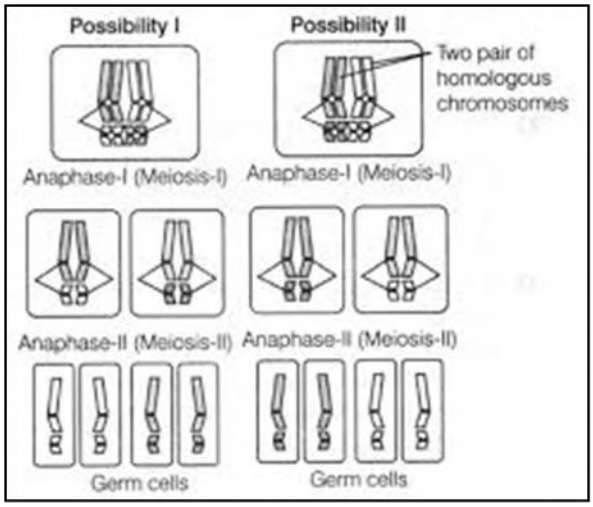


Incomplete dominance in *Mirabilis jalapa*

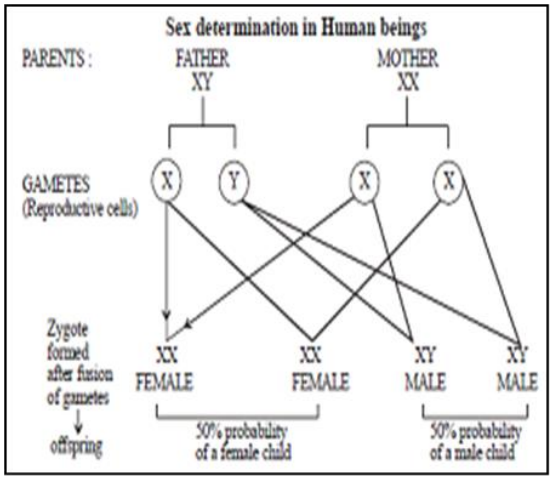
ALLELES OF BLOOD GROUP SHOWING CO-DOMINANCE

Blood Type	Genotype	
A	$i^A i$ $i^A i^A$	AA AO
B	$i^B i$ $i^B i^B$	BB BO
AB	$i^A i^B$	AB
O	$i\ i$	OO

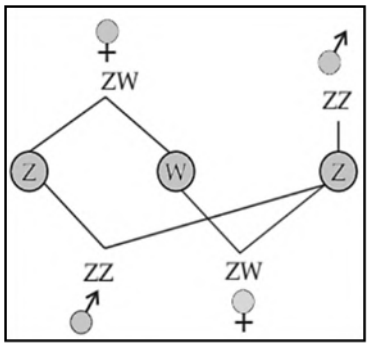
INDEPENDENT ASSORTMENT OF CHROMOSOMES



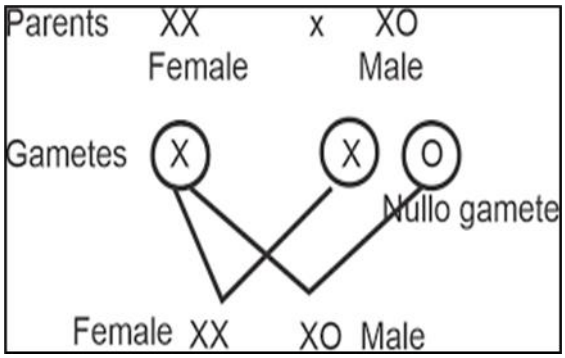
SEX DETERMINATION IN HUMAN



ZZ-ZW SEX DETERMINATION IN BIRDS

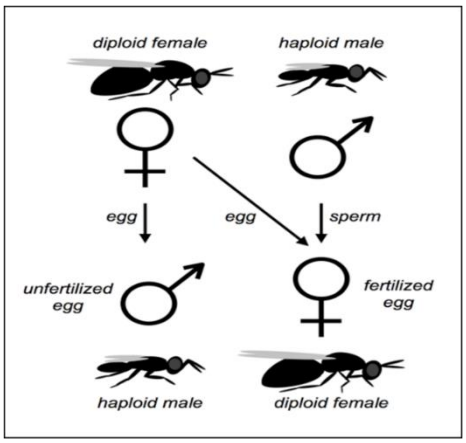


XX-XO TYPE SEX DETERMINATION IN GRASSHOPPER

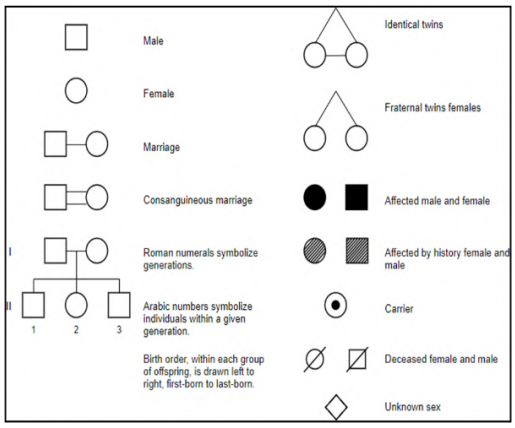


B

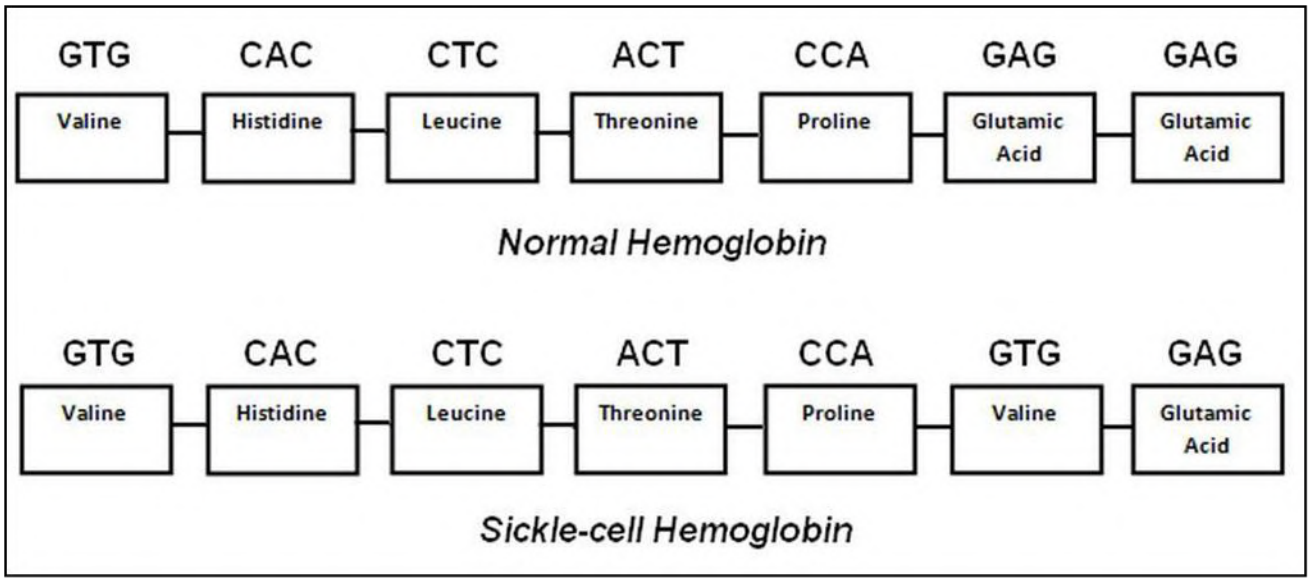
HAPLODIPLOIDY IN HONEY BEE



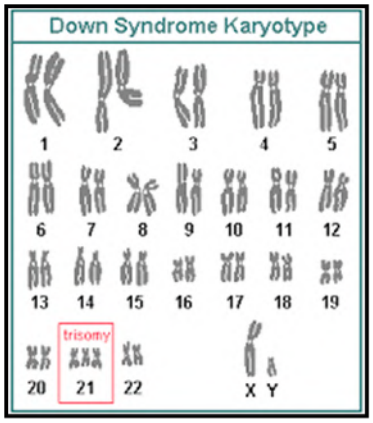
PEDIGREE CHART SYMBOLS

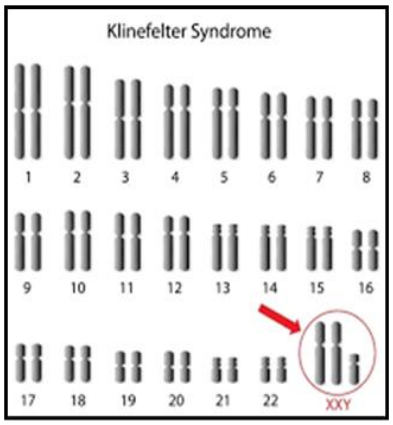


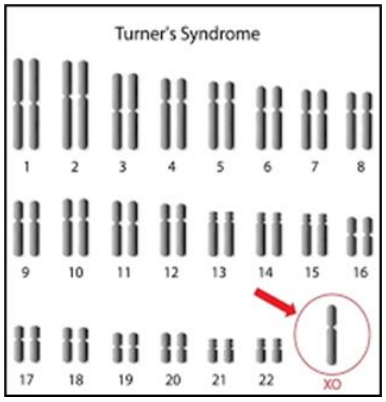
AMINOACID COMPOSITION OF beta-CHAIN OF HAEMOGLOBIN



KARYOTYPES OF CHROMOSOMAL DISORDERS





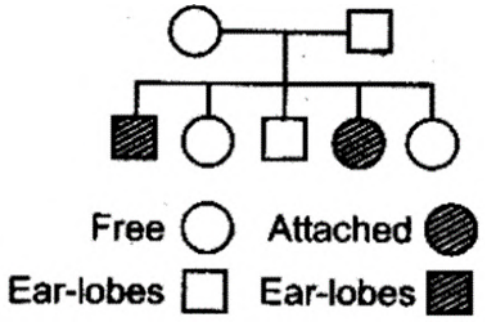


MULTIPLE CHOICE QUESTIONS (1 MARKS)

1. The degree by which progeny vary from parents is regarded as…….
   a)Inheritance b)Mutation c)Recombination d)Variation
2. Which is correct about traits chosen by Mendel?
   (a) Terminal pod is dominant (b) Constricted pod is dominant
   (c) green coloured pod is dominant (d) Tall plants are recessive
3. Name the process that needs to be avoided for carrying of efficient crosses?
   a) Self-pollination b) Fertilization
   c) Development of embryo d) Pollen tube development
4. Based on his experiments on pea plants, what were the things that he suspected of being transferred across generations?
   a) Genes b) Factors c) Chromosomes d) DNA
5. If the F1 generation produced by a cross between axial and terminal flower-bearing plants produces only axial flowers, the F2 progeny produced by the self-crossing of F1 will also produce only ……...
   (a)Axial flowers (b) Terminal flowers
   (c)Both Axial and Terminal flowers but in different ratios (d) None of the above
6. A cross between F1 hybrid and a recessive parent (Tt X tt) gives a ratio of
   (a) 1:1 (b) 2:1 (c) 3:1 (d) 4:1

7. A pink snapdragon is crossed to a white snapdragon. What is the probability of getting a red snap dragon?
   a) 1 b) ½ c) ¼ d) None
8. **Occasionally, a single gene may express more than one effect. The phenomenon is called**
   (a) multiple allelism (b) mosaicism (c) pleiotropy (d) polygeny
9. In polygenic inheritance
   (a) many genes govern a single character (b) heterozygous organisms express only one allele
   (c) heterozygous organisms express both alleles (d) a single gene influences many characters

10. Select the statements that describe the characteristics of genes.
    i. Genes are specific sequences of bases in a DNA molecule
    ii. A gene does not code for a protein
    iii. In individuals of a given species, a specific gene is located on a particular chromosome
    iv. Each chromosome has only one gene.
    a) i & ii (b) i & iii (c)i & iv (d) ii & iv
11. **If the percentage of crossing over between two genes is 15, then the distance between two genes will be**
    (a) 15 centimorgan (b) 1.5 centimorgans (c) 30 centimorgans (d) 30 map units
12. In a linear chromosome map distance between 4 loci is as follows a-b is 10%, a-d is 3%, b-c is 4% and a-c is 6%. The crossover frequency between c and d is
    (a) 4-12% (b) 3-6% (c) 9% (d) 3%
13. Percentage of recombination and distance between the genes shows
    (a) a direct relationship (b) an inverse relationship
    (c) a parallel relationship (d) no relationship
14. The map distance between genes A and B is 3 units, between B and C 10 units and between C and A 7units. The order of the genes in a linkage map constructed on the above data would perhaps be:
    a) A, B, C (b)A, C, B (c) B, C, A (d) B, A, C
15. The number of linkage group in E.coli is/are:
    a) 4 (b) 2 (c)1 (d) 5
16. Two genes R and Y are located very close on the chromosomal linkage map of maize plant. When RRYY and rryy genotypes are hybridized, the F2 segregation will show:
    A. Higher number of the recombinant types
    B. Segregation in the expected 9: 3: 3: 1 ratio
    C. Segregation in 3: 1 ratio
    D. Higher number of the parental types
17. **Which of the following will not result in variations among siblings?**
    (a) Independent assortment of genes (b) Crossing over
    (c) Linkage (d) Mutation
18. Given below is a pedigree chart of a family with five children. It shows the inheritance of attached earlobes as opposed to the free ones. Which one of the following conclusions drawn is correct?



    a) The parents are homozygous recessive
    b) The trait is Y-linked
    c) The parents are homozygous dominant d) The parents are heterozygous

19. A disease that shows its transmission from unaffected carrier females to some of its male progeny" Find the nature of the trait.
(a)Autosomal recessive (b) Autosomal dominant
(c) Sex-linked recessive (d) Sex-linked dominant
20. In sickle cell anaemia glutamic acid is replaced by valine. Which one of the following triplets codes for valine?
(a) G G G (b) A A G (c) G A A (d) G U G
21. Conditions of a karyotype 2n + 1, 2n – 1 and 2n + 2, 2n – 2 are called
(a) aneuploidy (b) polyploidy (c) allopolyploidy d) monosomy

Answers : MCQ

1	2	3	4	5	6	7	8	9	10	
d	c	a	b	c	a	d	c	a	b	
11	12	13	14	15	16	17	18	19	20	21
a	d	a	d	a	d	c	d	c	d	a

ASSERTION REASON TYPE QUESTIONS

. (A) Both Assertion and reason are true and the reason is the correct explanation of Assertion

(B) Both Assertion and Reason are true and Reason is not correct explanation of Assertion.

(C) Assertion is true but Reason is false. (D) Assertion is false but Reason is true.

1. Assertion: Indian breed, Sahiwal cows of Punjab is an example of Artificial selection.
Reason : Our ancestors had no idea about the scientific basis of this phenomenon.
2. Assertion: During Mendel's investigations into inheritance patterns it was not for the first time that statistical analysis and mathematical logic were applied to problems in biology.
Reason: His experiments had a large sampling size, which gave greater credibility to the data that he collected
3. Assertion: Mendel's law of Independent assortment does not hold good for the genes that are located closely on the same chromosome.
Reason: Closely located genes assort independently.
4. **Assertion :** In Mirabilis, selfing of F1 pink flower plants produces same phenotypic & genotypic ratio.
Reason : Flower colour gene shows incomplete dominance.
5. Assertion : The males have half the number of chromosomes than that of a female, in Honey bee.
Reason: An offspring formed from the union of a sperm and an egg develops as a female (queen or worker), and an unfertilized egg develops as a male (drone) by means of parthenogenesis.
6. Assertion: Study of the family history about inheritance of a particular trait provides an alternative.
Reason: In the pedigree analysis the inheritance of a particular trait is represented in the family tree over generations.
7. Assertion: Haemophilia is a sex linked recessive disease, which shows its transmission from unaffected carrier female to some of the male progeny has been widely studied.
Reason: In this disease, a single protein that is a part of the cascade of proteins involved in the clotting of blood is affected by point mutation.

Answer ASSERTION REASON TYPE QUESTIONS

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

SA-1(2 MARKS)

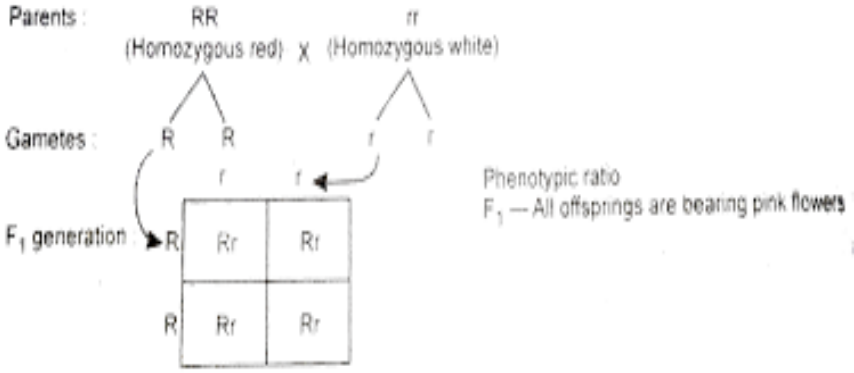
1 Analyze, why did Mendel self-pollinate the tall F1 plants to get the F2 generation and crossed a pure breeding tall plant with a pure breeding dwarf plant to obtain the F1 generation?

Answer:

The genotype of 50% of the offspring will resemble one parent and the rest 50% will resemble the other parent. The F1 generation obtained from the cross is heterozygous. So selfing the F1 generation is sufficient to obtain the F2 generation. It would also help to understand the inheritance of selected traits over generations

2 A cross between a red flower bearing plant and a white flower bearing plant of Antirrhinum produced all plants having pink flowers. Work out a cross to explain how this is possible.

Answer



3. A woman with blood group 'A' marries a man with blood group 'O'. Discuss the possibilities of the inheritance of the blood groups in the following starting with "Yes" or "No" for each.

Answer:

(b) Yes, if the mother is A (genotype I^AI^A

OR I^A i) and father has O (genotype ii) blood group, then the blood group of some children can be 'O' and some can be with blood group 'A'.

4. In a chromosome, the map distance in certain organism between genes A & B is 6 units, between B & C is units, & between C & D is 10 units which one of these gene pairs will show more recombination frequency? Support your answer with reason.

Answer:

C& D will show maximum gene recombination because genes which are more closely linked, frequency of recombination is least & vice versa

5. Write the types of sex-determination mechanisms the following crosses show. Give an example of each type.

(i) Female XX with Male XO

(ii) Female ZW with Male ZZ

Answer

(i) Female XX with male XO is male heterogamety. For example, grasshopper.
(ii) Female ZW with male ZZ is female heterogamety. For example, birds.

6. The male Fruitfly and female Fowl are heterogametic while the female Fruitfly and the male Fowl are homogametic. Why are they called so?

Answer: The male fruit fly has XY sex chromosomes and produces two types of gametes hence it is called heterogametic while female fowl has ZW sex chromosomes thereby producing two types of gametes thus they are called heterogametic. Female fruit fly has two X chromosomes i.e. XX and produces similar gametes hence they are homogametic

SA-2(3 MARKS)

1. A teacher wants his/her students to find the genotype of pea plants bearing purple coloured flowers in their school garden. Name and explain the cross that will make it possible.

Answer:
Test cross is a method devised by Mendel to determine the genotype of a plant with dominant phenotype (purple flower in this case). In a test cross, the unknown dominant genotype is crossed with recessive parent (white, WW in the given case).
(i) If the progeny consists of purple and white flowers in ratio of 1:1, the purple flower is a hybrid with PW genotype.
Cross---
(ii) If the progeny obtained have all purple flowers, both parents are homozygous, i.e. genotype of purple flower is PP.
Cross

2. Compare incomplete dominance and co-dominance with suitable examples?

Answer:
The phenomenon in which two true-breeding parents crossed to produce an intermediate offspring (also known as heterozygous) is called incomplete dominance. It is also referred to as *partial dominance*.
Co-dominance refers to the dominance in which the two alleles or traits of the genotypes (of both homozygotes) are expressed together in offspring (phenotype). There is neither a dominant nor recessive allele in cross-breeding. Rather the two alleles remain present and formed as a mixture of both of the alleles (each allele has the tendency to add phenotypic expression during the breeding process).

3. During his studies on genes in Drosophila that were sex-linked T.H. Morgan found F2 population phenotypic ratios deviated from expected 9:3:3:1. Explain the conclusion he arrived at.

Answer: The following is an explanation for the divergence from the Mendelian ratio: The genes that are implicated are found on the X chromosome. When two genes are on the same chromosome, parental gene combinations are far more common than non-parental gene combinations. Physical relationship of genes on a chromosome is known as linkage. Non-parental gene combination (recombination).

4. Over the past 20 years in India, 10 million female babies have been aborted. The pressure to have sons is terrifying - mothers who bear daughters are hated and cast aside by husbands and in-laws desperate to escape the financial burden of a girl's dowry.
Moreover, Women are often blamed for producing female children and consequently, they are ill-treated and ostracized. Suggest a way how you will address this issue scientifically if you were to conduct an awareness programme to highlight the values involved?

Answer:
It is not appropriate to blame women for producing female children because scientifically it is the father who determines the sex of the baby.
The scientific explanation for the following is:
The chromosome pattern in human females is XX and human males are XY. Males are heterogametic and produce two types of gametes one carrying X and the other carrying Y. The females are homogametic and produce same type of gamete carrying X chromosome. The sex of the child depends on the sperm that fuses with the ovum. If the fertilizing sperm has an X chromosome, then the baby would be a female and if a sperm with Y chromosome fuses with the ovum, it will develop into a male child. Thus, males are responsible for determination of the sex of a child. So, we should not blame women for the birth of a female child and stop ill-treating them.

CASE STUDY BASED QUESTIONS (4MARKS)

1. Mendel investigated characters in the garden pea plant that were manifested as two opposing traits, e.g., tall or dwarf plants, yellow or green seeds. This allowed him to set up a basic framework of rules governing inheritance, which was expanded on by later scientists to account for all the diverse natural observations and the complexity inherent in them. Mendel conducted such artificial pollination/cross pollination experiments using several true-breeding pea lines. A true breeding line shows the stable trait inheritance and expression for several generations.
a)List the traits studied for the flower in peas along with their allele, and state which one is dominant.
b)State the number of true breeding pea plant varieties that had been selected by Mendel in Pea Plant.
c)Explain which individuals will be called as a true breeding line.
d)Mention any two advantages of selecting pea plant for experiment by Mendel.
Answer:
a)Flower colour: Violet(dominant) and White (Recessive)
Flower position: Axial (dominant) and Terminal (Recessive)
b) 14

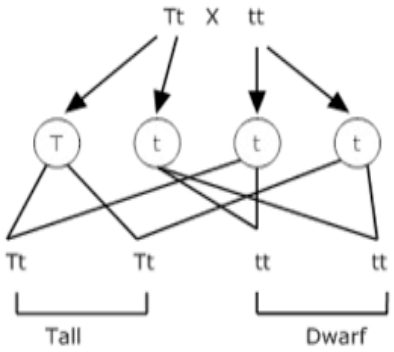
c)A truebreeding line is one that, having undergone continuous self-pollination, shows the stable trait inheritance and expression for several generations.
d)Short Life span, Easily Cultivable

2. Imagine that there are two alleles, B and b, for a given trait. B is dominant to b. Answer the following questions about this gene:
   a) List the possible homozygous and heterozygous genotypes?
   b) In which genotype or genotypes it is expressed that B is dominant?
   c) State with reason, whether B and b are located on different loci?
   d) Explain why the two alleles cannot be on the same chromosomes?

Answers:

a) BB, bb and Bb
b) Bb
c) B and b are the two different alleles for the same trait and each trait has a certain loci in a chromosome and both cannot acquire a single position in a chromosome. The chromosomal theory of inheritance proposed by Boveri and Sutton stated that the genes are present on specific locations on a chromosome. Similar or different alleles are located in the same loci of both the homologous chromosomes that they form pair.

3. By analysing the result of the cross, shown here:
   i) Identify the name, of this type of cross and express why it is used.
   ii) Interpret that what will be the genotype of the parental plants if they produce 26 TT: 48Tt: 24tt.
   iii) If F2 dwarf plants are self pollinated then the genotype of F3 and F4 will be……
      a) TT and tt
      b) tt and tt
      c) Tt and Tt
      d) TT and Tt



   iv) Compare the Genotypic and phenotypic ratio of Mendel's Monohybrid cross

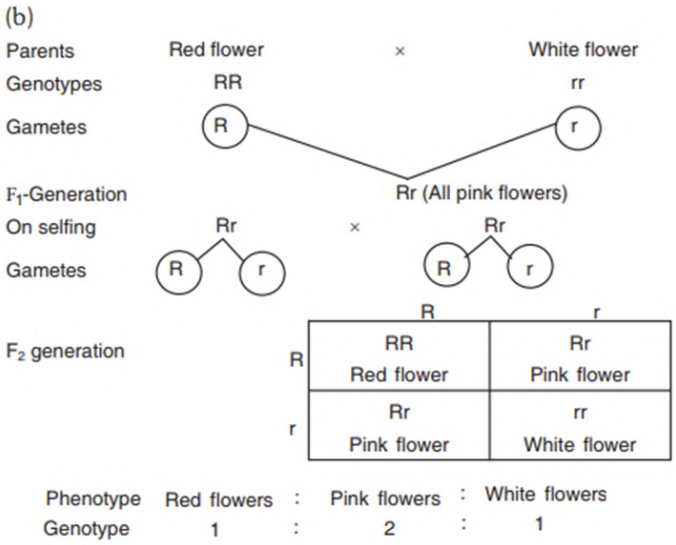
Answer:

i) Test cross. It is useful to determine the genotype of a parent plant.
ii) Tt and Tt
iii) tt and tt
iv) **Genotypic ratio- 1:2:1 and Phenotypic ratio- 3:1**

4. Work out a cross between true breeding red and white flowered dog flower plants (snapdragon) upto F_2 progeny. Explain the results of F_1 and F_2-generation.

Answer:

In F_1-generation Pink flowered plants obtained. It is due to incomplete dominance. In F_2-generation Alleles of the hybrid (F_1) segregate during gamete formation and the parental characters reappear without any change. So, the phenotypic and genotypic ratios in F_2-generation are same.



5. A 21-year-old female reported to the Outpatient Department of Periodontics, Mamata Dental College and Hospital, Khammam, with the chief complaint of multiple mobile teeth in the mouth since 1 year. On physical examination, it was seen that the patient was of short stature and had webbed neck with a low hair line at the back of the neck and the secondary sexual characters are also not visible. Ultrasound report of the abdomen revealed hypogonadism i.e she has rudimentary ovaries.

   a) By examining the symptoms, identify the disorder seen in the patient.
   b) Discuss the genetic cause of the state she is suffering from.
   c) Mention the karyotype of this type of chromosomal aberration.

Answer:

a) Turner's Syndrome

b) Such a disorder is caused due to the absence of one of the X chromosomes, 45 with XO.

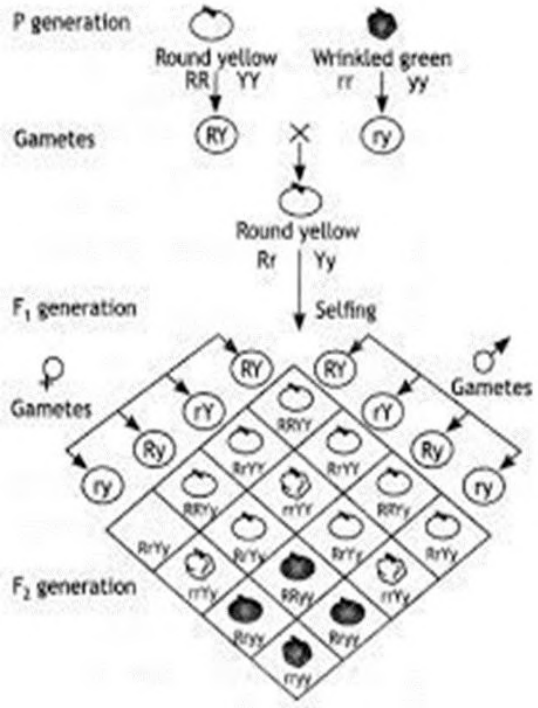
LA (5MARKS)

1. *Mendel did a dihybrid cross by observing the inheritance of two genes. In a dihybrid cross plants having 2 sets of contrasting characters are chosen. Based on various dihybrid crosses, Mendel proposed a second set of generalizations in the form of the Law of Independent Assortment. It is the third law of inheritance.*

   i) Design a cross for the genes seed colour and seed shape to show the results that obtained in this cross.
   ii) Evaluate the ratio obtained in this dihybrid crsoss.
   iii) Show the new combination of progeny obtained in the cross.

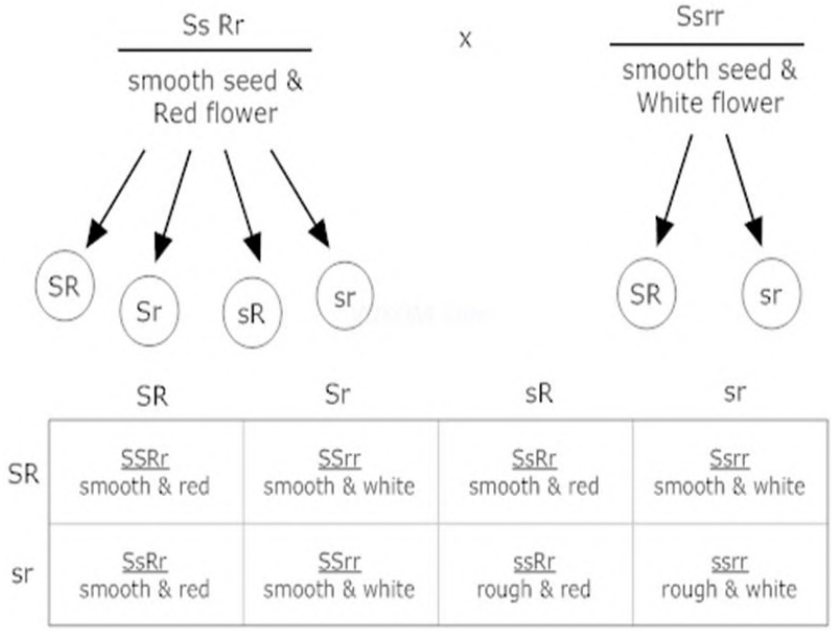
Answer:

(i) Punnett square with : RRYY and rryy individuals



(i) 9:3:3:1
(ii) Wrinkled Yellow and Round Green

2. **A smooth seeded & red – flowered pea plant (SsRr) is crossed with smooth seeded & white flowered pea plant (Ssrr). Determine the phenotypic & genotypic ratio in F1 progeny?**
Answer: 1. Smooth seed & red flower =3 2. Smooth seed & white flower =3 3. Rough seed & red flower =1 4. Rough seed & white flower =1



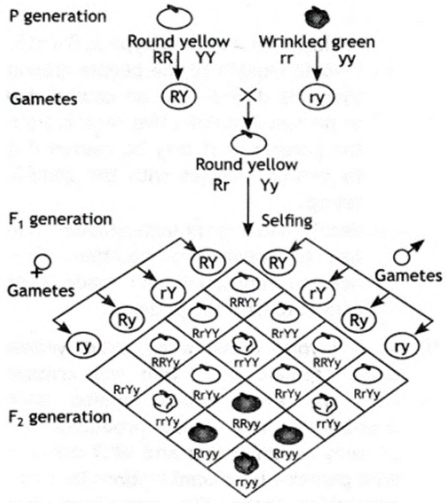
	SR	Sr	sR	sr
SR	SSRr smooth & red	SSrr smooth & white	SsRr smooth & red	Ssrr smooth & white
sr	SsRr smooth & red	Ssrr smooth & white	ssRr rough & red	ssrr rough & white

3. (a) State the law of independent assortment.

(b) Using Punnett square demonstrate the law of independent assortment in a dihybrid cross involving two heterozygous parents.

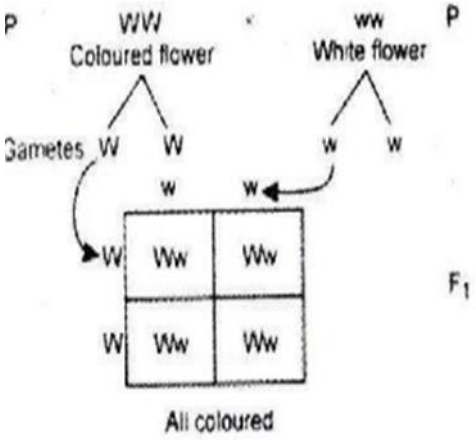
Answer:

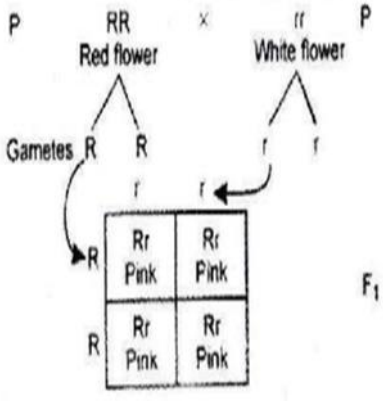
According to the law of independent assortment, during the inheritance of two different traits, the alleles of both the traits assort and are inherited independently of one another during gamete formation.



4. Inheritance pattern of flower colour in Garden Pea and Snapdragon differs. Compare the difference observed? Explain showing the crosses upto F2 generation.

Answer: The inheritance pattern of flower colour in *Pisum sativum* (garden pea) follows the law of dominance that is out of the two alleles of flower colour (gene) the dominant allele is expressed (phenotypically) and the recessive allele is suppressed when both are present together in heterozygous condition. The recessive trait is expressed only when the recessive allele is present in the homozygous condition. In the case of *Antirrhinum* (snapdragon) the flower colour shows incomplete dominance and all the *F*1 progeny is of pink colour.It is because the allele for red colour is not completely dominant over its recessive allele. The law of dominance is not exhibited in this case.





Bateson, Saunders, and Punnett decided to cross the F_1 plants with each other. After this

cross, the researchers expected the F_2 generation to have a 9:3:3:1 ratio (nine plants with purple flowers and long pollen grains, to three plants with purple flowers and round pollen grains, to three plants with red flowers and long pollen grains, to one plant with red flowers and round pollen grains). Instead, they observed the results shown in Table 1 (Bateson *et al.*, 1905), and these results were found to be statistically significant

Table 1: Characteristics of the F_2 Generation

Phenotype	Expected	Observed	(Observed-Expected)^2/Expected
Purple, long	1199	1528	90.3
Purple, round	400	106	216.1
Red, long	400	117	200.2
Red, round	133	381	462.4

i. From, the chart synthesize the fact that what deviation from Mendel's findings were found by the researchers?

ii. This is the reason why Mendel did not recognize linkage phenomenon in his experiments
(a) he studied only pure plants
(b) he did not have a powerful microscope
(c) characters he studied were situated on different chromosomes
(d) many chromosomes to handle

iii. Based on these findings, the trio proposed that certain alleles must somehow be coupled with one another. Point out the name of the phenomenon that is called later on? Name the Scientist who disovered it and what was the specimen used in his discovery?

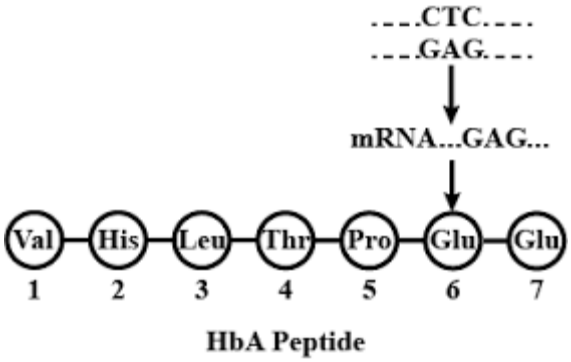
Answer:

(i) **The researchers realized that there was an excess in the number of parental phenotypes (purple-long and red-round) in the F_2 results. Because the parental phenotypes reappeared more frequently than expected, the three researchers hypothesized that there was a coupling, or connection, between the parental alleles for flower color and pollen grain shape, and that this coupling resulted in the observed deviation from Mendel's law of independent assortment.**

(ii) **(c)**

Linkage, T.H. Morgan, Drosophila melanogastor

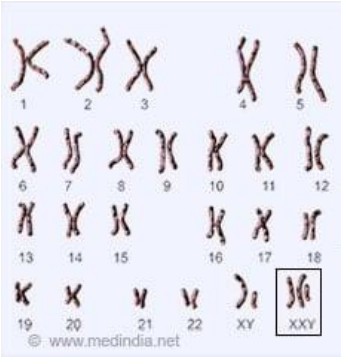
5. **In the image given below, a classical example of point mutation is shown. Identify the disorder. State the cause of the problem, its symptoms and the effect.**



HbA Peptide

Answer: Sickle Cell Anaemia, Its cause and effects.

Study the given illustration of an abnormal karyotype of an individual and answer the following questions:



a) Examine the genetic disorder visible in this karyotype.
b) Construct a list of abnormalities seen in the individual suffering from this disorder.

Name the phenomenon which is responsible for this condition.

Answer:

a) Klinefelter's Syndrome

b) Such an individual has overall masculine development, however, the feminine development (development of breast, i.e., Gynaecomastia) is also expressed. Such individuals are sterile.

This genetic disorder is also caused due to the presence of an additional copy of X chromosome resulting into a karyotype of 47, XXY

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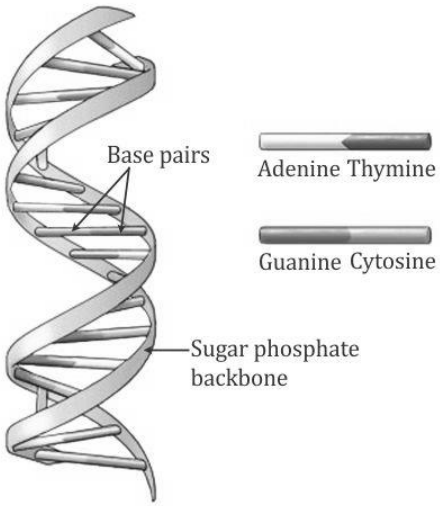
CHAPTER : 6 MOLECULAR BASIS OF INHERITANCE

(This is a lengthy chapter. Large number of concepts are there. Different types of application-based questions can be asked. Students are required to practice the summary as per their requirement to master the chapter. Diagrams need practice because questions are many a times based on the diagram. After mastering one concept students should move to another concept. Teacher's guidance is very important. Many processes mentioned in the summary are asked in 3 marks question.)

SUMMARY & DIAGRAMS

DNA & structure

- Components of DNA are (i) Deoxyribose sugar,
  (ii) A phosphate, and (iii) Nitrogen containing organic bases.
- DNA contains four different bases, grouped into two classes on the basis of their chemical structure:
  (i) Adenine (A) & Guanine (G): Purines (with a double ring structure) and
  (ii) Cytosine (C) & Thymine (T): Pyrimidines (with a single ring structure)
- Cytosine is common for both DNA and RNA and thymine is present in DNA. Uracil (U) is present in RNA at the place of thymine (T).

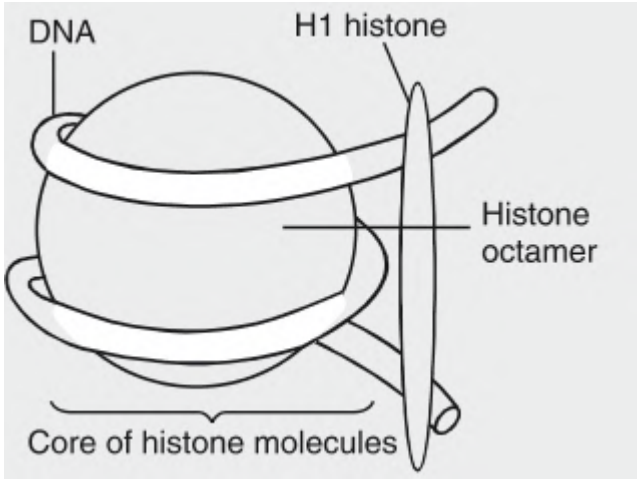


Double helical structure of DNA

- In 1953 James Watson and Francis Crick proposed three dimensional structure of DNA and won the Nobel Prize.
- Nitrogenous base + Sugar = Nucleoside {N-glycosidic linkage}
- Nucleoside + Phosphate = Nucleotide {phosphodiester linkage}
- Adenine - Thymine pair has two hydrogen bonds.
- Guanine - Cytosine pair has three hydrogen bonds.
- Upon heating at temperature above 80-90 degree two strands uncoil and separate (Denaturation)
- On cooling two strands join together (renaturation /annealing).
- DNA is mostly right handed and B form.
- Bacterial nucleoid consists of a single circular DNA molecule.
- In case of RNA, every nucleotide residue has an additional—OH group present at 2-position in the ribose.

Nucleosome (Packaging of DNA helix)

- DNA of eukaryotes is wrapped around positively charged histone proteins (H) to form nucleosome.
- Nucleosome contains 200 base pairs (bp) of DNA helix.
- Histone octamer= 2 (H2a+H2b+H3+H4)



- Linker DNA bears H1 protein.
- Chromatin fibres formed by repeated units of nucleosomes.
- Non histone proteins required for packaging.
- Regions of chromatin, loosely packed and stains lightly called **euchromatin.**
- Regions of chromatin, densely packed and stains darkly is called **heterochromatin.**

Experiments

(a) Griffith experiment/ Transformation experiment/ Griffith effect

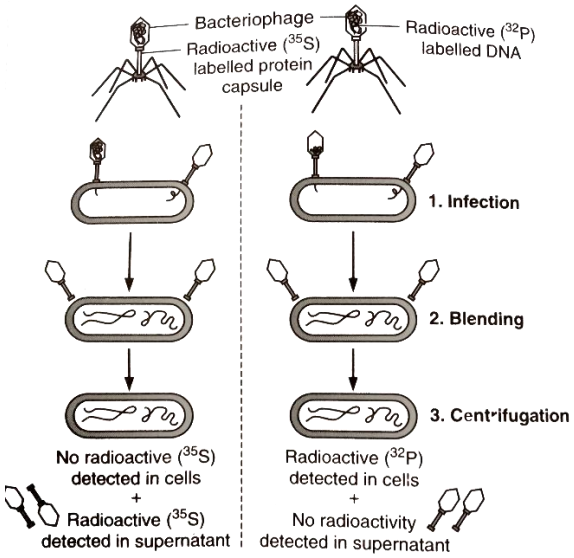
- Performed experiments on Mice using *Diplococcus pneumonia.*
- Two strains of bacteria are S-type and R-type cells.
  S Strain →→ inject into mice →→ mice die
  R strain →→ inject into mice →→ mice live
  S strain (heat killed) →→ inject into mice →→ mice live
  S strain (heat killed) + R strain (live) →→ inject into mice →→ mice die
- Griffith concluded that R type bacteria is transformed into virulent form.

(b) Biochemical characterisation of Transforming Principle

- Proved chemical nature of genetic material is DNA by using various enzymes like proteases, RNases and DNases (Avery, Macleod & Mc Carty)

(c) Hershay & Chase Experiment

- DNA is a genetic material in viruses (bacteriophage) was discovered by Hershey and Chase (1952).
- Use radioactive phosphorus and sulphur to demonstrate DNA is genetic material that passed from virus to bacteria.



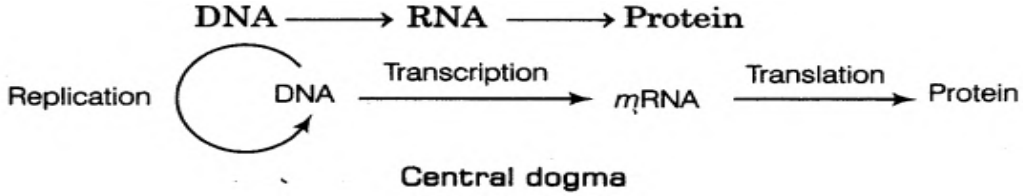
Properties of Genetic Material

- It became established that DNA is the genetic material from the Hershey-Chase experiment.
- In some viruses, RNA was also reported as genetic material, e.g. Tobacco mosaic virus.

- It should be able to replicate.
- It should be chemically and structurally stable.
- It should provide scope for slow changes (mutation) that are required for evolution.
- It should be able to express itself in the form of 'Mendelian characters'.
- DNA vs RNA: According to the above mentioned rules, both the nucleic acids (DNA and RNA) have the ability to direct duplications. Stability can be explained in DNA as the two strands being complementary if separated by heating come together in appropriate conditions. The 2′ — OH group present at every nucleotide in RNA is a reactive group and makes RNA labile and easily degradable, hence it is reactive. whereas, DNA is chemically less reactive and structurally more stable when compared to RNA. Thymine also confers additional stability to DNA. This concluded that the DNA being more stable is suitable for storage of genetic information, while for the transmission of genetic information, RNA is suitable. So, among the two nucleic acids, the DNA is a predominant genetic material.

Central Dogma

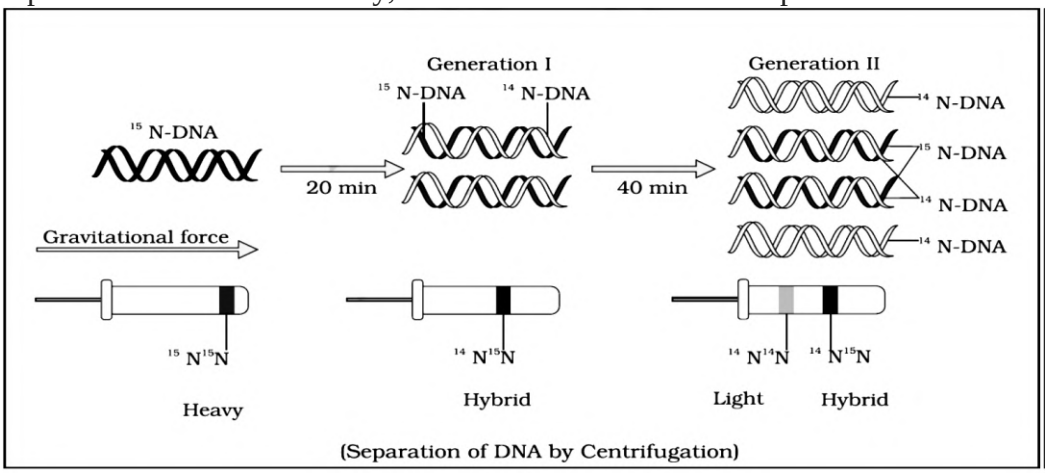
Francis Crick proposed the central dogma in molecular biology, which states that the genetic information flows from:



REPLICATION

- **Replication Scheme** for replication of DNA termed as semiconservative DNA replication.
- It was proposed by Watson and Crick (1953). According to it,
  (i) The two strands would separate and act as a template for the synthesis of new complementary strands.
  (ii) After replication, each DNA molecule would have one parental and one newly synthesised strand.
- **Experimental proof** that DNA replicates semi conservatively, comes first from E. coli and later from higher organisms, such as plants and human cells.
- **Matthew Meselson and Franklin Stahl** performed the following experiments to prove this in 1958.
  (i) E. coli was grown in a medium containing $^{15}NH_4C1$ as the only nitrogen source for many generations. ^{15}N got incorporated into newly synthesised DNA (and other nitrogen containing compounds). This heavy DNA molecule could be distinguished from the normal DNA by centrifugation in a Caesium Chloride (CsCl) density gradient.
  (ii) They then transferred the cells into a medium with normal $^{14}NH_4Cl$ and took samples at various definite intervals as the cells multiplied and extracted the DNA that remained as double stranded helices. DNA samples were separated independently on CsCl gradients to measure DNA densities.
  (iii) The DNA that was extracted from the culture, one generation (after 20 min) after the transfer from ^{15}N to ^{14}N medium had a hybrid or intermediate density. DNA extracted from the culture after another generation (after 40 min) was composed of equal amounts of this hybrid DNA and of light DNA.

(iv) Very similar experiments were carried out by **Taylor and Colleagues** on **Vicia faba (faba beans)** using radioactive **thymidine** and the same results, i.e. DNA replicates semi conservatively, were obtained as in earlier experiments.



Meselson and Stahl's experiment

DNA REPLICATION

Process of replication requires a set of catalysts (enzymes).

(i) The main enzyme is **DNA-dependent DNA polymerase**, since it uses a DNA template to catalyse the polymerisation of deoxy-nucleotides. The average rate of polymerisation by these enzymes is approximately 2000 bp/second.

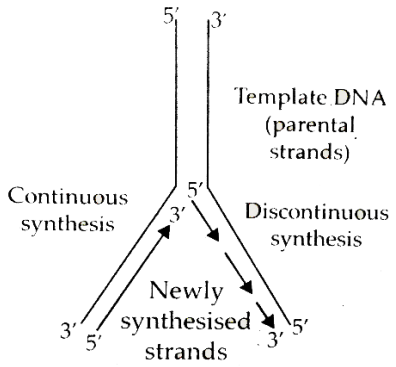
(ii) These polymerases have to catalyse the reaction with high degree of accuracy because any mistake during replication would result into mutations.

(iii) DNA polymerisation is an energy demanding process, so deoxy-ribonucleoside triphosphates (dATP, dGTP, dCTP, dTTP) serve dual purposes, i.e. act as substrates and provide energy for polymerisation reaction.

(iv) Many additional enzymes are also required in addition to DNA-dependent DNA polymerase.

Replication Process:

(a) Replication in DNA strand occurs within a small opening of the DNA helix, known as **replication fork**.



(b) DNA-dependent DNA polymerases catalyse polymerisation **only in one direction, i.e. 5′ -------> 3.** It creates additional complications at the replicating fork. Consequently, on one strand (template 3′-5′), the replication is continuous, while on the other strand (template 5′-3′), it is discontinuous. The discontinuously synthesised fragments called **Okazaki fragments** are later joined by DNA ligase.

Origin of Replication:

(a) DNA polymerases cannot initiate the process of replication on their own. Also, replication does not initiate randomly at any place in DNA. So, there is a definite region in E. coli DNA where the replication originates. The region is termed as **origin of replication**.
(b) Due to this requirement, a piece of DNA, if needed to be propagated during recombinant DNA procedures, requires a vector. The vectors provide the origin of replication.

RNA world

RNA was the first genetic material. There are evidences to prove that essential life processes, such as metabolism, translation, splicing, etc., have evolved around RNA.

(i) There are some important biochemical reactions in living systems that are catalysed by RNA catalysts and not by protein enzyme.
(ii) DNA has evolved from RNA with chemical modifications that make it more stable because RNA being a catalyst was reactive and hence, unstable.

Types of RNA

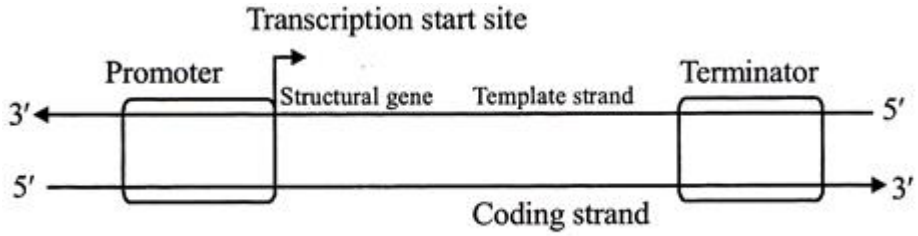
There are following three types of RNAs:

(i) mRNA (messenger RNA) provides the template for transcription.
(ii) tRNA (transfer RNA) brings amino acids and reads the genetic code.
(iii) rRNA (ribosomal RNA) plays structural and catalytic role during translation.
All the three RNAs are needed to synthesise a protein in a cell.

Transcription:

- Transcription is the process of copying genetic information from one strand of the DNA into RNA.
- The principle of complementarity governs the process of transcription, except the adenosine now forms base pair with uracil instead of thymine.
- In transcription, only a segment of DNA is duplicated. Only one of the strands is copied into RNA. Both the strands are not copied because if both the strands code for RNA, two different RNA molecules and two different proteins would be formed, hence complicating the genetic information transfer machinery.
- Since two RNA produced would be complementary to each other, they would form a double-stranded RNA without translation, making the process of transcription futile.

Transcription Unit



Schematic structure of a transcription unit

A transcription unit in DNA is defined by three regions in the DNA which are as follows:
(a) A promoter
(b) The structural gene
(c) A terminator

- The two strands of DNA have opposite polarity and the **DNA-dependent RNA polymerase** also catalyse the polymerisation in only one direction that is 5′ ---------» 3′.
- The strand that has the polarity 3′-------» 5′ acts as a template and is referred to as **template strand.** The other strand which has the polarity (5′ ------> 3′) and the sequence same as RNA (T at the place of U) is displaced during transcription. This strand is called as **coding strand**.

3′-ATGCATGCATGCATGCATGCATGC-5′ Template Strand

5′-TACGTACGTACGTACGTACGTACG-3′ Coding Strand

- The promoter and terminator flank the structural gene in a transcription unit.
- The promoter is located towards 5′ end (**upstream**) of the structural gene.
- It is the DNA sequence that provides binding site for RNA polymerase and the presence of promoter defines the template and coding strands.
- By switching its position with terminator, the definition of coding and template strands could be reversed.
- The terminator is located towards 3'-end (**downstream**) of the coding strand and it usually defines the end of the process of transcription.
- There are additional regulatory sequences that may be present further upstream or downstream to the promoter.

TRANSCRIPTION IN PROKARYOTES

A single DNA-dependent RNA polymerase catalyses the transcription of all types of RNA in bacteria. It has three steps: **initiation, elongation, and termination.** RNA polymerase is only capable of catalysing the process of elongation.
It associates transiently with **initiation-factor (σ)** and **terminator factor (ρ)**, to initiate and terminate the transcription, respectively. Thus, catalysing all the three steps.

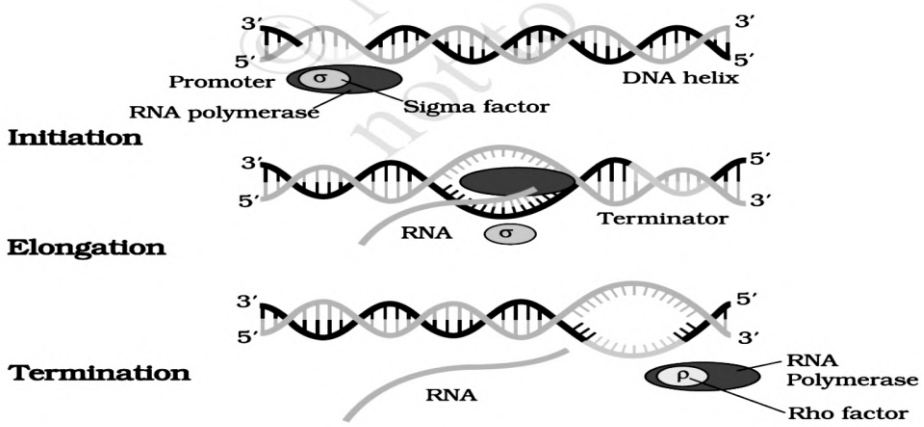


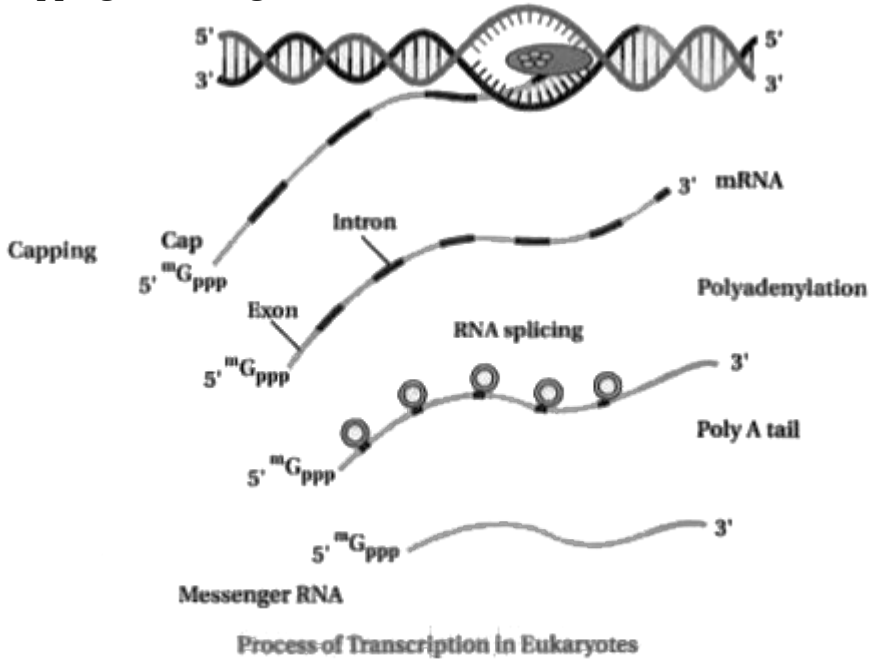
Figure 6.10 Process of Transcription in Bacteria

(Courtesy:NCERT)

TRANSCRIPTION IN EUKARYOTES

There are at least three RNA polymerases in the nucleus other than the RNA polymerase in organelles. The **RNA polymerase I** transcribes rRNAs (28S, 18S and 5.8S). **RNA polymerase III** is responsible for transcription of tRNA, 5srRNA and SnRNAs (small nuclear RNAs). **RNA polymerase II** transcribes precursor of mRNA, the heterogeneous nuclear RNA (hnRNA). Another complexity is that, the primary transcripts contain both the **exons** and the **introns** and are non-functional. Hence, subject to a process called **splicing**. In this process, introns are

removed and exons are joined in a definite order. hnRNA undergoes additional processing called as **capping** and **tailing**.



Process of Transcription in Eukaryotes

Genetic Code

- There are a total of 64 codons, of which 61 code for amino acids
- 3 codons do not code for any amino acids, they are called **stop codons-** UAA, UAG, UGA
- **AUG** is the **start codon** as well as codes for the amino acid methionine.

Genetic Mutation

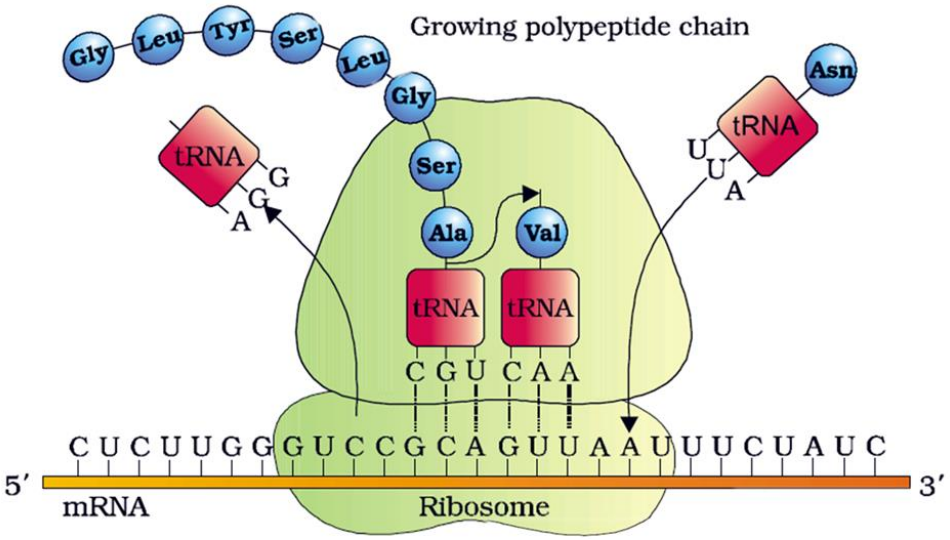
- **Point Mutation:** Change of single base pair results in the point mutation, e.g. **Sickle cell anaemia** is a result of a point mutation in the gene coding for the β-globin chain. As a result Glutamate in the normal protein gets converted to Valine in the sickle cell
- **Frameshift Mutation:** When there is loss or gain of one or two base pairs, it changes the reading frame at the point of insertion or deletion resulting in the frameshift mutation

Translation

- The translation is the process of amino acid polymerisation. Amino acids are joined by peptide bonds.
- All three RNAs have a different role in the process of translation
    1. **mRNA-** provides the template**.** The sequence of amino acids in a polypeptide chain is determined by the sequence of bases present in mRNA
    2. **tRNA-** acts as an **adapter,** it brings amino acids and reads the genetic code
    3. **rRNA-** performs a structural and catalytic role

- The first step in the process of translation is **aminoacylation of tRNA** (charging of tRNA).
- Ribosomes are a protein manufacturing factory.

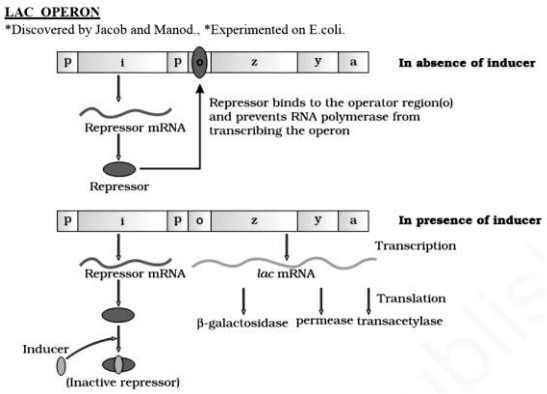
- mRNA to protein translation begins with the presence of mRNA in the small subunit of ribosomes.
- The process of translation is always in 5'→3' direction
- Peptide bond formation occurs between two amino acids present on tRNAs in close vicinity.



- **Untranslated regions (UTRs)-** UTRs are present before the start codon, i.e. at 5' end and after the stop codon, i.e. towards 3' end. They are not translated but they make the translation process efficient.
- The **Release factor** binds to the stop codon at the end terminating the process. The polypeptide gets released from the ribosome.

Regulation of Gene Expression

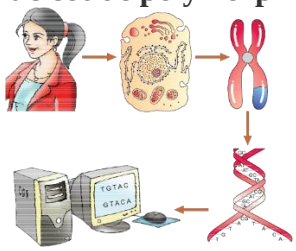
- In prokaryotes, control of gene expression is mainly at the initiation of transcription.
- The accessibility of the promoter region is regulated by an operator sequence adjacent to it, which binds with the specific protein, mostly a repressor.
- In each operon, there is a specific operator and repressor protein.



HUMAN GENOME PROJECT

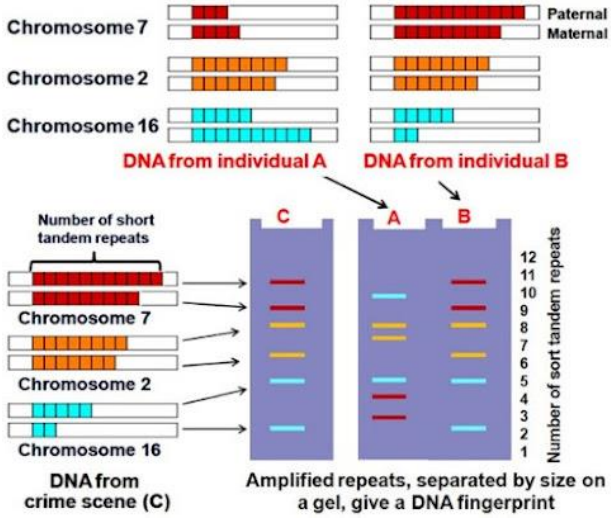
- Human genome project (HGP) was launched in 1990 to decipher the complete DNA sequence of the human genome.

- Some of the key findings of HGP are:
  i. The human genome has 3164.7 million base-pairs (bp).
  ii. Total ~30,000 genes are present with an average of 3000 bases per gene
  iii. **Dystrophin** gene is the largest human gene having 2.4 million bases
  iv. 99.9 % of nucleotides are the same in all people
  v. Only 2 % of genome codes for proteins
  vi. Most genes are found on chromosome 1, i.e. 2968
  vii. Least genes are found on the Y chromosome, i.e. 231
  viii. There are around 1.4 million locations, where there is a single base difference in DNA, it is called **single nucleotide polymorphism- SNPs** (snips)



DNA FINGERPRINTING

- **Alec Jeffrey** initially developed the DNA fingerprinting techniques and named it as **VNTR (Variable Number of Tandem Repeats).**
- DNA fingerprinting involves identifying the difference between two DNA molecules at the specific regions where the sequence is repeated many times called **repetitive DNA.**
- These repetitive DNAs make a small peak during density gradient centrifugation and known as **satellite DNA.**
- A high degree of polymorphism present in these sequences is the basis of DNA fingerprinting
- DNA fingerprinting is used for: -
  i. Paternity test as this polymorphism is inherited to the child
  ii. It has been widely used in forensic science.
  iii. DNA fingerprinting can be used in determining genetic diversity existing in a population.



KEY WORDS & CONCEPTS

• Transformation: change in the genetic constituent of an organism by picking up genes present in the remains of its relatives.

• Gene can be defined as the functional unit of inheritance.

• Cistron is a segment of DNA coding for a polypeptide.

• Monocistronic: The structural gene in a transcription unit could be said as monocistronic (mostly in eukaryotes) or polycistronic (mostly in bacteria or prokaryotes)

QUESTION BANK WITH THEIR ANSWER

MULTIPLE CHOICE QUESTION (MCQ)

1. Sickle cell anaemia is caused

a. When valine is replaced by glutamic acid in beta polypeptide chain
b. When glutamic acid is replaced by valine in beta polypeptide chain
c. When glutamic acid is replaced by valine in alpha polypeptide chain
d. When valine is replaced by glutamic acid in alpha polypeptide chain

Ans.b

2. Match the names of scientists in column I with their achievements in column II and choose the correct answer given below

Column I	Column II
A) Watson and Crick	P) DNA fingerprinting
B) R. W. Holley	Q) Decipher genetic code
C) Marshal Nirenberg	R) Double helix of DNA
D) Jacob and Monod	S) Clover model of tRNA
E) Alec Jeffrey	T) Lac operon concept

	(A)	(B)	(C)	(D)	(E)
a.	R	S	P	T	Q
b.	R	S	Q	T	P
c.	R	Q	P	T	S
d.	R	T	S	P	Q

Ans. B

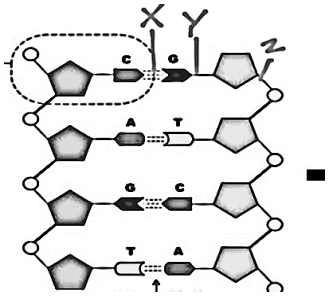
3. Match the entries in column I with those of column II and choose the correct answer.

Column I	Column II
A) Alkali treatment	M) separation of DNA fragments on gel slab
B) Southern blotting	N) split DNA fragments into single strands
C) Electrophoresis	O) DNA transferred to nitrocellulose sheet
D) PCR	P) X-ray photography
E) Autoradiography	Q) produce fragments of different sizes
F) DNA treated with REN	R) DNA amplification

a) A - N, B- Q, C- P, D- R, E- M, F - O
b) A - P, B - R, C - M, D -O, E - N, F – Q
c) A - Q, B - O, C - M, D - R, E - P, F - N
d) A - N, B - O, C - M, D - R, E - P, F – Q

Ans.d

4. Figure A shows the structure of polynucleotide chain, identify the types of bond shown by X, Y, Z and choose correct option from the table below.



	X	Y	Z
A	Hydrogen Bond	Glycosidic linkage	Phosphodiester linkage
B	Hydrogen Bond	Phosphoester linkage	Glycosidic linkage
C	Hydrogen Bond	Glycosidic linkage	Phosphoester linkage
D	Glycosidic linkage	Hydrogen Bond	Phosphoester linkage

Ans-C

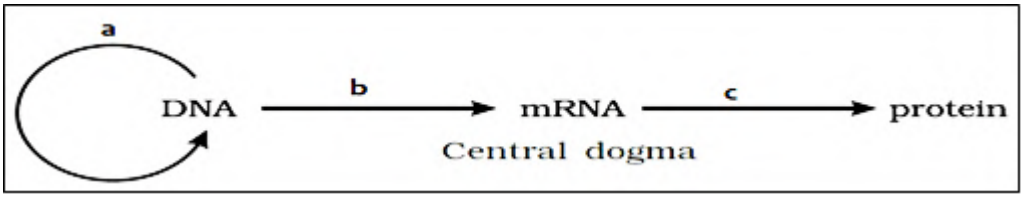
5. DNA replication requires various enzymes, table represent enzyme and function, choose the function of respective enzyme.

		X	Y	Z	W
(i)	Helicase	Breakdown of H bond	Joining DNA fragments	Formation of RNA primer	Joining DNA fragments
(ii)	DNA polymerase	Polymerization of nucleotides	Polymerization of nucleotides	Polymerization of nucleotides	Polymerization of nucleotides
(iii)	Ligase	Joining DNA fragments	Formation of RNA primer	Joining DNA fragments	Breakdown of H bond
(iv)	Primase	Formation of RNA primer	Breakdown of H bond	Breakdown of H bond	Formation of RNA primer

a) X
b) Y
c) Z
d) W

Ans-A

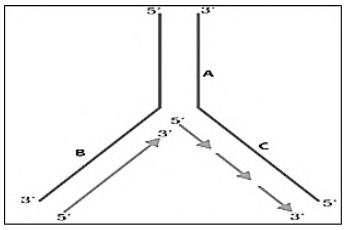
6. Identify ‘a’, ‘b’ and ‘c’ from the given figure.



a) a-Replication, b-Translation, c-Transcription
b) a-Reverse Transcription, b-Replication, c-Translation
c) a-Replication, b-Transcription, c-Translation
d) a-Translation, b-Replication, c-Transcription

Ans-C

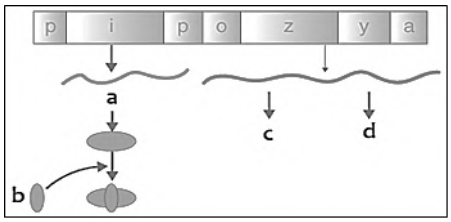
7. Identify 'A', 'B' and 'C' from the given figure.



a) A-Discontinuous strand, B-Continuous strand, C-Template strand
b) A-Template strand, B- Discontinuous strand, C-Lagging strand
c) A-Parental strand, B-Leading strand, C-Lagging strand
d) All of these.

Ans-C

8. Identify 'a', 'b', 'c' and 'd' from the given figure.



a) a-Repressor protein, b-Inducer, c- permease, d- β-galactosidase
b) a-Repressor mRNA, b-Inducer, c-β-galactosidase, d-permease
c) a-Repressor mRNA, b- permease, c- Inducer, d- β-galactosidase
d) a-Repressor mRNA, b-Inducer, c-β-galactosidase, d-transacetylase

Ans-D

ASSERTION REASON

DIRECTION- Choose correct option from given below:
A) Both assertion and reason are true and reason is a correct explanation of the assertion.
B) Both assertion and reason are true but the reason is not the correct explanation of assertion.
C) If the assertion is true but the reason is false.
D) If both assertion and reason are false.
14 Assertion: HGP is closely associated with the rapid development of a new area in biology called Bioinformatics.

Reason: Bioinformatics uses high speed computational devices for data storage, retrieval and analysis of enormous amount of data generated from HGP.

Answer: B

44 Assertion (A): Replication and transcription occur in the nucleus but translation takes place in the cytoplasm

Reason (R): mRNA is transferred from the nucleus into cytoplasm where ribosomes and amino acids are available for protein synthesis.

Answer: A

CASE BASED QUESTIONS

The Intelligent Design

In September 2013, intelligence agencies raided a house in Zephyr Heights in Mangaluru in search of the alleged bombers of Hyderabad Twin blasts, but found it empty. A forensic team picked up DNA samples from the house, and when the accused were finally caught, the samples matched with theirs. It helped NIA secure convictions for all five accused.

(i) Identify the phenomenon mentioned above:

A) NIA raid
B) Escape of suspects
C) DNA fingerprinting
D) None of these

(ii) DNA profiling was initially developed by _____.

A) Alec Jeffreys
B) James Watson
C) Francis Crick
D) Matthew Meselson.

(iii) Select the correct sequence of the process used to identify DNA samples:

A) DNA isolation > Hybridisation using labelled VNTR probe > Gel electrophoresis > Southern blotting > Digestion of DNA > Autoradiography.
B) DNA isolation > Digestion of DNA >Southern blotting >Gel electrophoresis > Hybridisation using labelled VNTR probe >Autoradiography.
C) DNA isolation >Autoradiography >Digestion of DNA >Gel electrophoresis >Southern blotting >Hybridisation using labelled VNTR probe
D) DNA isolation >Digestion of DNA >Gel electrophoresis >Southern blotting >Hybridisation using labelled VNTR probe >Autoradiography.

(iv) Assertion: polymorphism in DNA sequence is the basis of DNA fingerprinting technology.

Reason: If more than one variant (allele) at a locus occurs in human population with a frequency greater than 0.01 is called DNA polymorphism.

A) Both assertion and reason are true and reason is correct explanation of assertion.
B) Assertion and reason both are true but reason is not the correct explanation of assertion.
C) Assertion is true, reason is false.
D) Assertion is false, reason is true.

Answer: (i) C (ii) A (iii) B (iv) B

SHORT ANSWER TYPE QUESTIONS (2 MARK)

1.What do you mean by the central dogma? Who proposed it?

Ans. Schematic Diagram 2.Francis Crick

2. Write two chemical differences between the DNA and RNA.

Ans. Chemical name , number of helix

3. What is the role operator gene in lac operon?

Ans. Contain the code necessary to begin the process of transcription.

4. What do you mean by the satellite DNA? How it is useful in DNA finger printing?

Ans. Highly repetitive DNA consisting of short sequences repeated a large number of times

(a) Forensic Analyses on Animals

(b) Paternity Testing

5. What do you mean by the DNA polymorphism? What is its application?

Ans. **Sequence variation if more than one variant (allele) at a locus occurs in human population with a frequency greater than 0.01.**

Satellite DNA as probe that shows very high degree of polymorphism(variation) to compare.

6. What are the common functions performed by RNA

Ans.messenger,adaptor,structural component of ribosome, catalyst

7. What are 5' end and 3'end of DNA?

Ans. **"5 prime end" has a phosphate on a 5' carbon and the "3 prime end" has a free hydroxyl on a 3' carbon (carbon atoms in the sugar ring are numbered from 1' to 5';).**

8. How do histone acquire positive charge?

Ans. They contain a very high amount of positively charged amino acids such as lysines and arginines.

9. Expand SNPs. What are they?

Ans. SNPs - Single nucleotide polymorphisms.

These are locations on DNA, where single base differences are observed.

10.If the length of E.Coli DNA is 1.36 mm, Calculate the number of base pairs it contains.

Ans. The distance between two adjacent bp = 0.34 x 10-9 m length = Total no. of bp x distance between two bp.

No. of bp. = 1.36 x 10-3 /0.34x 10-9 = 4 x 106 bp

11. Why it is that transcription & translation could be coupled in prokaryotic cell but not in eukaryotic cell?

Ans. Prokaryotic polycistronic eukaryotes mRNA need processing

12.Why is DNA & not RNA is the genetic material in majority of organisms?
Ans.The -OH group in the nucleotides of RNA is much more reactive & makes RNA labile & easily degradable .

13.Give two reasons why both the strands are not copied during transcription?
Ans.i) If both the strands codes for RNA, two different RNA molecules & two different proteins areformed hence genetic machinery would be complicated.
ii)Since two RNA molecules produced would be complementary to each other, they would wind together to form ds-RNA.

SHORT ANSWER TYPE QUESTION (3 MARKS)

Q 1. Following are the features of genetic code. What does each one indicate? Stop codon, Unambiguous codon, Degenerate codon and Universal codon.

Ans 1. Stop codon: Codons that cause termination of protein synthesis and do not code for any amino acid; Example: UAA (ochre), UGA (opal) and UAG (amber).

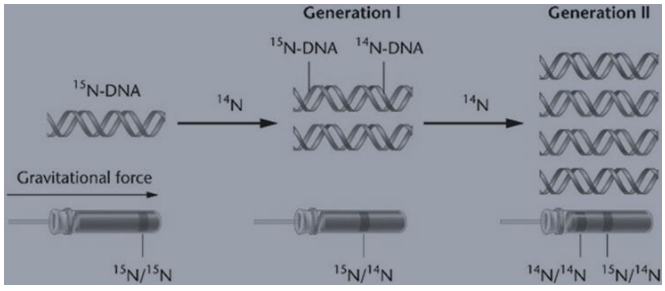
Unambiguous codon: one codon for one amino acid only; Example: GAA codes for glutamine only.

Degenerate codon: multiple codons specify single amino acid; Example: UUU and UUC code for phenylalanine.

Universal codon: a particular codon specifies a particular amino acid in all the organisms. The mRNA codon "ACU" codes for threonine, irrespective of its source.

Question 2. Describe Meselson and Stahl's experiment that was carried in 1958 on E. coli. Write the conclusion they arrived at after the experiment.

Ans 2.



Observation and conclusion: Since E coli cell takes 20 min to complete one round of cell cycle, the DNA extracted after 20 min had a hybrid density while that extracted after 40 min exhibited equal amounts of hybrid and light density;

it was concluded that each new DNA molecule has one parental and one new strand i.e. the semi conservative mode of replication.

3. Write the basic difference between the Replication and Transcription.

Replication	Transcription
1. It is the process of formation of two copies of DNA molecules. Entire genomic DNA is copied.	1. Only a segment of DNA is copied to RNA.
2. It is the synthesis or formation of DNA from DNA.	2. It is the synthesis of RNA from DNA.
3. Both the strands of DNA take part in replication.	3. Only one strand of DNA acts as a template strand and gets transcribed to RNA.
4. Nitrogenous bases found in DNA polynucleotide chains are adenine, thymine, guanine and cytosine.	4. Nitrogenous bases found in RNA polynucleotide chains are adenine, uracil, guanine and cytosine.
5. It is catalysed by DNA dependent DNA polymerase enzymes.	5. It is catalysed by DNA dependent RNA polymerase enzymes.

4. What are the goals of the Human genome project?

Ans . Optimization of the data analysis. Sequencing the entire genome. Identification of the complete human genome. Creating genome sequence databases to store the data. Taking care of the legal, ethical and social issues that the project may pose.

5. What do you mean by the BAC and YAC? How they are useful in Human genome project?

Ans. YAC stands for Yeast Artificial Chromosome and BAC stands for Bacterial artificial chromosome.

YAC and BAC being artificial chromosomes were utilized for cloning large sections of the human genome within them. This enabled researchers to identify the start and end points for that particular section of the human DNA.

6. The base sequence on one strand of DNA is ATGTCTATA

(i) Give the base sequence of its complementary strand.

(ii) If an RNA strand is transcribed from this strand what would be the base sequence of RNA?

(iii)What holds these base pairs together?

Ans. (i) TACAGATAT. (ii) UACAGAUAU

(iii) Hydrogen bonds hold these base pairs together. Adenine & thymine are bounded by two hydrogen bonds & cytosine & Guanine are bonded by three hydrogen bonds.

7. A tRNA is charged with amino acid methionine.

i) At what site in the ribosome will the tRNA bind?

ii) Give the anticodon of this tRNA?

iii) What is the mRNA codon for methionine?

iv) Name the enzyme responsible for this binding?

Ans. (i) P- site (ii) UAC (iii) AUG (iv) Amino acyl tRNASynthetase

8. The DNA packaging in eukaryotes is carried out with the help of lysine and arginine rich basic proteins called histamine. The unit of compaction is nucleosome.

(a) What would happen if histones were to be mutated and made rich in aspartic acid and glutamic acid in place of basic amino acids such as lysine and arginine?

(b) What is the role of non-histone chromosomal proteins in DNA packing?

Ans. (a) If histone proteins were rich in acidic amino acids instead of basic amino acids then they may not have any role in DNA packaging in eukaryotes as DNA is also negatively charged molecule. The packaging of DNA around the nucleosome would not happen. Consequently, the 81 chromatin fibre would not be formed.

(b) The packaging of chromatin at higher level requires non-histone chromosomal proteins (NHC)

LONG ANSWER TYPE QUESTIONS (5 MARKS)

1. Answer the following question regarding Griffith experiment

(a) Name the bacteria with which the experiment has done.

(b) What do you mean by the R-Strain and S-Strain?

(c) Did the mice developed the disease when he injected the heat killed S Strain to the mice?

(d) Among the two strains which one is Virulent??

(e) What was the finding of his experiment?

Ans. (a) *Streptococcus pneumonia* (b) Rough & Smooth strain

(c) No Mice Live (d) Smooth

(e) Transforming principle is transferred from heat killed S strain has enabled the R strain to synthesize a smooth polysaccharide coat and become virulent.

2. When did replication takes place in eukaryotic cell? Describe briefly the mechanism of DNA replication.

Ans. Synthetic Phase of Cell division

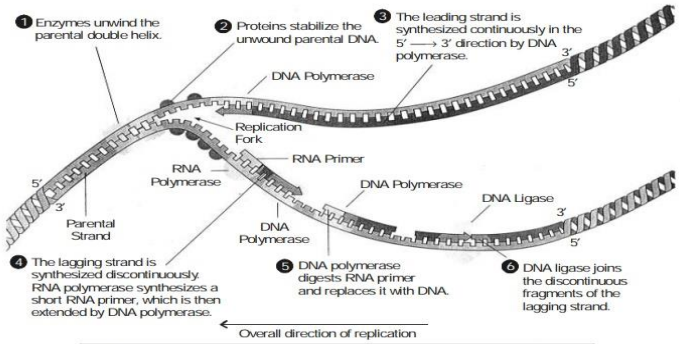
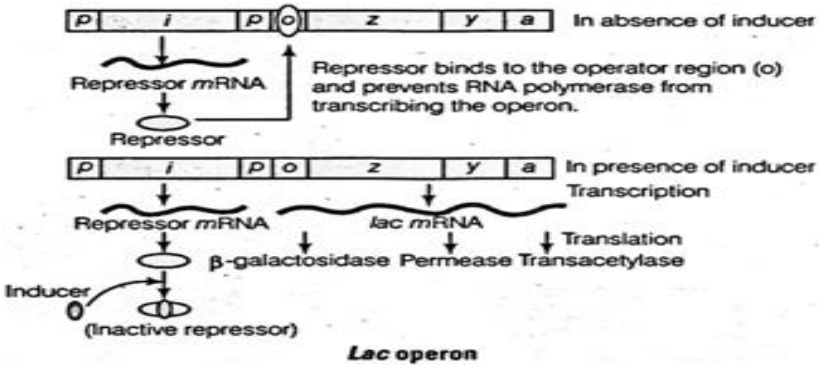


Fig. 6.2. Summarized Sequel of Events at the Replication Fork

3. What are different component of the lac operon? Describe the mechanism of

regulation of the lac operon.

Ans.The lac operon consists of 3 structural genes, and a promoter, a terminator, regulator, and an operator.



Lac operon

4. (a) Explain the process of amino acylation of tRNA. Mention its role in translation.

(b) How do ribosomes in the cells act as factories for protein synthesis?

Ans. (a)Amino Acid + ATP + tRNA → Aminoacyl-tRNA + AMP + PP.

This is an essential step as only activated amino acids are carried to the site of protein synthesis by their respective tRNA.

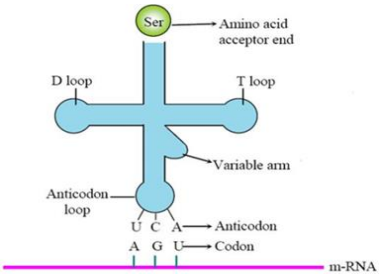
(b) By translating the genetic code transcribed in mRNA into an amino acid sequence. Ribosomes use cellular accessory proteins, soluble transfer RNAs, and metabolic energy to accomplish the initiation, elongation, and termination of peptide synthesis

5. (a) Describe the structure and function of a t-RNA molecule. Why is it referred to as an adapter molecule?

(b) Explain the process of splicing of hn-RNA in a eukaryotic cell.

a) t-RNA (transfer RNA) reads the genetic code on one hand & transfers amino acids on the other hand, so it is called as adapter molecule by Francis Crick.

Structure of t-RNA:



Secondary structure of t-RNA is clover leaf like but the 3-D structure is inverted L-shaped.

t-RNA has five arms or loops

(i) Anticodon loop has bases complementary to the code.

(ii) Amino acid has an acceptor end to which amino acid binds.

(iii) T-loop help in binding to ribosome.

(iv) D-loop help in binding amino acyl synthetase.

(v) Variable loop has no known function.

The function of tRNA is to align the required amino acids according to the nucleotide sequence ofmRNA.

tRNA is also called the adapter molecule because on one hand it can read the code and on the other hand it can bind to specific amino acid. It acts as intermediate molecule between triplet code ofmRNA and amino acid sequence of polypeptide chain.

6.A DNA segment has a total of 1000 nucleotides, out of which 240 of them are adenine containing nucleotides. How many pyrimidine bases this DNA segment possesses?

Or

A DNA segment has a total of 1500 nucleotides, out of which 410 are guanine containing nucleotides. How many pyrimidine bases this segment possesses?

Or

A DNA segment has a total of 2000 nucleotides, out of which 520 are adenine containing nucleotides. How many purine bases this DNA segment possesses?

Answer:

According to Chargaff's rule, ratio of purines to pyrimidines is equal,

i.e. A + G = C + T

The number of adenine (A) is equal to the number of thymine (T). A = 240(given)

Therefore, T = 240

Also, the number of guanine (G) is equal to cytosine (C). Thus, G + C = 1000 – [A + T]

G + C = 1000 – 480= 520 Hence, G = 260, C = 260

The number of pyrimidine bases, i.e. C + T= 240 + 260 = 500

Or

(i) Given, G = 410 therefore, C = 410 A + T = 1500 – (G + C)

= 1500 – 820 = 680

Hence, A = 340; T = 340

The number of pyrimidine bases, i.e. C + T = 410 + 340 = 750

Or

(i) Given, A = 520 therefore, T = 520

A + T = 520 + 520 = 1040

Total number of nucleotides = 2000

G + C = 2000 – 1040 = 960 G = 960/2 = 450

Hence, total number of purine bases are

⇒ A + G = 520 + 480 = 1000

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CHAPTER 7: EVOLUTION

KEY WORDS AND CONCEPTS:

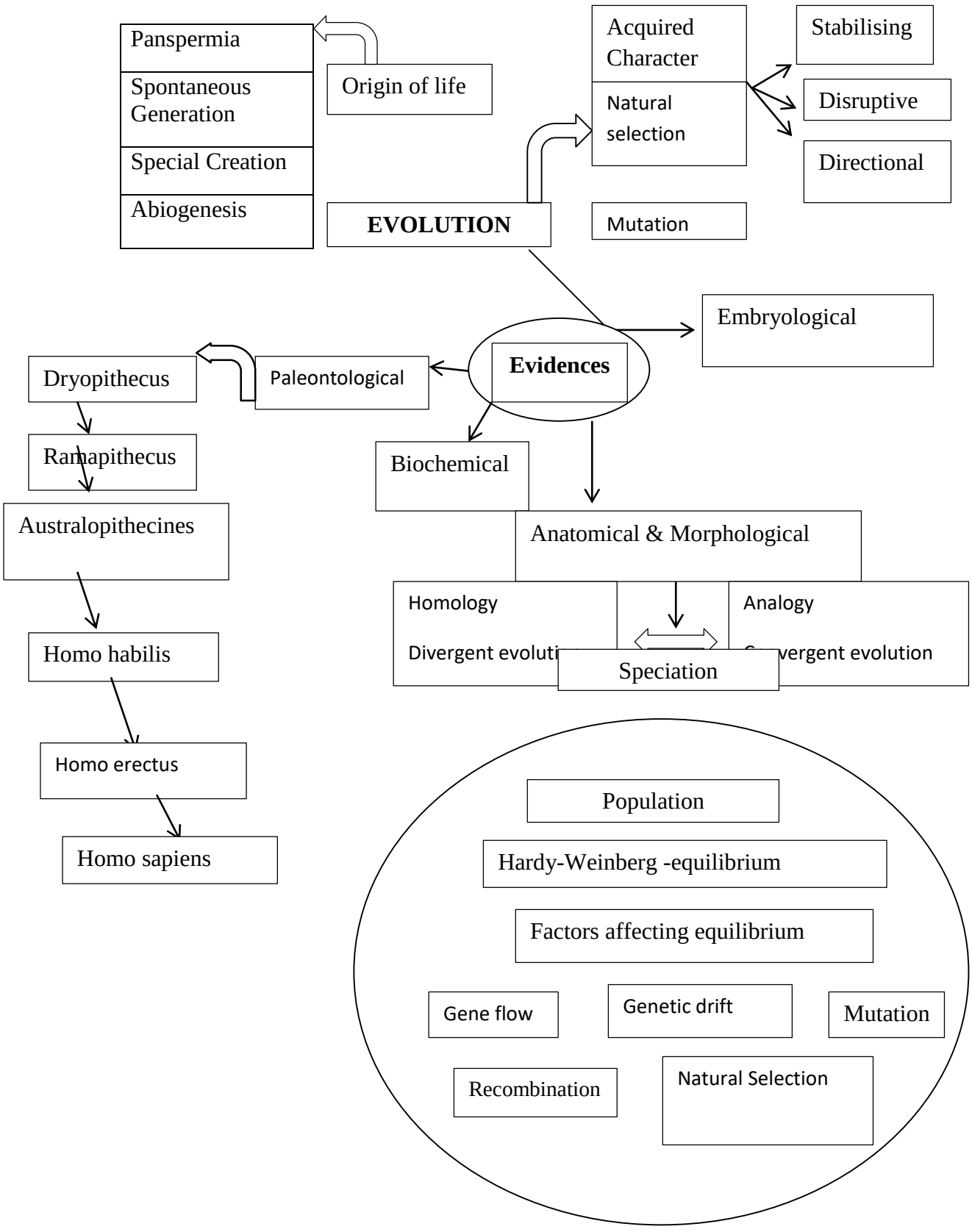
KEY WORDS	CONCEPTS
Fossils	Remains of hard parts of life-forms found in rocks. indicates the geological period and history of earth in which they existed.
Paleontology	Systematic and scientific study of fossils.
Paleontological evidence.	New forms of life have arisen at different times in the history of earth. All this is called paleontological evidence
Embryological support for evolution	Proposed by Ernst Heckel based upon the observation of certain features during embryonic stage common to all vertebrates that are absent in adult.
Homologous	Organs with similar origin and structure (SOS) but differ in appearance and function (DAF).E.g. Forelimbs of bat, whale, cheetah, horse and human beings.
Divergent evolution	Due to adaptations to different needs the same structure developed along different directions.
Analogous	Organs with similar appearance and function (SAF) but differ in origin and structure (DOS).E.g. Wings of butterfly and of bird/ bat.
Convergent evolution	Different structures evolving for the same function and hence having similarity
Biogenesis	Life originates from pre-existing life
Biochemical evidence	Similarities in proteins and genes performing a given function among diverse organisms give clues to common ancestry.
Industrial melanism	Evolution by natural selection comes from England. In a collection of moths made in 1850s, i.e., before industrialisation set in, there were more white-winged moths on trees than dark-winged or melanised moths. However, in the collection carried out from the same area, but after industrialisation, i.e., in 1920, there were more dark-winged moths in the same area, i.e., the proportion was reversed.
Lichens	Lichens, composed of a fungus in symbiotic union with an alga.
Biogeographical evidence	Species restricted to a region develop unique features. Species present in widely separated regions show similarity of ancestry.
Evolution by anthropogenic action.	Microbes against which we employ antibiotics or drugs against eukaryotic organisms/cell.Resistant organisms/cells are appearing in a time scale of months or years and not centuries
Adaptive radiation	This process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography (habitats)
Natural selection	The process in which heritable variations enabling better survival are enabled to reproduce and leave greater number of progeny.
Branching descent	The process of evolving a new species from a single common ancestor.
Saltation	Single step large mutation in a single leap/saltus.
Hardy-Weinberg principle	The frequency of occurrence of alleles of a gene or a locus. is supposed to remain fixed and even remain the same through generations. it is stated using algebraic equations
Genetic equilibrium	The gene pool (total genes and their alleles in a population) remains a constant.

Gene migration/Gene flow	When individual migrate to another place or population, new genes / alleles are added to new population and are lost from the old population in turn changing the frequencies when gene migration occurs many a time.
Genetic drift	Changes occurring in gene frequencies by chance.
Founder effect	The effect -Sometimes the change in allele frequency is so different in the new sample of population that they become a different species. The original drifted population becomes founders .
Mutation	A change in the DNA sequence of an organism.
Genetic recombination	The rearrangement of DNA sequences by the breakage and rejoining of chromosomes or chromosome segments.
Speciation	Creation of a new kind of plant or animal species.
Stabilizing-natural selection	More individuals acquire mean character value.
Directional change	More individuals acquire value other than the mean character value
Disruption	More individuals acquire peripheral character value at both ends of the distribution curve
Dryopithecus	Primates existing about 15 mya. They were hairy and walked like gorillas and chimpanzees. was more ape-like.
Ramapithecus	Primates existing about 15 mya. hairy and walked like gorillas and chimpanzees. more man-like
Neanderthal man	With a brain size of 1400cc lived in near east and central Asia between 1,00,000-40,000 years back. They used hides to protect their body and buried their dead.
Homo sapiens	Arose during ice age between 75,000-10,000 years ago in Africa and moved across continents and developed into distinct races.

Origin of life:

Scientist	**Year**	**Theory/ Experiment**	**Conclusion**
Lemaitre	1972	The Big Bang theory	Explaining the origin of universe. It talks of a singular huge explosion unimaginable in physical terms. The universe expanded from explosion of a primordial, hot substance
Oparin and Haldane	1924-1929	Chemical evolution proceeds organic evolution	The first form of life could have come from pre-existing non-living organic molecules (e.g. RNA, protein, etc.)
Stanley Miller and Harold C. Urey	1953	Synthesis of biomolecules by creation of similar conditions as primitive atmosphere on laboratory scale	Amino acids were synthesized from ammonia, methane and Carbon di oxide inside specialized apparatus

CONCEPT MAPS:



FIGURES

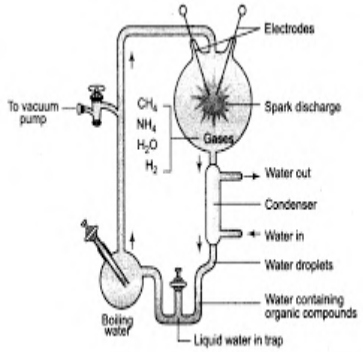


Figure 6.1 Diagrammatic representation of Miller's experiment

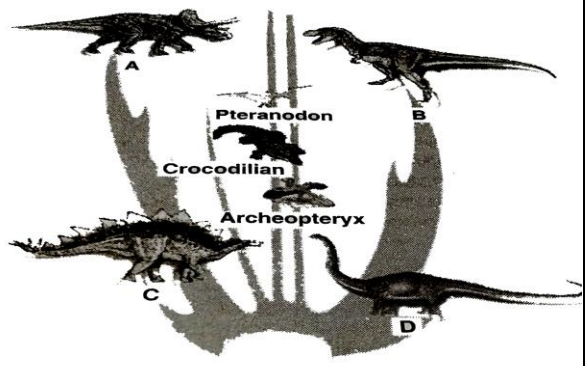


Figure 6.2 A family tree of dinosaurs and their living modern day counterpart organisms like crocodiles and birds

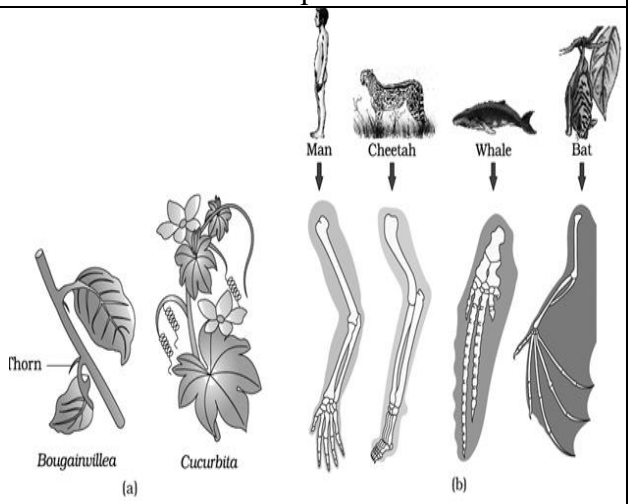


Figure 6.3 Example of homologous organs in (a) Plants and (b) Animals

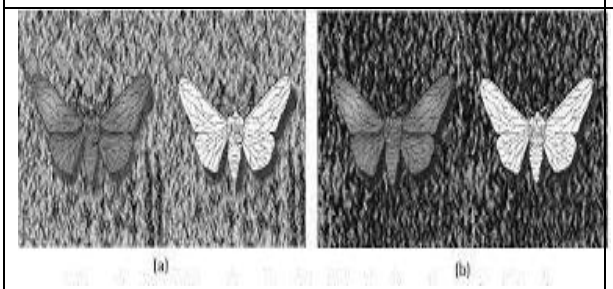


Figure 6.4 Figure showing white - winged moth and dark - winged moth (melanised) on a tree trunk (a) In unpolluted area (b) In polluted area

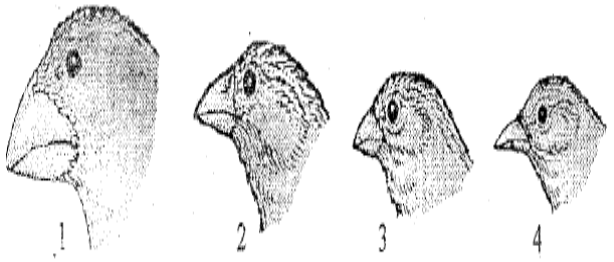


Figure 6.5 Variety of beaks of finches that Darwin found in Galapagos Island

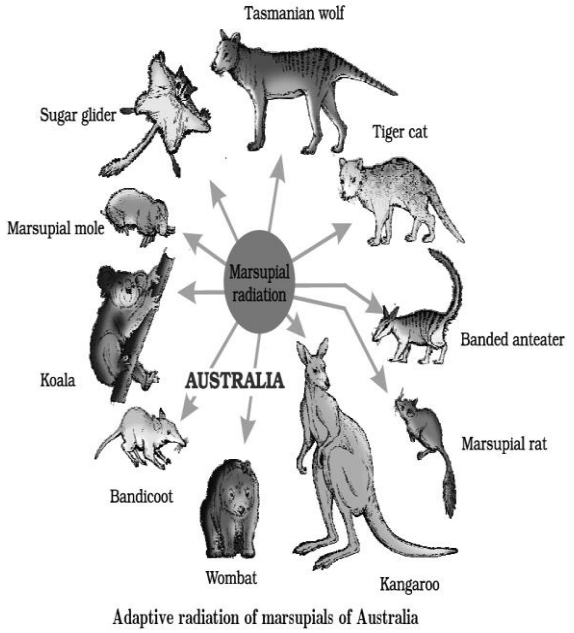


Figure 6.6 Adaptive radiation of marsupials of Australia

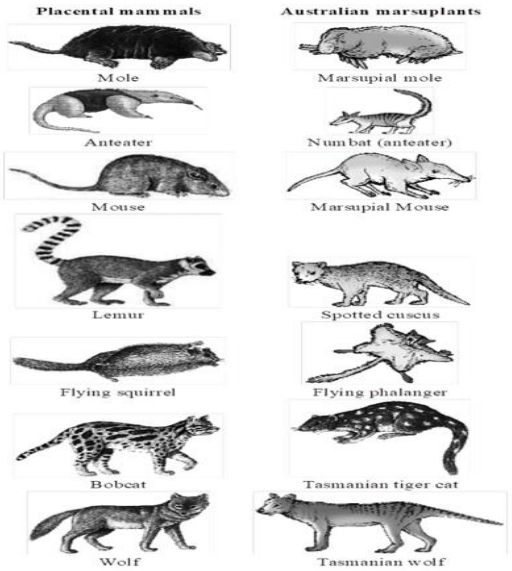


Figure 6.7 Picture showing convergent evolution of Australian Marsupials and placental mammals

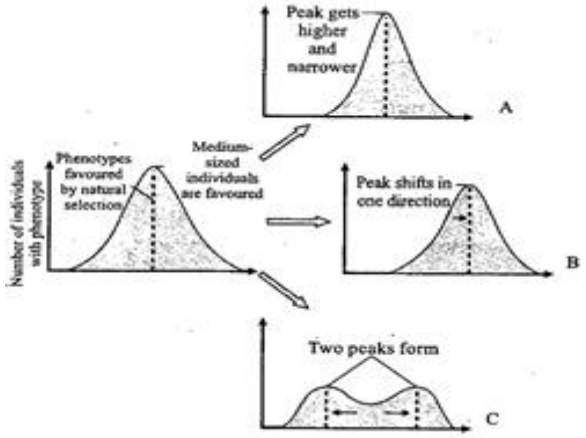


Figure 6.8 Diagrammatic representation of the operation of natural selection on different traits : (a) Stabilising (b) Directional and (c) Disruptive

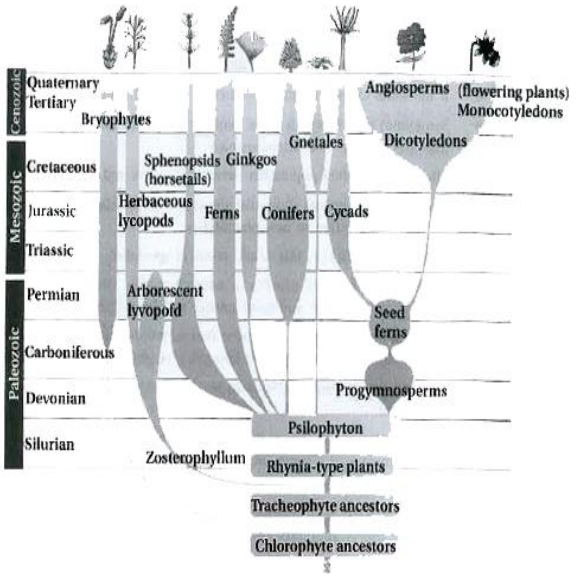


Figure 6.9 A sketch of the evolution of plant forms through geological periods

MULTIPLE CHOICE QUESTIONS (1 MARKS):

Sl no	Questions: **1 mark each**
1	The theory of spontaneous generation started that (a)life arose from living forms only. (b)life can arise from both living and non living. (c) life arose from non-living things only. (d) life arises spontaneously neither from living nor non-living.
2	The fitness according to Darwin , refers ultimately and only to: (a)physical fitness (b) reproductive fitness (c)chemical fitness (d) none of the above
3	Paleontological evidences for evolution refer to the (a)development of embryo (b)homologous organs (c)fossils (d)analogous organs
4	Darwin's finches are excellent example of (a)brood parasitism (b)connecting link (c) adaptive radiation (d) seasonal migration

5	Choose the correct answers from the alternatives given. Darwin believed that a giraffe has a long neck because (a). God designed it that way. (b). Catastrophes eliminated short-necked forms. (c). Its ancestors stretched their necks to get food. (d). Ancestral giraffes with slightly longer necks got more food than others and left more surviving offspring.
6	Single step large mutation is called (a)speciation (b) saltation (c) mutation (d)genetic drift
7	Which is the correct formula of hardy –Weinberg Principle? (a)$p^2+pq+q^2=0$ (b) $p^2+pq+q^2=1$ (c) $p^2+pq+q^2=$infinity (d) $p^2+2pq+q^2=1$
8	Which of the following is an example for link species? (a)Lobefin (b)Dodo bird (c)Sea weed (d)Chimpanzee
9	The Neanderthal man having a brain size around (a)600 cc (b) 700 cc (c)800 cc (d)1400 cc
10	Evolution of life shows that life forms had a trend of moving from (a)Land to water (b)dry land to wet land (c)fresh water to sea water (d)water to land
11	'Those who are better fit in an environment, leave more progeny than others. They will survive more and hence are selected by nature'. What is it called? (a)natural selection (b) adaptive radiation (c) physical fitness (d)chemical evolution
12	The bones of forelimbs of whale,bat,cheetah and man are similar in structure because (a)One organism has given rise to another (b)they share a common ancestors (c)they perform the same function(d)they have biochemical similarities
13	When more than one adaptive radiation appeared to have occurred in an isolated geographical area(representing different habitats), this is called (a)divergent evolution (b)convergent evolution (c)founder effect (d)mutation
14	The best description of natural selection is (a)the survival of the fittest (b)the struggle for existence (c)the reproductive success of the members of a population (d)a change in the proportion of variation within a population
15	Sometimes the change in allele frequency is so different in the new sample of population that they become a different species. This effect is called (a)stabilizing (b) directional (c) disruptive (d) founder effect
16	Change of frequency of alleles in a population results in evolution. This statement is proposed in (a)darwin's theory (b)Lamark's theory (c)Hardy-Weinberg Principle (d)de Vries theory
17	The biggest dinosaurs was (a)*Tyrannosaurus rex* (b)*Spinosurus sp* (c) *Allosaurus sp* (d)*Triceratops sp*
18	*Ramapitheceus* was more (a)ape-like (b) man- like (c)gorllas –like (d)chimpanzees like
19	The hypothesis that 'Life originated from pre-existing non-living organic molecules was proposed by (a)Oparin and Haldane (b)Louis Pasteur (c)S L Miller (d)Hugo de Vries
20	The geological history of earth closely correlates with the (a)biological history of earth (b)paleontological history (c)geological history (d) none of the above
21	Thorn of Bougainvillea and tendril of Cucurbita are example of (a)vestigial organ (b)retrogressive evolution (c) analogous organ (d)homologous organ
22	The diversity in the type of beak of finches adapted to different feeding habits on the

	Galapagos Islands as observed by Darwin provides evidences for (a)intraspecific variation (b)interspecific variation (c)interspecific competition (d) origin of species by natural selection
23	Darwin was influenced by (a)Thomas Malthus (b) Lamarck (c) hugode Vries (d)Oparin
24	Stabilising selection favours (a)only one extreme form of a trait (b)both the extreme forms of a trait(c) intermediate form of a trait (d)none of these
25	Coelacanths are primitive (a) bony fish (b) cartilaginous fish (c)amphibian (d) reptile
26	Java man was (a)*Homo habilis* (b) *Homo erectus* (c) *Homo sapiens* (d)*Ramapithecus*
27	Which type of selection explains industrial melanism observed in moth, *Biston bitularia*? (a)stabilizing (b)directional (c) disruptive (d)artificial
28	Evolution of different species in a given area starting froma point and spreading to other geographical areas is known as (a) adaptive radiation (b)natural selection (c)migration (d)divergent evolution
29	Variations caused due to mutations are a) random and directionless b) random and directional c) random and small d) random, small and directional
30	A team of archaeologists found a fossilized skeleton of a human-like creature with a brain capacity of more than 700cc. The structure and its associated findings also show evidence that this creature could use tools for hunting. Which stage of human evolution is this creature NOT from? (a) Homo erectus (b) Homo habilis (c) Neanderthal Man (d) Australopithecines

Answers of MCQ

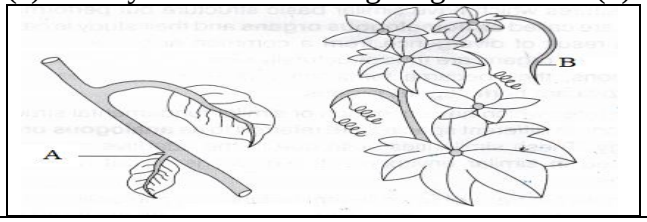
1	2	3	4	5	6	7	8	9	10
C	B	C	C	D	B	D	A	D	D
11	12	13	14	15	16	17	18	19	20
A	B	B	C	D	C	A	B	A	A
21	22	23	24	25	26	27	28	29	30
D	D	A	C	A	B	B	A	B	B

	ASSERTION(A) AND REASON(R)(1 mark each)
	The following Questions consist of two statements –**Assertion(A) and Reason(R).**Answer these questions selecting the appropriate option given below: (a)Both A and R are true and R is the correct explanation of A (b)Both A and R are true and R is not the correct explanation of A (c)A is true but R is false (d)A is false but R is true
1	**Assertion** : Louis Pasteur showed that in flask open to air, new living organisms appeared in the heat killed yeast culture. **Reason:** Life arises from pre-existing life.
2	**Assertion** :Any population has built in variation in characteristics. **Reason:** Those characteristics which enable some to survive better in natural conditions
3	**Assertion** :The eye of the octopus and of mammals show analogy. **Reason**: Analogous organs are anatomically different but functionally similar.
4	**Assertion:** Darwin's finches show a variety of beaks suited for eating large seeds, flying insects and cactus seeds. **Reason:** Ancestral seed-eating stock of Darwin's finches radiated out from South

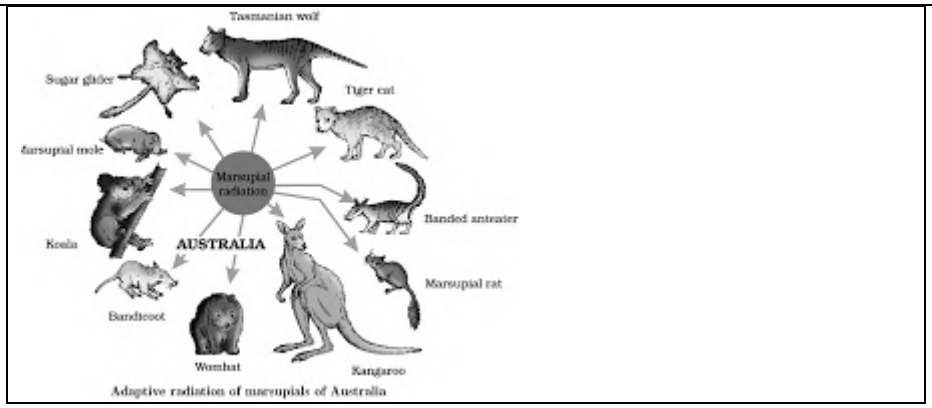
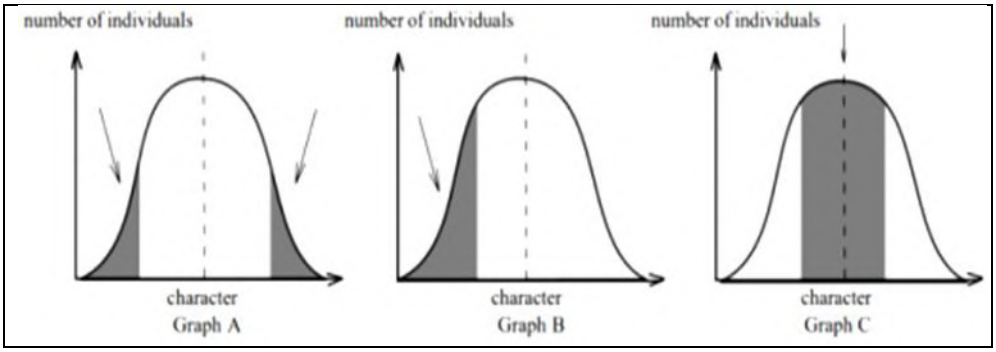
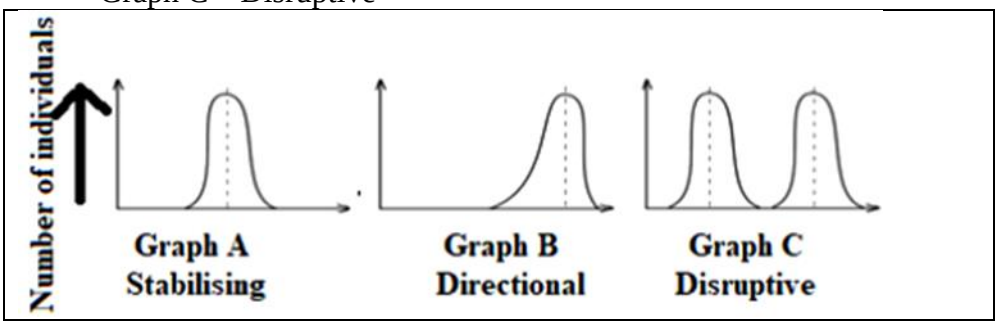
	America main land to different geographical areas of the Galapagos Islands, where they found competitor-free new habitats.
5	**Assertion**: Excessive use of herbicides and pesticides has selected the resistant varieties of microbes. **Reason:** Pathogenic bacteria are appearing in very short period of time because of chemical resistance.
6	**Assertion:** deVries believed mutation caused speciation. **Reason:** Evolution for Darwin was gradual.
7	**Assertion:** Genetic drift refers to changes in allelic frequency. **Reason:** Heritable variations enable survival of the fittest.
8	**Assertion:** The first organisms that invaded land were plants. **Reason:** They were widespread on land when animals invaded land.
9	**Assertion:** Among the primates, chimpanzee is the closest relative of the present day human. **Reason:** DNA matching shows that human similarity is 100%with chimpanzee
10	**Assertion:** Wings of butterfly and birds show analogy**.** **Reason:** Analogous organs are anatomically different but functionally similar.
11	**Assertion:** Disruptive selection changes the population into two or more groups. **Reason:** This type of selection favours average sized individuals.
12	**Assertion:** Hardy Weinberg principle explains the occurrence of variations in population and species. **Reason**: It concludes that disturbances in genetic equilibrium results in evolution.
13	**Assertion:** The number of white winged moths decreased drastically after industrialization in England. **Reason:** Effects of industrialization were more marked in rural areas of England.

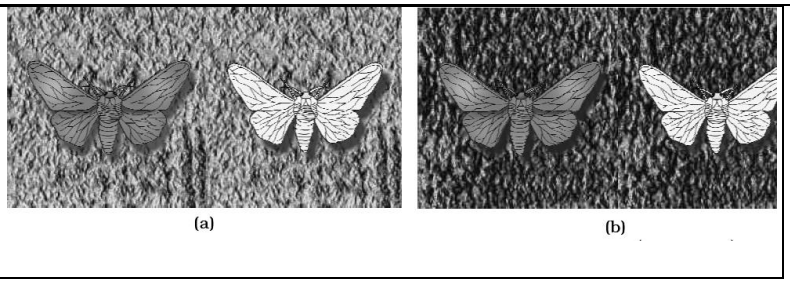
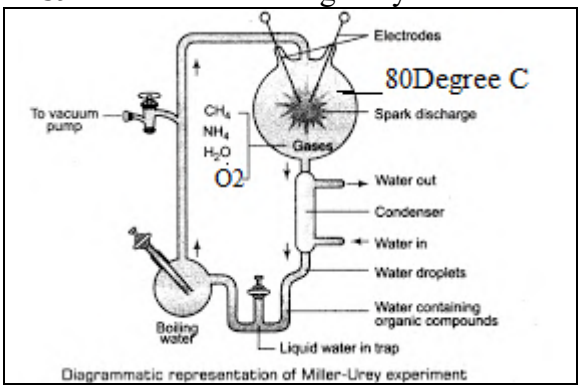
Answer: Assertion(A) and Reason(R)

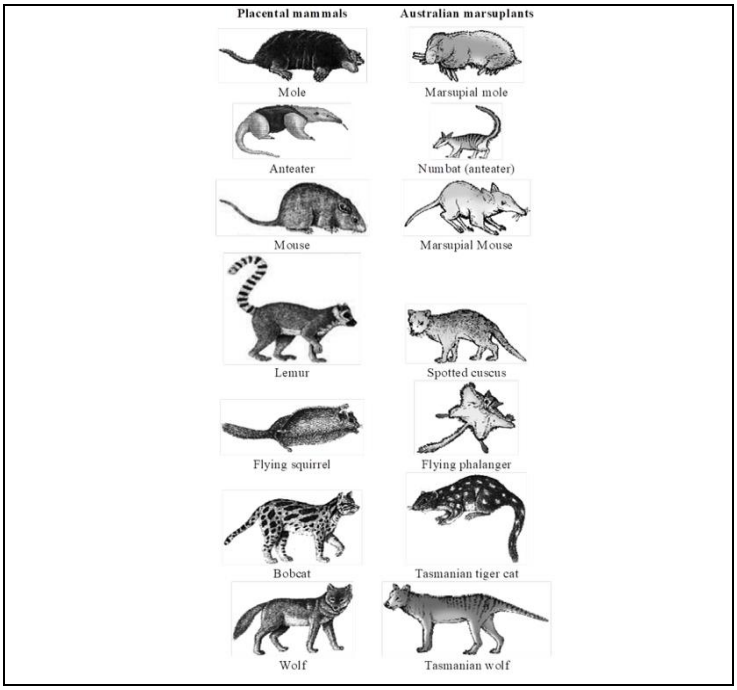
1	2	3	4	5	6	7	8	9	10	11	12	13
B	A	A	A	B	D	B	B	C	A	C	D	C

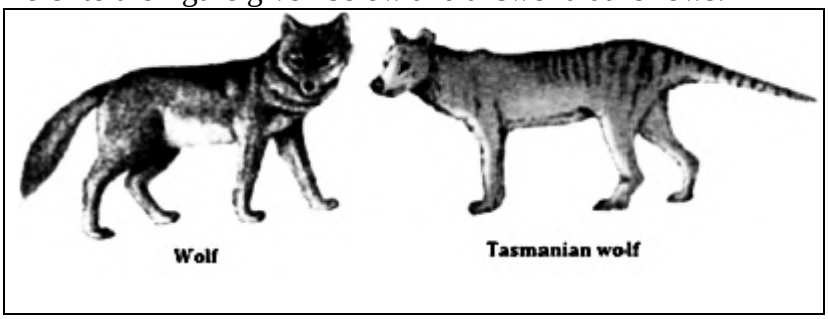
	SECTION – B-SA1 (2 marks each)
1	If abiotic origin of life is in progress on a planet other than earth what should be the condition there?
Ans	Reducing atmosphere i.e no free oxygen will be present,there must be continuous supply of energyfrom lightening,thunder,volcanic eruption and stellerradiation.
2	Why does a population obtain variation?
Ans	Because variation enable such population to survive better in natural conditions.(climate , food , physical factors).
3	(a)Identify A and B in the figure given below.(b)What does this figure represent? 
Ans	a)A=Thorn of Bougainvillea B=Tendrils of Cucurbita (b) In plants also, the thorn and tendrils of Bougainvillea and Cucurbita represent homology
4	Write the Oparin and Haldane‘s hypothesis about the origin of life on earth. How does meteorite analysis favour this hypothesis?

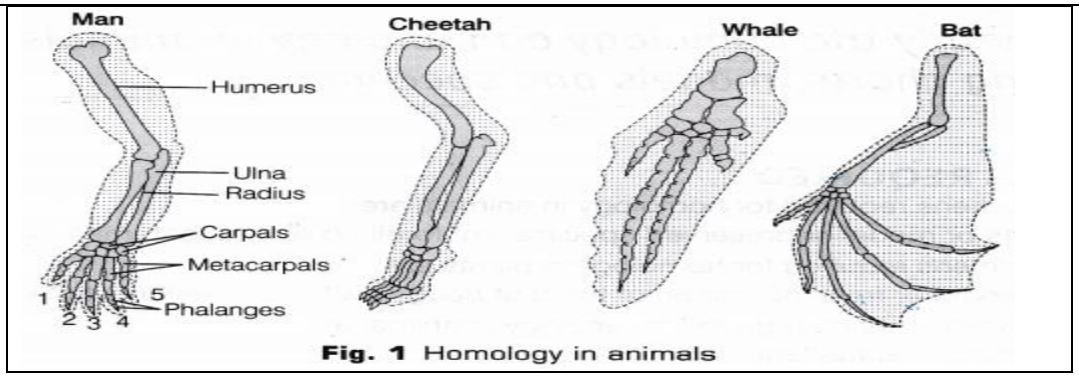
Ans	Life originated from pre-existing non –living organic molecules.(eg RNA, protein etc.meeriors analysis results presence of similar compounds which concludes that the similar process is going on elsewhere in the space.
5	Darwin observed an amazing diversity of finches at Galapagos Islands. Mention the varieties of fiches Define the phenomenon related to finches.
Ans	(a)From the original sed –eating features , many other forms with altered beaks arose, enabling them to become insectivorous and vegetarian finches. (b)Adaptive radition
6	Branching descent and natural selection are two key cncepts of Darwinian ther of evolution.expalin each concept with the help of suitable example.
Ans	Brnching descent:different species descending from the common ancestor get adapted in differenr habitat. e.g.darwin's finches . Natural selection:Heritable variations enable better variations enale better variations enable better enable better survival of the species to reproduce in large number.
7	What does the following equation represent? p2+2pq+q2=1.Jutify
Ans	This equation represents Hardy-Weinberg principle. This principle says that allele frequencies in a population are stable and is constant from generation to generation. The gene pool (total genes and their alleles in a population) remains a constant. Sum total of all the allelic frequencies is 1. Individual frequencies, for example, can be named p, q, etc. In a diploid, p and q represent the frequency of allele A and allele a. The frequency of AA individuals in a population is simply p2.This is simply stated in another ways, i.e., the probability that an allele A with a frequency of p appear on both the chromosomes of a diploid individual is simply the product of the probabilities, i.e., p2 . Similarly of aa is q2 , of Aa 2pq. Hence, p2+2pq+q2=1.
8	How can you say the lobefin fish were the ancestors of amphibians?
Ans	Fish with stout and strong fins could move on land and swim in water to maintain a a duel lives like amphibians
9	When and where did *Australopithecines* live?Mention their characteristics.
Ans	*Australopithecines* probably lived in East African grasslands. - They were probably not taller than 4 feet but walked up right. -Two mya, Australopithecines probably lived in East African grasslands. -Evidence shows they hunted with stone weapons but essentially ate fruit.
10	Select two pairs from the following which exhibit divergent evolution. Give reasons for your answer. (a)Forelimbs of Cheetah and mammals (b)Flippers of donphils and penguins (c)Wings of butterflies and birds (d)Forelimbs of whales and mammals
Ans	(a)Forelimbs of Cheetah and mammals and (b)Flippers of donphils and penguins exhibit divergent evolution . These pairs have similar anatomical structures or origin but performdifferent functions
	SECTION – C SA2 (3 marks each)
1	What are analogous organs?How are they different from homologous organs?Prove with an example of each
Ans	Definition , differences exaples
2	What is the disturbance in Hardy-weinberg genetic equilibrium indicative of?Explain how is it caused?Explain any three.
Ans	Definition of gene migration or gene flow, genetic drift, mutation, genetic recombination and natural selection. (any three)
3	Write the characteristics of Ramapithecus, Dryopithecus and Neanderthal man.
Ans	Characters of Ramapithecus, Dryopithecus and Neanderthal man.

4	 Adaptive radiation of marsupials of Australia **a**)Mention the specific geographical regionwhere these organisms are found. (b)Name and explain the phenomenon that has resulted in the evolution of such diverse species in the region. (c)How do the Placental wolf and Tasmanian wolf share the same habitat.
Ans	(a)Australian Island contitent (b)Definition of adaptive radiation (c) proper reason
5	The graphs below show three types of natural selection. The shaded areas marked with arrows show the individuals in the population which are not selected. The dotted vertical lines show the statistical means  a) What names are given to the types of selection shown in graphs A, B and C. b) After the selection has operated for several generations in the above populations indicated as Graph A, B and C, graphically illustrate the probable results
Ans	a) A -stabilising; B - directional; C - disruptive; b) Graph A – Stabilising Graph B – Directional Graph C – Disruptive 
6	**(**a)When and where did Neanderthal man live? (b)What was his brain capacity?

	(c)mention the advantages he showed over *Homo sapiens*.
Ans	(a) lived in near east and central Asia between 1,00,000-40,000 years back.(b) brain size of 1400cc (c) They used hides to protect their body and buried their dead.Their brain size of 1400cc whereas Homo erectus had brain around 900cc
7	 What do these pictures (a)and (b) represent?Illustrate with reference to evolution.Explain.
Ans	Industrial melanism-explanation
8	(a)What is adaptive radiation?(b)Epalin with the help of an suitable example where adaptive radiationhas occurred to represent convergent evolution.
Ans	(a)Definition (b) correct example and explanation
9	a) Darwin's theory of natural selection is widely accepted but some limitations have been identified by modern biologists. Mention the limitations identified. (b) Name and state the most accepted theory of evolution in modern times. (c) Mention any two ways the of evolution are explained in modern biology.
Ans	a)Limitation of Darwin's theory of evolution(i)The theory of evolution could not explain how and where variations have arisen.(ii)It also could not explain how the variations are inherited. (b) The synthetic theory of evolution or Neo-Darwinism, also called the modern concept. According to this theory, the origin of new species is based on the interaction of genetic variations and natural selection. (c)(i) evolution is the change of gene (allele) frequencies in the gene pool of a population over many generations.(ii) species (and their gene pools) are isolated from one another, and (iii) the gene pool of each species is held together by gene flow; an individual .
	SECTION – D CASE BASED QUESTIONS (4 marks each)
	Read the following passages and answer the following:
1	A student was simulating Urey and Miller's experiment to prove the origin of life.  Diagrammatic representation of Miller-Urey experiment **(**a)Find out the reasons why he could not get desired result? (b)What conclusion was drawn by Urey and Miller through this experiment? Or, What was the purpose of this experiment? (c)Compare the conclusion drawn with the theory of panspermia generation.
Ans	(a)Rason : He could not get desired result because (i)Oxygen was used instead of Hydrogen (b) Temperature maintained was 80 degree C intead of 800 degree C

	(b)Life could have come from pre-existing non-living inorganic molecules by chemical evolution Or, To confirm abiogenesis (origin of life from organic matter) (c)Urey and Miller proved that life originated abiogenetically whereas theory of spontaneous generation emphasized that units of life called spores were transferred to different planets including earth.
2	Darwin found the varieties of finches that in travelled to Galapagos Islands and observed variation in them.  (a)What role does an individual organism play as per Darwin's theory of natural selection? (b)How did Darwin explain the existence of different varieties of finches of Galapagos Islands? Or, How did darwin's illustrate adaptive radiation? (c)What is fitness of individuals according to Darwin?
Ans	a)An individual organism passes on the variations,mutations and adaption from one generation to another. (b)Darwin explained it as the process of evolution of different spcies in agiven geographical areastarting from a point and literally radiating to other areas of geography(habitats)called adaptive radiation.OR, Explanation of Darwin's finches as an example of adaprive radiation. (c)'Fitness of an individual'is the ability of an organism to survive and pass of its genes to future generations
3	Study the given diagram below and answer the following questions.  (a)Mention the specific geographical region where these organisms are found.

	(b)Name and explain the phenomenon that had resulted in the evolution of such diverse speies in the region. (c)Explain giving reasons the existence of Placental wolf and Tasmanian wolf shairing the same habitat. OR Which evolution is responsible for the existence of lemur and spotted cuscus shairing the same habitat.
Ans	(a)Australia (b)Adaptive radiation (convergent evolution)has resulted in this evolution. The process of evolution of different spcies in agiven geographical areastarting from a point and literally radiating to other areas of geography(habitats)called adaptive radiation.It is the development of different functional structures from a common ancestors. .(c)Placental wolf and Tasmanian wolf share similar habitat due to converge Evolution and evolved into unrelated group of organisms.OR, Lemur and spotted cuscus share similar habitat due to convergent evolution and evolved into correlated group of organisms
4	Refer to the figure given below and answer that follows:  (a)Recognize and xplain the process by which Tasmanian wolf evolved. (b)Give one example of an animal that has evolved along with Tusnmanian wolf. OR, Name the process that results in evolution of Wolf and Tasmanian wolf. (c)Compare and contrast the two animals shown.
Ans	(a)Tasmanian wolf evolved by adaptive radiation. The process of evolution of different spcies in agiven geographical areastarting from a point and literally radiating to other areas of geography(habitats)called adaptive radiation (b)tiger cat/banded ant eater/marsupial rat **OR**, Convergent evolution has resulted in evolution of wolf and Tasmanian wolf (c)Wolf is placental mammal whereas Tasmanian wolf is a marsupial mammal
	SECTION – E LONG ANSWER QUESTIONS (5marks each)
1	(a)Name the primates that lived aout 15 million years ago.List their characteristic fetures. (b)(i)Where was the first man like anials found? (ii)Wrte the order in which Neanderthals,*Homohabilis* and *Homo erectus* appeared on the earth. State the brain capacity of each of them (iii)When did modern *Homo sapiens* appear on this planet?
Ans	(a)Dryopithecus and Ramapithecus Characters: (i)hairy (ii) walked like gorillas and chimpanzees. (iii)Ramapithecus was more man-like while Dryopithecus was more ape-like. (b)(i)East African grassland (ii) Homo habilis brain capacities were between 650-800cc.Homo erectus had a large brain around 900cc. Neanderthal man with a brain size of 1400cc. (iii) Homo sapiens arose during ice age between 75,000-10,000 years ago
2	Study the figure and answer the following:

	 **Fig. 1** Homology in animals (a)Name and define the type of evolution these organisms exhibit. (b)What are such organisms called?What do they indicate about ancestry? (c)Contrary to the above ondition organs that are not anatomically similar, but perform similar functions in different groups of oranisms are also found. (i)What are such organs called and what type of evolution do they exhibit? (ii)Give two examples (one from plants and one from anilmals) of such organs.
Ans	a)Divergent evolution-definition (b)(i)Homologous organ-they are called homolohous organs (c)(i)Analohous organs- exhibit convergent evolution(ii)Example from plants –Tuber of potato and of sweet potato Example from animals(i)Eyes of Octopus and of mammals (ii)Flippers of Penguines and of dolphins (iii)Wings of insects and of birds (any one)
3	(a)State what is disturbance in Hardy –Weinberg eqalibrium indicative of.(b)Write any four factors that affect the equilibrium. Explain how?
Ans	a)Explanation of Hardy-Weinberg principle.Any deviation from this value ‘one’is indicative of evolutionary change. (b)Factors affecting genetic eqalibrium-gene migration or gene flow, genetic drift, mutation, geneticrecombination and natural selection- definition of each (any four)
4	(a)Differentiate `between analogy and homology giving one example eachof plant and animal respectively. (b)How are they considered as an evidence in support of evolution?
Ans	(a)Differences (b)Homology-Two examples each from plants and animals Analogy: Two examples each from plants and animals 3+2=5

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Chapter 8: HUMAN HEALTH AND DISEASE

Diseases caused by pathogens

Name of diseases	Pathogen	Type of organism	Mode of transmission	Symptoms
Typhoid	*Salmonella typhi*	bacteria	Enter small intestine through contaminated food & water	Sustained fever of 40°C, Weakness,headache,loss of appetite, intestinal perforation
Pneumonia	*Streptococcus pneumonia, Haemophilus influenzae*	Bacteria	Infects alveoli of lungs through inhaling droplets released by infected person or sharing of utensils with infected person	fever,chills,cough,headache,lips & finger nails turning blue
Common cold	Rhino virus	Virus	Inhaling droplets released by coughing or sneezing by infected person.infect respirstory passage but not lungs	Nasal congestion(blocked nose) & discharge (runny nose),Sore throat,cough,hoarseness
Chikunguny a	Alphavirus	Virus	Bite of female Aedes aegypti	Sudden onset of fever, crippling joint pain, in some haemorrhagic manifestations
Dengue	Flavivirus	Virus	Bite of female Aedes aegypti	Sudden onset of fever, severe frontal headache, muscle & joint pain, rashes on the body
Malaria → Malignant malaria→	*Plasmodium vivax Plasmodium falciparum*	Protozoa	Bite of female Anopheles mosquito (vector)	Recurring fever & chills every 3 to 4 days (due to release of Haemozoin from RBC)
Name of diseases	Pathogen	Type of organism	Mode of transmission	Symptoms
Amoebiasis/ Amoebic dysentery	*Entamoeba histolytica*	Protozoa	Contaminated food & water (Housefly carry parasite from faeces of infected person to food)	Stool with excess mucous & blood clots,abdominal pain & cramp
Ascariasis	*Ascaris lumbricoidis*	Helminth (Roundw orm)	Food & water contaminated with eggs of parasite	Internal bleeding,muscular pain,fever,anaemia(parasite infect intestine)
Elephantiasi s/ Filariasis	*Wuchereria bancrofti*	Helminth (filarial worm)	Bite of female mosquito (vector)	Inflammation(swelling) of organs usually lower limb (parasite live inside lymph vessel)
Ringworm	*Microsporum, Trichophyton, Epidermophyton*	Fungus	Use of towel,clothes ,comb etc. Used by infected person or from soil	Dry,scaly lesion on skin accompanied by itching

Drugs

Name	Chemical nature	Source	Part of plant	Effect	Mode of action
Heroin/smack (diacetylmorphine) By snorting, injection	Opioid	*Papaver somnifera* (Poppy)	Latex of stem	Depressant, slows down body function	Binds to receptors in CNS & gastrointestinal tract

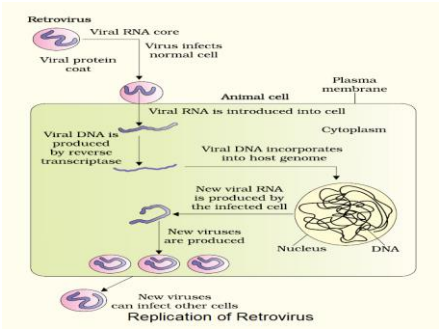
Marijuana,hashish, charas,ganja By inhalation oral ingestion	cannabinoid	*Cannabis sativa*	inflorescence leaf, resin	Depressant & stimulant	Binds to receptors in brain
Cocaine/coke/crack By snorting	Coca alkaloid	*Erythroxylum coca*	leaf	Stimulating action,Sense of euphoria & increased energy	Interferes with transport of neurotransmitter dopamine

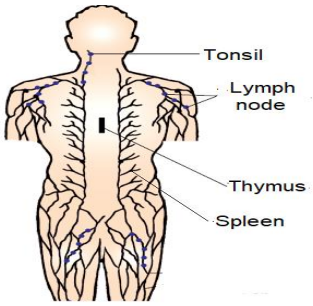
Drug abuse –When drugs are taken for purposes other than medicinal use or in amounts that impairs one's physical,physiological & psychological functions,its called drug abuse. Eg– Barbiturates,amphetamines,benzodiazepines ,**Morphine(Effective sedative and pain killer in post surgery patients).**

Effects of Tobacco : Harmful Chemical – **Nicotine** (alkaloid) Forms of use – smoke/chew/snuff

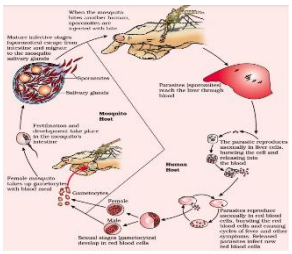
Effect of nicotine – 1. Stimulate release of adrenaline & nor – adrenaline from adrenal gland Which raises blood pressure & increase heart rate.
Effect of smoking – 1. Increases CO level in blood & decreases concentration of O_2 bound to haemoglobin. This causes O_2 deficiency in body.
2. Increases chances of cancer of lung, urinary bladder& throat
3. Increased incidence of bronchitis, emphysema, heart diseases, gastric ulcer
Effect of tobacco chewing – oral cancer.
Long term effect of alcohol consumption – liver cirrhosis
Plants that cause hallucinations – *Erythroxylum coca, Atropa belladonna, Datura sp.*
Performance enhancing drugs used by athletes – Anabolic steroid
Addiction – psychological attachment to effects associated with drugs. Eg. Euphoria
Dependence – tendency of body to manifest characteristic **withdrawal syndrome** if drug is discontinued.eg anxiety, shakiness, nausea and sweating.

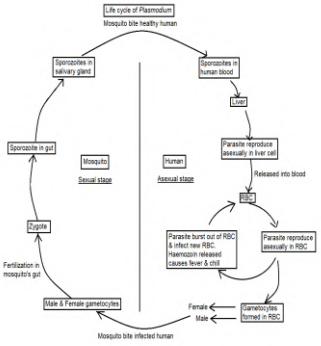
Important diagrams

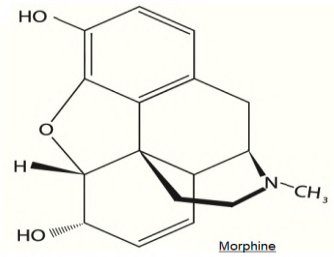




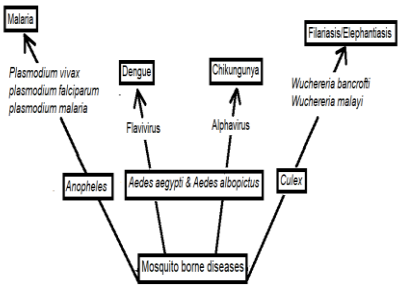
Lymphoid organs

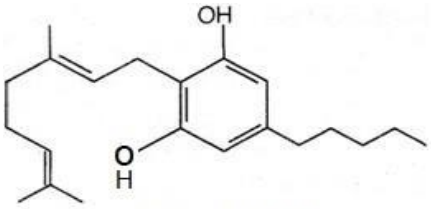

Life cycle of *Plasmodium*





Morphine





Cannabinoid

Key Terms/Concepts	
Health	State of complete physical, mental and social well-being
Communicable/infectious disease	Diseases that can be transmitted from one person to another
Pathogen	Disease causing organisms
Immunity	Ability to fight disease causing organism conferred by immune system
Innate immunity	Non-specific immunity present at birth
Acquired immunity	Pathogen specific immunity acquired by exposure to these pathogen
Interferon	Protein secreted by virus infected cells which protect non-infected cells from further viral infection
Primary response	Low intensity immune response generated when our body encounters a pathogen for the first time
Secondary/Anamnestic response	High intensity response generated on subsequent encounter with the same pathogen
Cell mediated immunity	Conferred by T lymphocyte
Humoral immunity	Conferred by B lymphocyte, involved production of antibody
Antibody	Immunoglobulin molecule produced by B lymphocyte against a specific pathogen/antigen
Active immunity	Antibodies produced by host on exposure to pathogen or antigen
Passive immunity	Ready-made antibodies are given to give protection against antigen
Vaccine	Preparation of antigenic protein of pathogen/ inactivated or weakened pathogen
Allergy	Exaggerated immune response to certain antigens (allergens)
Autoimmunity	Immune cells attack self- cells
Primary lymphoid organs	Immature lymphocytes differentiate into antigen sensitive lymphocyte
Secondary lymphoid organs	Lymphocytes interact with antigen and become effector cells
Retrovirus	Virus with RNA genome
Reverse transcription	Formation of DNA from RNA
Benign tumour	Tumour that remain confined to a location and doesn't spread to other parts of the body
Key Terms/Concepts	
Malignant tumour	Tumour grow rapidly and spread to other locations in the body
Metastasis	Process by which cancer cells spread to other parts of body
Contact inhibition	Property of normal cells in which contact with other cells prevent uncontrolled growth
Carcinogen	Cancer causing agents such as radiations, chemical etc
Oncogene	Cancer causing genes
Neoplastic growth	Abnormal excessive growth of tissue
Drug abuse	When drugs are taken for purposes other than medicinal use or in amounts that impairs one's physical,physiological & psychological functions,its called drug abuse.
Addiction	Psychological attachment to effects associated with drugs. Eg. Euphoria
Dependence	Tendency of body to manifest characteristic withdrawal syndrome if drug is discontinued.eg anxiety, shakiness, nausea and sweating

MCQ (1 MARK EACH)

Q1. Antibodies produced against allergens are –

a) IgA b) IgE c) IgG d) IgM

Q2. Immature lymphocytes become antigen sensitive in -

a) Spleen b) Thymus c) Lymph node d) Tonsil

Q3. The plant that does not cause hallucination is –

a) *Atropa belladonna* b) *Erythroxylum coca* c) *Papaver somniferum* d) *Datura sp.*

Q4. Cellular barrier that provides non-specific innate immunity does not include –

a) Erythrocyte b) Neutrophil c) Macrophages d) Monocyte

Q5. Fertilization between gametocytes occur in –

a) Gut of mosquito b) liver of human c) salivary gland of mosquito d) erythrocyte of human

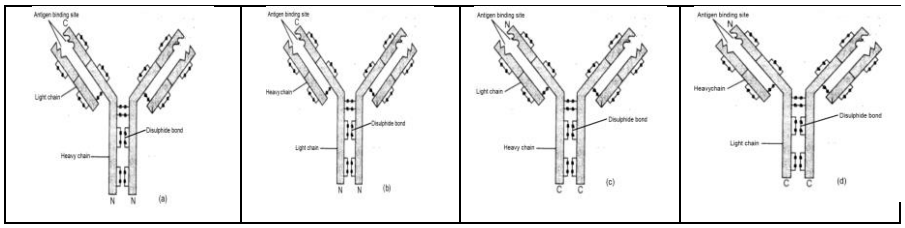
Q6. Ringworm is caused by –

a) *Ascaris* b) *Wuchereria* c) *Microsporum* d) *Entamoeba*

Q7. The disease that does not spread through contaminated food and water is –

a) Ascariasis b) Typhoid c) Amoebiasis d) Filariasis

Q8. Which one of the following is a correct depiction of antibody molecule?



Q9. The percentage of lymphoid tissue in our body comprising of MALT is –

a) 5% b) 15% c) 25% d) 50%

Q10. Which one of the following is a physical barrier?

a) Tear from eyes b) Acid in stomach

c) Mucus coating on respiratory tract epithelium d) Saliva in mouth

Q11. Vaccines have made it possible for us to control various diseases. Which one of the following diseases is an exception to this?

a) Measles b) Rubella c) Dengue d) Polio

Q12. *Wuchereria bancrofti* is a –

a) Bacteria b) Nematode c) Fungus d)Protozoa

Q13. Malignant malaria is caused by –

a) *Plasmodium falciparum* b) *Plasmodium ovale* c) *Plasmodium vivax* d) *Plasmodium malaria*

Q14. Chewing of tobacco increases the risk of-

a) Lung cancer b) Oral cancer c) Prostate gland cancer d) Cervical cancer

Q15. Marijuana is produced from –

a) Poppy plant b) cannabis plant c) coca plant d) *Datura* plant

Answer of MCQ

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

ASSERTION REASON QUESTIONS (1MARK EACH)

The following questions consist of two statements – Assertion (A) and Reason (R).
Answer these questions selecting the appropriate option given below:
a) Both A and R are true and R is the correct explanation of A.
b) Both A and R are true and R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.

Q1. **Assertion** : Thymus is a primary lymphoid organ.
Reason : Immature lymphocyte differentiate into antigen sensitive lymphocyte in thymus.

Q2. Assertion : People become addicted to drugs with repeated use.
Reason : With repeated use of drugs the tolerance level of the receptors in our body increases.

Q3. Assertion : Colostrum provides passive immunity to foetus during gestation.
Reason : colostrum is rich in antibodies like IgA.

Q4. Assertion : cases of allergy is more common in children living in cities than in villages.
Reason : modern lifestyle has lowered immunity in urban children.

Q5. Assertion : Malignant tumour is more dangerous than benign tumour.
Reason : Malignant tumour undergoes metagenesis.

Q6. Assertion : Anamnestic response is less intense than primary response to a pathogen.
Reason : First exposure to pathogen generates memory B and T cell that recognises the same pathogen more quickly on subsequent exposure.

Answer of Assertion and reason questions

1	**2**	**3**	**4**	**5**	**6**
A	**A**	**D**	**A**	**C**	**D**

2 MARKS QUESTIONS WITH ANSWERS

Q1.	a) How a foetus is protected from infections? b) What type of immunity does it represent? **Ans**. a) Foetus receives antibodies from their mother/through placenta. b) Passive immunity.
Q2.	a) Is lymph node primary or secondary lymphoid organ? b) State its role in immune response. **Ans**. a) Secondary lymphoid organ. b) Trap micro-organism or antigen/activate lymphocyte/elicit immune response

Q3.	a) Why macrophages are referred to as HIV factory? b) Name another cell which is also infected by the virus after it enters human body. c) What happens as a result of such infection? **Ans**. a) Initially HIV infects macrophages and multiply to produce virus b) Helper T lymphocyte. c) Number of T helper cell decrease/patient starts suffering from various infections like fever, diarrhoea etc.
Q4.	HPV vaccine protects against cervical cancer caused by Human Papilloma virus. a) Name the gene present in HPV that causes cancer. b) Human cells also have similar cancer causing genes. What are they called? c) If a person possesses these genes, will he definitely suffer from cancer? Give reason. **Ans**. a) viral oncogene. b) cellular oncogene /Proto oncogene. c) No. when proto oncogenes are activated under certain conditions/it may result in oncogenic transformation of the cell into cancerous neoplastic cells.
Q5.	a) What is 'contact inhibition' property of cell? b) What happens when a cell loses this property? **Ans**. a) contact with other cells stop uncontrolled growth. b) Cells continue to divide giving rise to tumour.
Q6.	a) Name a parasitic protozoa and a bacteria that usually infect a person suffering from AIDS. b) What makes AIDS patients more vulnerable to these infections than others? **Ans.** a) Protozoa – *Toxoplasma*, Bacteria – *Mycobacterium* *(½ + ½)* b) HIV attacks T – helper cells leading to a progressive decrease in their number, as a result an AIDS patient cannot overcome infections like other people.
Q. 7	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
Q. 8	a) Which disease is detected by Widal test? b) What are the symptoms of this disease? c) How does it spread from infected to a healthy person? **Ans**. a) Typhoid b) Sustained high fever (39^{o} C to 40^{o} C)/weakness/headache/loss of appetite/intestinal perforation in critical case. c) Contaminated food and water.
Q9	a) Apart from *Streptococcus pneumonia*, which other bacteria causes pneumonia? b) How does this disease affect the lungs? c)How is it transmitted from one person to another? **Ans**. a) *Haemophilus influenza.* b) Alveoli of lungs get filled with fluid leading to respiratory problems. c) Droplet or aerosol released by infected person.
Q. 10	a) Write the scientific name of the plant from which heroin is obtained? b) How is this drug obtained? c)How does this drug affect human body? **Ans**. a) *Papaver somniferum* b) By acetylation of morphine extracted from latex of the plant. c) Depressant/slows down body function.

3 MARKS QUESTIONS

Q.1	a) What is innate immunity? b) How is it different from acquired immunity? c) List the cells that act as cellular barriers. **Ans.** a) Non-specific immune response that is present at birth.

b) -Acquired immunity is immunity that develops during our life time from exposure to various antigen unlike innate immunity which is present at birth.
- Innate immunity is non-specific but acquired immunity is very specific.
- Innate immunity involves cellular barriers as well as physical, physiological and cytokine barriers. Acquired immunity involved B and T lymphocyte.
c) Neutrophil, monocyte, macrophage, natural killer cell

Q.2 a) What is a vaccine?
b) What happens when vaccine is introduced in our body?
Ans. a) A vaccine is a preparation containing antigenic protein of pathogen or inactivated or weakened pathogen.
b) Antibodies are produced by the body against the antigen that neutralise the antigen during infection/ It also generate memory B and T cell that recognise the pathogen quickly on subsequent exposure and neutralise it before it can do any harm.

Q.3 Considering the fact that HIV spreads through body fluid, who are at high risk of getting infected with HIV?
Ans. individuals with multiple sexual partners/drug addicts who take drug intravenously/patients who require frequent blood transfusion/children born to HIV infected mother.

Q.4 Biopsy helps in detection of cancer.
a) What is biopsy? b) How does it help in detection of cancer?
c) List the other techniques that are available for diagnosis of cancer.
Ans. a) Removal of tissue for examination under microscope.
b) Microscopical examination of a probable cancerous tissue will reveal abnormalities in the tissue.
c) Biopsy/CT scan/MRI/X-ray/Antibody against cancer specific antigen.

Q.5 The following diagram depicts a vector borne disease.

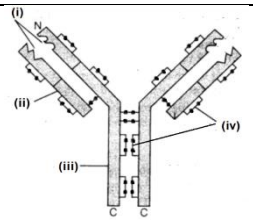
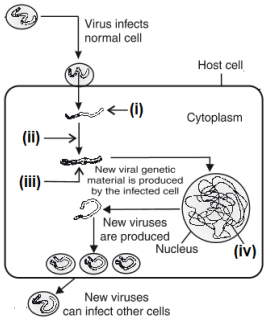
a) Name the disease and the pathogens that cause it.
b) Name the vector that is responsible for transmission of this disease.
c) What causes such deformities of body?
Ans. a) Disease – Filariasis/Elephantiasis
Pathogen – *Wuchereria bancrofti, W. malayi*
b) Female culex or Aedes mosquito.
c) Worms grow for a long time in lymphatic vessels of lower limb developing chronic inflammation, resulting in gross deformities of lower limb and genital organ.

Q.6 Q. Identify (i) to (vi) in the following table.

Name of disease	Causal organism	Symptom	Mode of transmission
Common cold	Rhinovirus	(i)	(ii)
Chikungunya	(iii)	(iv)	Through female *Aedes* mosquito
Dengue	(v)	Fever, joint pain, muscle pain, rashes, low levels of platelets	(vi)

Ans. i) Nasal congestion/discharge/sore throat/cough/headache
ii) Droplets released during cough or sneeze ii) Alphavirus
iv) Fever, joint pain, muscle pain, headache v) Flavivirus
vi) Female *Aedes aegypti*

Q.7 A person is complaining of abdominal pain and is passing stool with mucous and blood.
a) Name the disease he is suffering from.

	b) Which pathogen is responsible for this infection and how is it transmitted from infected to healthy individual? c) Suggest two ways of preventing the spread of this disease. **Ans**. a) Amoebiasis b) *Entamoeba histolytica* / Housefly transmit parasite, water contaminated by faecal matter c) Drink boiled/purified water, proper disposal of waste and excreta, regular cleaning and disinfection of water bodies or reservoirs, eat clean fruits and vegetables and keep food covered.
	5 MARKS QUESTIONS WITH ANSWERS
Q.1	a) Identify the molecule represented by the diagram given below.  b) Label the parts marked (i) to (iv). c) What do 'N' and 'C' signify in the diagram? d) Name the type of cell that produces these molecules. (e) When are these produced? **Ans.** a) Antibody b) i) Antigen binding site, ii) Light chain, iii) Heavy chain, iv) Disulphide bonds c) N terminal end and C terminal end of polypeptide chain. d) B lymphocyte (plasma cell) e) Produced in response to pathogens present in our blood.
Q.2	The diagram below shows replication of retrovirus inside an animal cell. a) Label (i) to (iv) in the diagram. (b) Why a person infected with HIV becomes immune deficient? (c) Name the steps taken to prevent the spread of HIV infection.  **Ans.** a) i) viral RNA, ii) reverse transcriptase, iii) viral DNA, iv) host DNA b) HIV infects macrophages which play an important role in innate immunity and also eliciting cell mediated immunity. It attacks helper T lymphocyte which are associated with cell mediated immunity and also initiating humoral immunity. The decreased number of T_H lymphocyte results in immunodeficiency. c) Ensuring blood from blood bank is free of HIV, only disposable syringe are used, free distribution of condoms, controlling drug abuse,, advocating safe sex, regular check-up of vulnerable populations.
Q.3	Name the infective stage of *Plasmodium* that is introduced into the human body when a mosquito bites him/her. b) Trace the stages of life cycle of the parasite from the point of entry into human body till the time another mosquito bites this person. Ans. a) Sporozoite. b) Sporozoite injected with bite of infected mosquito. ↓ Sporozoite reach liver through blood. ↓ Parasite reproduce asexually in liver cells and burst out of the cell into blood. ↓ Parasite reproduce asexually in RBC. ↓ Parasite burst out of RBC every 3-4 days releasing haemozoin which causes fever and chill. ↓ Sexual stage Gametocyte develop within RBC ↓ Gametocytes transferred to mosquito when it bites.

Q.4

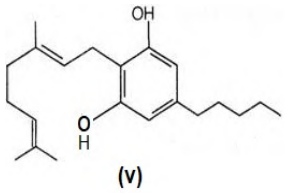
a) Name the alkaloid which is primarily associated with the harmful effects of consumption of tobacco.
b) How does it affect our body?
c) The risk of which type of cancer is increased by smoking?
d) Why does smoking cause O_2 deficiency in the body?
Ans. a) Nicotine.
b) Stimulate adrenal gland to release adrenaline and nor-adrenaline into blood/which raise blood pressure and increase heart rate.
c) Cancer of lungs, urinary bladder and throat.
d) Smoking increases CO content in blood and reduce the concentration of haembound O_2.

Q.5

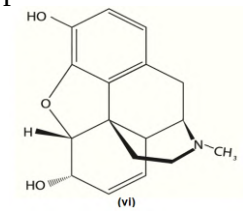
a) Fill in the blanks in the following table.

Type of drug	Plant source	Means of consumption	Effect on body
Opioid	*Papaver somniferum*	Snorting & injection	**(i)**
Cannabinoid	**(ii)**	**(iii)**	Depressant & stimulant
Coca alkaloid	*Erythroxylum coca*	**(iv)**	Stimulant

b) Which one of the following structures represent cannabinoid molecule?



(v)



(vi)

c) Which part of the plant is utilised for extracting cannabinoid drug?
d) Which one the drugs mentioned in the list causes hallucinations? Name another plant with hallucinogenic property.
e) Give one medicinal use of any one the drugs mentioned in the list.
Ans. a) i) Depressant ii) *Cannabis sativa* iii) inhalation, oral ingestion iv) Snorting
b) (v) is a cannabinoid molecule
c) Inflorescence
d) Coca alkaloid, *Atropa belladonna* or *Datura*
e) Morphine used as sedative and painkiller.

Q.6

a) Why do athletes use drugs like anabolic steroids?
b) What are the side effects of these drugs in male and female? (Mention 2 points for each)
Ans. a) To enhance their performance.
b) **Male** – Increased aggressiveness, mood swings, depression, reduced testicles, decreased sperm production, breast enlargement, premature baldness, enlargement of prostate gland, potential for kidney and liver dysfunction.
Female – Masculinisation, Increased aggressiveness, mood swings, depression, abnormal menstrual cycle, excessive hair growth on face and body, enlargement of clitoris, deepening of voice.

Q.7

Maintenance of personal and public hygiene is important for control of infectious diseases.
a) Give examples of water borne, air borne and insect vector borne diseases and suggest specific measures for prevention of these diseases.
b) Apart from these measures what is the best way to protect oneself from

	bacterial or viral infection? **Ans.** Water borne – Typhoid, Amoebiaisis Clean drinking water, well cooked food, disinfection of water, proper disposal of waste and excreta. Air borne – Pneumonia, common cold Avoid contact with infected person and their belongings. Insect vector borne – malaria, filariasis Elimination of vector, spraying of insecticides. b) Through vaccine

4 MARKS (CASE BASD) QUESTIONS WITH ANSWERS

Q.1 All children between 9 months and 15 years were given a dose of Measles – Rubella (MR) Vaccine in their schools across West Bengal as a part of a campaign to eradicate Measles and control Rubella.
The vaccination campaign were held from 9th January 2023 to 11th February 2023 in all schools across West Bengal.
This was an additional dose of MR vaccine irrespective of previous vaccination.
The same MR vaccine administered to children during routine immunisation will be used during the campaign.
One new auto AD (auto disabled) syringe will be used for each child.
More than 32.4 crore children had already been vaccinated with MR vaccine in 24 states of India.
a) What is a vaccine?
b) Why was this campaign organised?
c) Name another disease against which a similar is being carried out in India.
d) Why AD syringe were being used?

Ans. A) A preparation of inactive or weakened pathogen or antigen.
b) to eradicate measles and control Rubella
c) Polio
d) to prevent contamination and spread of any other pathogen through it.

Application Of Knowledge,Concepts ASSERTION REASON QUESTIONS

MCQ (1MARK EACH)

Q1. Which of the following is not a reason why youngsters try drugs or alcohol ?

a) They are curious to try new thing. b) They feel it is progressive

c) They have supportive family d) peer pressure

Q.2 The recurring chill and fever in a malaria patient occurs due to –

a) Release of haemozoin from liver b) Release of sporozoites from liver

c) Release of sporozoites from erythrocytes d) Release of haemozoin from erythrocytes

Q.3. Which one of the following diseases can be controlled by eradication of *Aedes* mosquito?

i) Malaria ii) Dengue iii) Chikungunya iv) Filariasis

<table>
<tr><td></td><td>TWO MARKS QUESTONS WITH ANSWERS</td></tr>
<tr><td>Q.1</td><td>An accident victim has been brought to a doctor’s clinic. What would the doctor inject him with – Tetanus vaccine or tetanus antisera? Explain with reason.
Ans. Tetanus antisera/because it has ready-made antibody /therefore quick response can be generated against bacteria.</td></tr>
<tr><td>Q.2</td><td>Differentiate between cell mediated immunity and antibody mediated immunity.
Ans.
<table>
<tr><th>Cell mediated immunity</th><th>Antibody mediated immunity</th></tr>
<tr><td>T lymphocyte mediated</td><td>B lymphocyte mediated</td></tr>
<tr><td>Doesn’t produce antibodies against specific antigen</td><td>Produce antibodies against specific antigen</td></tr>
</table></td></tr>
<tr><td>Q.3</td><td>Explain anamnestic response with an example.
Ans. Anamnestic response or secondary immune response is generated when a body encounters the same pathogen the second time/it is due to the production of memory B and T cells/ which is able to neutralise the pathogen more quickly. Eg. A person who has suffered from chicken pox once in his life, is not likely to suffer again from the same infection.</td></tr>
<tr><td>Q.4</td><td>Why breastfeeding is important for new born babies?
Ans. Initial days of lactation colostrum is secreted by the mother which has abundant antibodies (IgA) which protects infants from infection and keeps him healthy.
Breast milk is also the only source of nutrition for the baby for the first 6 months.</td></tr>
<tr><td>Q.5</td><td>a) Why HIV is called a retrovirus?
b) Why people who need frequent blood transfusion are at a higher risk of getting infected with HIV?
Ans. a) It has RNA genome.
b) HIV spread through body fluid like blood/patient might receive contaminated blood from blood bank.</td></tr>
<tr><td>Q 6.</td><td>Explain how molecular biology can help in prevention of cancer.
Ans. Techniques of molecular biology can be used to detect genes with inherited susceptibility to cancer/ which predispose an individual to certain cancer/individual may be advised to avoid exposure to a particular carcinogen they are susceptible to.</td></tr>
<tr><td>Q.7</td><td>HIV is a retrovirus. How is it able to integrate its genetic material into the host DNA?
Ans. Viral RNA/is converted to Viral DNA/by reverse transcriptase enzyme/this viral DNA is integrated into host DNA.</td></tr>
<tr><td>Q.8</td><td>a) Why people who take drugs intravenously are at a greater risk of getting infected with HIV?
b) Apart from HIV which other viral infection can be transmitted in similar way?
Ans. a) HIV is transmitted through body fluids/Drug addicts often share syringe to inject drug/if one in a group is HIV+ve, others will also get infected through contaminated needle.
b) Hepatitis B</td></tr>
<tr><td>Q.9</td><td>Recurring chill and high fever is a typical symptom of malaria.
a) What gives rise to this symptom?
b) Why does this symptom not appear immediately after bite of an infected mosquito?
Ans. a) Every 3 to 4 days Plasmodium multiplying in RBC/rupture of RBC/releases haemozoin which causes chill & fever.
b) Initially Plasmodium attack liver cells and then RBC</td></tr>
</table>

Correct option is

a) i & ii b) ii & iii c) i & iv d) i & iii

Q.4. Which of the following pathogen is not transmitted through a vector?

a) Alphavirus b) Flavivirus c) Rhinovirus d) *Plasmodium*

Q.5. Drug which will not reduce symptoms of allergy is –

a) Anti-histamine b) Adrenalin c) Paracetamol d) Steroid

ASSERTION REASON QUESTIONS

The following questions consist of two statements – Assertion (A) and Reason (R).
Answer these questions selecting the appropriate option given below:
a) Both A and R are true and R is the correct explanation of A.
b) Both A and R are true and R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.

Q.6. **Assertion** : Smoking causes O_2 deficiency in the body.
Reason : Smoking increases CO_2 concentration blood and reduces concentration of haem bound O_2.

Q.7. Assertion : Administration of antivenin is an example of passive immunity.
Reason : Antivenin quickly neutralises the venom released during snake bite.

Q.8. **Assertion** : Tissue matching is essential before organ transplant.
Reason : Cell mediated immunity causes graft rejection.

Q.9. **Assertion** : Ringworm is common in groin area and between toes.
Reason : Heat and moisture help worms to grow.

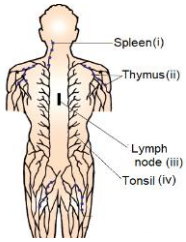
Q.10 Assertion : Transmission of HIV from mother to child is considered to be congenital.
Reason : The infection is present at birth.

Answer

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
C	**D**	**B**	**C**	**C**	**C**	**B**	**A**	**D**	**D**

5 MARKS QUESTIONS WITH ANSWERS

Q.1 a) A student has made mistakes while labelling the lymphoid organs in the following diagram. Label them correctly.
b) Differentiate between primary and secondary lymphoid organs.
c) Identify the primary lymphoid organ in the diagram.
d) What is the function of spleen?
e) Why doctors are reluctant to remove tonsil?



Ans. a) i) Tonsil, ii) Lymph node s , iii) Thymus, iv) Spleen
b)

<table>
<tr><td></td><td>
<table>
<tr><th>Primary lymphoid organ</th><th>Secondary lymphoid organ</th></tr>
<tr><td>Immature lymphocyte differentiate into antigen sensitive lymphocyte.</td><td>Site of interaction of lymphocyte with antigen which then become effector cells.</td></tr>
</table>
c) Filter blood by trapping blood borne microorganisms, reservoir of erythrocyte.
d) Tonsil fight infection & stop germs as they enter through mouth or nose. Removal may lead to more instances of respiratory, allergic or infectious diseases later in life.</td></tr>
<tr><td>Q.2</td><td>a) Which stage of life cycle of Plasmodium is completed within the body of the female Anopheles mosquito?
b) Show with the help of flow chart the various steps in the life cycle from the time the parasite enter the body of the mosquito up to the point where it bites a healthy person.
c) Suggest a few ways to prevent breeding of mosquito in water bodies like pond.
Ans. a) Sexual stage.
b) Female mosquito takes up gametocyte with blood meal.
↓
Fertilization and development occurs in gut of mosquito.
↓
Sporozoites (mature infective stage) migrate to salivary gland.
↓
Sporozoites are transferred to a healthy person through mosquito bite.
c) Introduce fish like Gambusia that feeds on mosquito larvae.
Spraying of insecticide.</td></tr>
<tr><td>Q.3</td><td>“Smoking is injurious to health” “Smoking causes cancer”
a) Where are these statutory warnings displayed?
b) How does smoking affect our health?
c) Which forms of cancer are commonly associated with tobacco consumption?
d) Suggest two ways in which youth can be dissuaded from smoking?
Ans. a) On packets of cigarette, during movies.
b) Causes emphysema/bronchitis/coronary heart disease/gastric ulcer.
c) Smoking increases risk of cancers of lung, urinary bladder, throat and oralcavity.
d) Informing youth about the ill effects of smoking, Teach them ways of healthy management of stress, Showing visuals of people suffering from emphysema/cancer due to smoking.</td></tr>
<tr><td>Q.4</td><td>You are living in a hostel room with three other students. One of them develop scaly lesions on the skin which are itchy.
a) What is he suffering from?
b) Name two pathogens responsible for this disease. What type of pathogens are they?
c) What type of conditions are suitable for growth of this pathogen?
d) Suggest a few you and your friends should take to prevent the pathogen from infecting you.
Ans. a) Ringworm
b) Epidermophyton/Microsporum/Trichiphyton, fungi
c) Warm and humid
d) Keep body clean/ not share towel, comb with others etc</td></tr>
</table>

4 MARKS QUESTIONS (CASE BASED)WITH ANSWERS	
Q.1	A national level survey conducted to generate a database on substance abuse in India in 2016 found a staggering 1.58 crore children aged between 10 and 17 years were addicted to some substance in the country. Alcohol is the most commonly used psychoactive substance followed by cannabis and opioids. a) Why according to you such a large number of children are addicted to drugs and alcohol? b) Which of the above mentioned drugs is also used as a medicine? What purpose is it used for? c) Suggest a few steps to protect children from drug abuse. **Ans.** a) Curiosity, need for adventure and excitement and experimentation/ study related stress, to appear cool and progressive, celebrities promoting the use of alcohol on social media, peer pressure etc. b) Opioids – used as sedative and painkiller. c) Avoid undue peer pressure, Education & counselling, support from parents and peer, providing professional and medical help
Q.2	A friend of yours has suddenly isolated himself from his classmates. His performance in school exam has also deteriorated. He is not attending school regularly either. When he comes to school he is often found sleeping in class. On being asked he behaves very aggressively and brushes you off. a) What can be the possible reason for this sudden change? b) What should you do to help your friend? c) How can this adversely affect his social life? **Ans.** a) He is most likely using drugs or alcohol because all of these are danger signs of possible drug abuse. b) Seek help from school counsellor, consult his parents, inform teachers, form a group of friends to help him. c) Deteriorating relationship with family and friends, social adjustment problems etc

Analyze, evaluate & create

MCQ

Q1. The following are the reasons why climate change may increase the occurrences of mosquito borne diseases all over the world. Which one of the following may not be the reason for this increase?

a) Lengthening of breeding season of mosquito b) Expansion of areas where mosquito thrive

c) Droughts becoming longer and more intense

d) Re-emergence of mosquito in areas where their numbers had subsided

Ans. c

Q2. The following graph depicts the prevalence of HIV among injecting drug users (IUDs) and non-injecting drug users (Non-IUDs) in three cities.

The reason for prevalence of HIV among injecting drug users is –

a) HIV spreads through transfusion of contaminated blood

b) HIV spreads through sharing of contaminated syringe and needle

c) HIV spreads through having unprotected sex with infected person

d) HIV spreads from mother to child through placenta

ASSERTION REASON QUESTIONS

3. The following questions consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:
a) Both A and R are true and R is the correct explanation of A.
b) Both A and R are true and R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.

Q1**. Assertion** : Transmission of HIV from mother to child is considered to be congenital.
Reason : The infection is present at birth.

Answer Q.No 1-C 2- B 3- d

2 MARKS QUESTIONS WITH ANSWERS

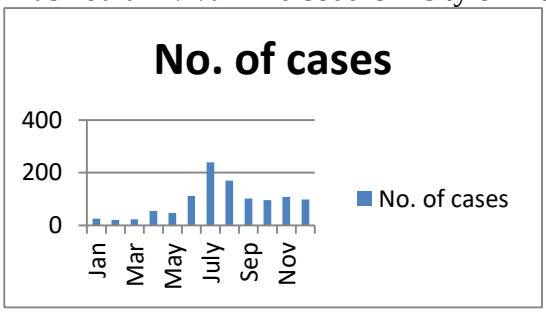
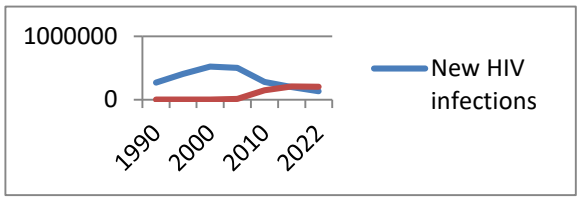
Q.1 Abir felt a soft roundish lump just beneath the skin on his neck. The doctor said it is a benign fatty tumour. The word tumour made Abir think of cancer and he was very worried.
a) What is a benign tumour?
b) Do you think Abir needs to worry about cancer? Give reason.
Ans. a) Tumour which is confined to its original location and do not spread to other part.
b) No. the do not spread from one location and cause little damage.

Q.2 HPV vaccine protects against cervical cancer caused by Human Papilloma virus.
a) Name the gene present in HPV that causes cancer.
b) Human cells also have similar cancer causing genes. What are they called?
c) If a person possesses these genes, will he definitely suffer from cancer? Give reason.
Ans. a) viral oncogene.
b) cellular oncogene /Proto oncogene.
c) No. when proto oncogenes are activated under certain conditions/it may result in oncogenic transformation of the cell into cancerous neoplastic cells.

3 MARKS QUESTIONS WITH ANSWERS

Q.1. A lot of *Parthenium* was growing in and around a playground where children usually played. A few children started complaining of breathing difficulty, sneezing, watery eyes etc.
a) What is possible reason for these symptoms?

b) Which chemicals are responsible for these symptoms?
c) Which drugs will be effective in treating these symptoms?
Ans. a) Pollen allergy b) Histamine and serotonin released from mast cell
c) Anti-histamine, Adrenalin, Steroids

	4 MARKS CASE BASED QUESTIONS WITH ANSWERS
Q.1	The following is a graphical representation of number of individuals infected with *Plasmodium vivax* in a southern city of India in a year.  a) Suggest a possible reason for the sharp rise in the number of cases during the month of July-August. b) What steps should be taken to control the spread of such vector borne disease. c) Name two other mosquito borne diseases that also occur during this time of the year in India. **Ans.** a) *Plasmodium vivax* causes malaria. It is transmitted by female Anopheles mosquito. Mosquito breeds in water. Since June- September is the monsoon season in south India and all the states receive a lot of rainfall, the overflowing water bodies provide suitable breeding places for mosquito. This increases the number of cases of mosquito borne disease such as malaria. b) Prevent unnecessary accumulation of water/Spray insecticides in drains and ditches/ introduce mosquito larva eating fish like mosquito in pond/ clear blockages in drains for quick drainage of rain water. c) Dengue, Chikungunya.
Q.2	Mother to child transmission of HIV can occur – During pregnancy – the foetus is infected with HIV passing through placenta During delivery – baby is infected with HIV through mother's blood during childbirth During breastfeeding – the baby is infected with HIV through mother's breast milk. The following graph is showing new HIV child infections vs. number of infections averted due to effective prevention of mother to child transmission (PMTCT) in the world between 1990 and 2022.  a) How the numbers of new HIV cases have been brought down? (suggest 2 ways) b) Suggest a few ways in which spread of HIV infections in adult population can be brought. Ans. a) Testing of vulnerable populations, early child testing, Anti-retroviral therapy for mother and new-borns, stop breastfeeding by infected mother. b) Ensure blood from blood bank is not contaminated, Advocating safe sex, Promoting use of disposable syringe and needle, regular, regular checking of vulnerable populations.

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CHAPTER -9 MICROBES IN HUMAN WELFARE

Summary

Microbes are the major components of the biological system on the earth.
They are diverse in forms - Protozoa, Bacteria, Fungi, Viruses and Viroids to Prions (Proteinaceous infecting agents).

Microbes in household products:

1. LAB (Lactic Acid Bacteria): It converts milk into curd and improves nutritional value of milk by increasing vitamin $\mathbf{B_{12}}$ .It stops the growth of pathogens in the stomach,

2. Dough: The dough is fermented by bacteria or yeast(*Saccharomyces cerevisiae)* is used for making Dosa & Idli. The puffed up appearance of dough is due to production of $\mathbf{CO_2}$ gas during anaerobic respiration.

3. Toddy: is an alcoholic drink made by fermenting sap from palm tree by bacteria in South India.

4.Cheese: Different varieties of cheese are formed by different microbes that give different taste, flavour and texture, e.g., "Swiss cheese " is formed by bacterium *Propionibacterium sharmanii*, which produce large amount of CO_2 and hence large holes.

"Roquefort cheese" is ripened by growing a fungus *Penicillium roqueforti* on them that give them a particular flavour.

Microbes In Industrial Products

1.Fermented Beverages: *Saccharomyces cerevisiae* (Brewer's yeast) is used in bread making , fermenting malted cereals & fruit juices to produce Ethanol. Wine & Beer are produced without distillation, Whisky, Brandy & Rum are produced by distillation of fermented broth.

2.Antibiotics: Are chemical substances, which are produced by microbes and kill the growth of disease causing microbes.

Penicillin: First antibiotic discovered by Alexander Fleming in 1929.

He extracted Penicillin from *Penicillium notatum*. Ernest Chain & Florey established its full potential as an effective antibiotic. Fleming, Chain and Florey were awarded Noble prize in (1945).

Some deadly diseases treated by antibiotics – plague ,whooping cough, diphtheria, leprosy.

3.Chemicals, Enzymes & others Bioactive molecules:Some Microbes are used for commercial and industrial production of certain chemicals that are used for human welfare.

1.Organic Acids: They are raw materials for chemical industries.

Aspergillus niger (a fungus): produces Citric Acid
Acetobacter aceti (a bacterium): Acetic Acid
Clostridium butylicum (a bacterium) : Butyric Acid
Lactobacillus (a bacterium) : Lactic Acid

2. Alcohol : Yeast (*Saccharomyces cerevisiae*) – Ethanol

3.Enzymes:

Lipases: Used in detergent formulations. Help to remove oily stains.
Pectinases & Proteases: Used to clarify the bottled juices.
Streptokinase: Produced by *Streptococcus* bacteria. It is used as a "clot buster " to remove clots from blood vessels of patients who have myocardial infarction.

4. Other Bioactive molecules:

Cyclosporin A- Is produced by fungus *Trichoderma polysporum* and is used as immunosuppressant in organ transplant patients.

Statins -Are produced by a fungus *Monascus purpureus* and is used as blood - cholesterol lowering agents.

Microbes in Sewage Treatment:

Sewage: It is municipal wastewater that contains human excreta, organic matter and microbes(many are pathogenic).

Sewage is treated in Sewage Treatment Plants (STP) to make it less polluting. This treatment is carried out in two stages:

Primary Treatment (Physical treatment): In the **primary settling tank**

• Removal of floating debris by filtration, Removal of soil & pebbles by sedimentation.

• All solids that settle form the **primary sludge** and supernatant form the **primary effluent.** The effluent is taken for secondary treatment.

Secondary treatment (Biological treatment):

• Primary effluent passed into a large **aeration tank** & constantly agitated.

• This allows vigorous growth of aerobic microbes like chlorella, fungi, bacteria and protozoans into **flocs**.Flocks are masses of bacteria associated with the fungal filaments These microbes consume major part of the organic matter.

• This reduces the **BOD (**(Biochemical Oxygen Demand) of the effluent.

• The effluent is then passed into a **settling tank** where bacterial flocs are allowed to sediment. This sediment is called "**Activated Sludge**".

• The small part of activated sludge is pumped back into aeration tank to serve as inoculum. And remaining part into large tank **(Anaerobic sludge digesters)**. Some anaerobic bacteria digest the bacteria and fungi in the sludge by producing gases: CH_4, H_2S, and CO_2 **(Bio** gases). Finally, this treated sewage is allowed for chemical treatment for disinfection and thrown into natural water bodies.

BOD: Represent the amount of dissolved O_2 required for the complete oxidation of all the organic matter present in one litre of H_2O by bacteria at 20^0C.

Higher BOD indicates water is highly polluted. Lower value of BOD means water is less polluted.

Microbes in production of Biogas: Methane gas is the main gas of Bio gas. Used for cooking & lighting. Methanogens grow anaerobically on cellulosic material and produce methane gas.

Biogas plant:

1.A concrete tank: 10-15 feet deep collects biowaste & slurry of dung.

2.Floating cover: placed over slurry

3. An outlet: is connected to a pipe to supply Biogas.

IARI and KVIC developed the technology of Biogas production in India.

Microbes as Biocontrol agents:

Biocontrol: Biological methods for controlling plant diseases and pests that relies on natural predation rather than introducing chemicals.

Bacillus thuringiensis (Bt.)

1-It is available in sachets as dried spores mixed with water and sprayed on plants as Brassica, Cotton & fruit trees, where leaves are eaten by insect larvae. In the gut of larvae, toxin is released & larvae get killed.

2-Baculoviruses (genus Nucleopolyhedrovirus): They are pathogens on insects and other arthropods that damage crops. They are species-specific, as such have narrow spectrum insecticidal application on insects & pathogens . Desirable in IPM programme to conserve beneficial insects.

Microbes as Biofertilizers:

Microbes that enrich the nutrient quality of the soil: Bacteria, fungi, cyanobacteria are used as Biofertilizer to promote Organic farming and check overuse of chemical fertilisers. Rhizobium bacteria and Cyanobacteria have property of N_2 fixation.

1-Free living bacteria such as **Azospirillum & Azotobacter** enrich N_2 content of the soil.

2-Mycorrhiza: is symbiotic association of fungi e.g., Glomus with roots of higher plants. Fungus absorbs phosphorus from soil and pass it to plant, give resistance to pathogens, tolerance to salinity & drought.
3-Cyanobacteria: Anabaena, Nostoc, Oscillatoria fix N_2.

Key Words & Concepts

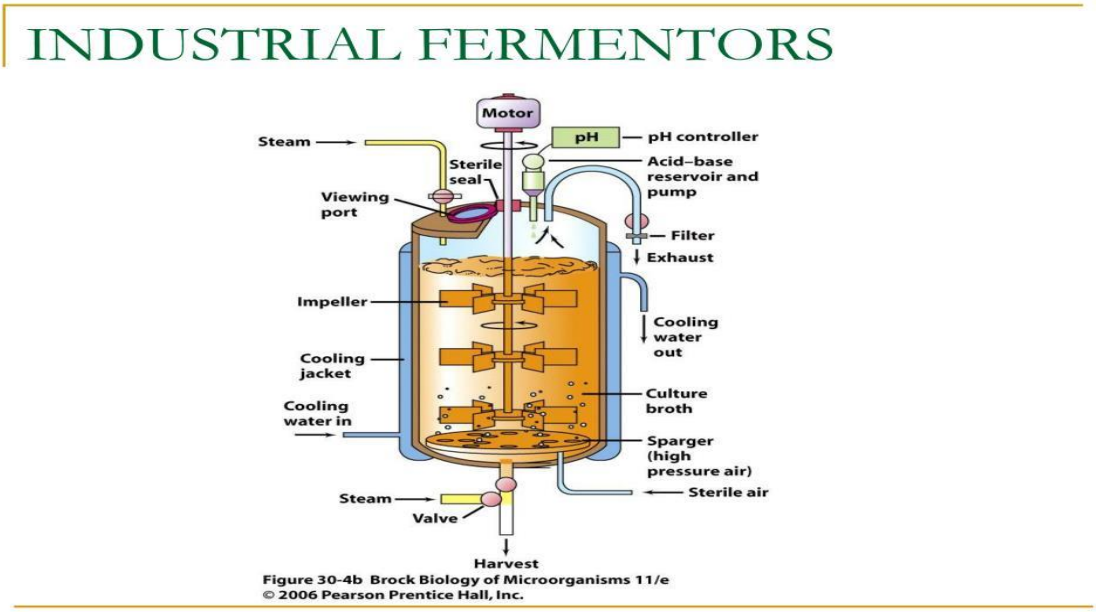
Activated sludge-The sediment formed in the settling tank during secondary treatment , mainly consists of bacterial flocs is called activated sludge.
Baculoviruses- These are viral pathogens that attack insects and arthropods. They are used to kill harmful pests and arthropods e.g., *Nucleopolyhedrovirus*.
Bioactive Molecules: Molecules produced for commercial use from microbes and used for various purposes in human welfare. e. g., *Trichoderma polysporum* (fungus) is used to obtain immunosuppressive agent cyclosporin-A.
Biofertilisers-These are the organisms that enrich nutrient quality of the soil. These Microorganisms produce fertilisers and enrich the soil e.g., Bacteria, Cyanobacteria and Fungi.
Fermentors-Very large vessels used for growing microbes on industrial/commercial scale.
Flocs-The masses of bacteria which grow anaerobically on cellulosic material and produce large amount of methane along with CO_2 and H_2.These are formed during secondary treatment of effluent.
Immunosuppressive Agent-Chemicals which suppress the immunity against organ transplant.
Methanogens: Bacteria producing large quantity of methane during decomposition of organic matter.
Organic Farming: Technique of farming, in which biofertilizers are used to enrich the soil, without using chemical fertilisers and pesticides to reduce their harmful effect on human health.
Primary sludge- All solids that settle during the primary treatment of sewage.
Thermal vents-: The sites deep inside the geysers/hot springs and oceans where the average temperature is as high as 100°C.
IARI- Indian agricultural research institute
GAP - Ganga Action Plan
YAP - Yamuna Action Plan
KVIC - Khadi and Village Industries Commission
TMV - Tobacco Mosaic Virus
IPM - Integrated Pest Management.

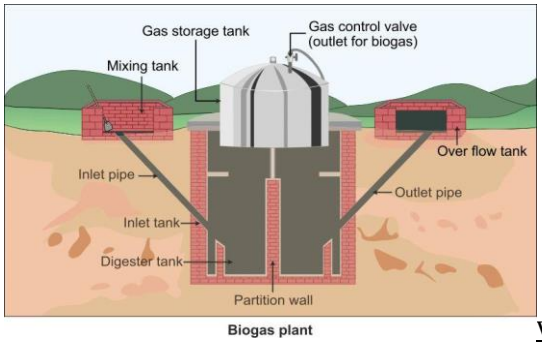
Certain chemicals like organic acids, alcohols and enzymes are produced by microbes.

Microbes	Product
Aspergillus niger (a fungus)	Citric acid
Acetobacter aceti (a bacterium)	Acetic acid
Clostridium butylicum (a bacterium)	Butyric acid
Lactobacillus (a bacterium)	Lactic acid
Saccharomyces cerevisiae (Yeast)	Ethanol

Microbial product		Commercial use
Lipases (*bacillus and pseudomonas*)		Useful in removing oily stains from the laundry.
Pectinases (*Aspergillus niger)* and proteases (*Streptomyces* sp. & *Bacillus subtilis*)		Clarifying fruit pulp in bottled juices
Source organism	Bioactive molecule	Medicinal use
Streptococcus(bacterium)	Streptokinase	Used as a clot buster'. Removing clots from the blood vessels of patients who have undergone myocardial infarction
Trichoderma polysporum (fungus)	Cyclosporin-A	Immunosuppressive agent in organ-transplant patients
Monascus purpureus (Yeast)	Statins	Blood-cholesterol lowering agents.It acts by competitively inhibiting the enzyme responsible for synthesis of cholesterol

Figures





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QUESTION BANK

TOPIC-MICROBES IN HOUSEHOLD PRODUCTS

Q1. Rashi was asked by her teacher to list the use of microbes in household products. What couldn't have been her 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.

Q2.Toddy a drink mostly consumed in some southern parts of India are prepared by fermentation of sap of:

Papaya (b) Palms (d) Grapes (d) Mango

Ans- 1-(b) 2- (b)

Q3. **ASSERTION REASONING QUESTIONS**

Answer these questions with appropriate options given below:

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

(i) Assertion: For bread making, dough is fermented by yeast only.
Reason: The dough got puffed-up due to the production of carbon dioxide.

Ans- d. Assertion is false and Reason is true.

(ii) Assertion: Meals having curd is good for health.
Reason: LAB present in curd have very beneficial role in checking disease causing microbes and providing Vitamin B12 to human body.

Ans-a. Both Assertion and Reason are true and Reason is the correct explanation of Assertion

Q4. A microbe is deliberately grown over Roquefort cheese to give it a particular flavour. Identify the microbe.

Ans- It is a fungus, *Penicillium roqueforti* which is grown with Roquefort cheese to give it a particular flavour.

Q5. Suggest any one benefit obtained from these microbes:

a) LAB b) *Saccharomyces cerevisiae c) Propionibacterium sharmanii*

Ans-a) Convert milk to curd b) Helps in Bread/ alcoholic drinks
c) Produces large holes in Swiss cheese.

Q6. **CASE BASED QUESTION**

Read the passage and answer any 4 questions out of 5 questions:

Some microbes have an expanding application in Food industry. These microorganisms can ferment carbohydrates to produce chemicals, and are currently widely used in the food fermentation industry. They are used to improve the flavour of fermented foods, increase the nutritive value of foods, reduce harmful substances, increases shelf life, and so on. They can also be used as probiotics to promote health in the body.

(i) State the full form of LAB.

Ans-Lactic Acid Bacteria.

(ii) Lactic acid bacteria can be found in which type of food?

Ans-In curd and yogurt

(iii) Give an outline of curd formation.

Ans-Curd is formed by adding a small amount of curd to warm milk, which acts as a

starter(inoculum). Microbes (LAB) present in the starter multiply at suitable temperature and convert milk into curd.
(iv) What happens to the milk protein during formation of the curd?
Ans- Acids released by LAB during the growth coagulate and partially digest milk protein, casein thus increases the digestibility of milk protein.
(v) State the useful applications of LAB.
Ans-Application of LAB:
(i) Improves nutritional quality of milk by increasing vitamin-B12.
(ii) Check disease-causing microbes in the stomach.

LONG ANSWER QUESTION
Q 1. Some Microbes release a gas during metabolism that is used to make household beneficial products.
a)Name the gas produced due to their metabolic activity .
b) Summarise the role of any four microbes in making house hold beneficial products.
Ans. a) CO_2
(i) Large holes in Swiss cheese -- Propionibacterium sharmanii
ii)Ripening of Roquefort cheese ---A specific fungi
iii)) Puffed appearance in Dough and softness in Bread --- *Saccharomyces cerevisiae*
(iv) Conversion of milk to curd - LAB

TOPIC-MICROBES IN INDUSTRIES
Q1. Select out of these which one of the following alcoholic drinks is produced without distillation? **(1mark)**
a) Wine b) Rum c) Whisky d) Brandy
Ans- a) Wine.
Q2.Identify the producer of citric acid:
(a) *Aspergillus* (b) *Clostridium* (c) *Saccharomyces* (d) *Pseudomonas*
Ans- (a) Aspergillus.

Q3. **ASSERTION REASONING QUESTIONS**
Answer these questions with appropriate options given below:
a. Both Assertion and Reason are true and Reason is the correct explanation of Assertion
b. Both Assertion and Reason are true and Reason is not the correct explanation of Assertion
c. Assertion is true and Reason is false
d. Assertion is false and Reason is true.
Assertion: Cyclosporin A is an immunosuppressive medicine.
Reason: It causes activation of T-cells and prevents rejection of new organ in body.
Ans- c. Assertion is true and Reason is false.
Q4. Suggest how the discovery of antibiotics helped mankind in the field of medicine?

Ans- Antibiotics have helped mankind in treating most of the deadly bacterial and fungal diseases of humans.
Q5.(i)As a Doctor what would you suggest for a patient who had suffered myocardial infarction and for clots found in his blood vessels? Name the microbe from which it is extracted?
(ii) Children normally prefer fruit juices that are purchased from market rather than prepared at home as they are much clearer. State what is added to make clearer fruit juices? **(3marks)**
Ans- (i) Streptokinase- Clot buster can be used to dissolve clots. It is obtained from the bacteria *Streptococcus*. (ii) Pectinases

Q6. Case Based Questions:

Read the passage and answer the questions:

Microbes are used for commercial and industrial production of certain chemicals like organic acid, alcohol and enzymes.Examples of organic acids producers are *Aspergillus niger* (a fungus) , *Acetobacter aceti* (a bacterium); *Clostridium butylicum* (a bacterium) and *lactobacillus* (a bacterium) . A yeast and a fungus produces other bioactive molecules that have a life saving role in human welfare.

i) Suggest what is to be used in detergent formulations that are helpful in removing oily stains from the dirty clothes?

a) Lipases b) Proteases c) Pectinases d) Statins

ii) Identify a clot buster used in patients suffering from myocardial infarction.

a) Streptokinase b) Cyclosporin A c) Lipases d) Statins

iii) Arsha had a kidney transplant. She is kept isolated and administered a bioactive compound for her new kidney to work properly. Identify the molecule being administered to her.

a) Streptokinase b) Cyclosporin A c) Monascus purpureus d) Statins

iv) For industries, *Aspergillus niger* is used for commercial production of which acid?

a) acetic acid b) butyric acid c) lactic acid d) citric acid.

v) —---------- is used in production of breads & ethanol.

a) Spirogyra b) Bacteria c) Blue green algae d) Yeast

Ans. i) -a ii) –a iii)-b iv) –d v) d)

LONG ANSWER QUESTION

7. Suggest one usefulness of these microorganisms to mankind**:**

(i) *Streptococcus (ii) Clostridium butylicum (iii) Monascus Purpureus*

(iv) Trichoderma polysporum. (v) Penicillium notatum

Ans-(i) *Streptococcus*- Production of Streptokinase that is used as clot buster in blood vessels.

(ii) *Clostridium butylicum*-Production of butyric acid.

(iii) *Monascus Purpureus*- To produce statins as blood cholesterol lowering agent.

(iv)*Trichoderma polysporum*-Preparation of cyclosporin A having immuno-suppressive properties.

(v)*Penicillium notatum*-Production of antibiotic, Penicillin.

TOPIC-MICROBES IN SEWAGE TREATMENT

Q.1. The greater the BOD of waste water, more is its —----------.

a) cleanliness b) CO_2 potential c) polluting potential d) water level

Q.2.The masses of bacteria held together by fungal filament to form mesh-like structure are called

a) primary sludge b) flocs c) activated sludge d) anaerobic sludge.

Ans- 1-(c) 2-b

Q.3.**ASSERTION REASONING QUESTION**

Answer these questions with appropriate options given below:

a. Both Assertion and Reason are true and Reason is the correct explanation of Assertion

b. Both Assertion and Reason are true and Reason is not the correct explanation of Assertion

c. Assertion is true and Reason is false

d. Assertion is false and Reason is true.

(i) Assertion: The chief component of biogas is CH4.

Reason: Biogas plants are prepared on foreign technology

Ans- c. Assertion is true and Reason is false.

(ii) **Assertion**: Activated sludge is formed during secondary treatment.
Reason: All solids that settle in the settling tank by sedimentation form the primary sludge.
Ans-c. Assertion is true and Reason is false
4. State the relationship between BOD and organic matter in sewage?
Ans- The greater the BOD of wastewater the more is the amount of organic matter in sewage.
5. How Flocs are formed during sewage treatment. State its application in sewage treatment.
Ans- Flocs are mesh-like structures containing aerobic bacteria and fungal mycelium. These are formed in aerobic tanks when organic matter is abundant. They digest the organic matter in sewage and reduce its pollution potential.

Q.6. CASE BASED QUESTIONS

Read the following text and answer any 4 out of 5 of these questions:

Nowadays a large quantity of wastewater is generated every day in metro cities and towns which is treated in sewage treatment plants (STPs) because it contains human excreta, organic matter and microbes. Many of which are pathogenic. So, this cannot be discharged into natural water bodies like rivers and streams directly. Treatment of this sewage in STPs to make it less polluting by heterotrophic microbes through primary & secondary treatments.
1. State what happens during the primary treatment of sewage?
Ans- 1.-Suspended solids, floating debris are removed, grit and soil settle in settling tanks to form Primary sludge.
2. What is sewage? In which way can sewage be harmful to us?
Ans-Sewage is the municipal waste-water collected from city or town, homes, that contains toilet, bathroom and kitchen waste. It contains large amounts of organic matter and many pathogenic bacteria to cause many diseases.
3. Primary effluent is passed into large aeration tanks:
A) To allow bacterial flocs to settle down B) To allow fast growth of aerobic microbes into flocs C) To allow anaerobic sludge digestion D) None of these.
Ans- B) To allow fast growth of aerobic microbes into flocs
4.State the technical term used for sediment formed in sewage treatment:
A) Flocs B) Effluent C) Activated sludge D) Anaerobic sludge
Ans-C) Activated sludge.
5. Which step in sewage treatment removes suspended solids:
A) Tertiary treatment B) Secondary treatment C) Primary treatment D) Sludge treatment.
Ans-C) Primary treatment.

LONG ANSWER TYPE QUESTION

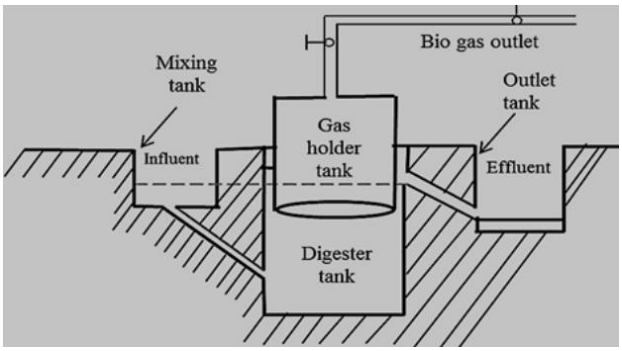
Q.7. Describe the primary and secondary treatment of domestic sewage before it is released for Reuse.
Ans- Treatment of domestic sewage. The municipal wastewaters are treated in Sewage Treatment Plant (STP) prior to disposal in water bodies.
It consists of 2 steps: Primary, Secondary.
1. Primary treatment. It includes physical processes, such as sedimentation, floatation, shredding (fragmenting and filtering). These processes remove most of the large debris.

2. Secondary treatment. It is a biological method. Sewage, after primary treatment, is pumped into aeration tanks. Here, it is mixed with air and sludge containing Fungal filaments with bacteria into flocs. Bacteria consume organic matter. During secondary treatment, biological processes are used to remove dissolved and suspended organic matter measured as biochemical oxygen demand (BOD).As BOD decreases pollution level of sewage is also reduced and now it can be passed to water bodies.

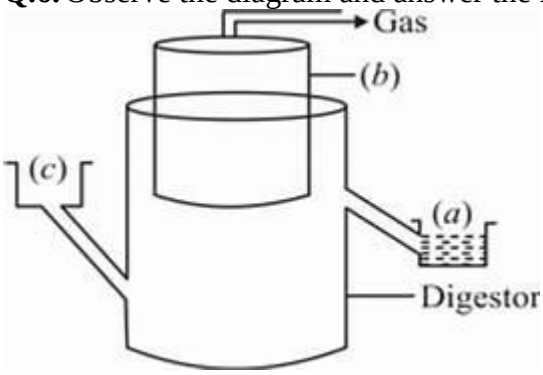
TOPIC-MICROBES IN BIOGAS PRODUCTION

Q.1. The spent slurry from biogas plant can be used as
(a) Cooking fuel (b) Manure (c) Biofertilizer (d) Inoculum.
Ans- (b) Manure
Q.2. State the group of microbes that produces Biogas
(a)Aerobic Bacteria (b) Anaerobic bacteria (c) Protozoa (d) Viruses
Ans- (b) Anaerobic bacteria
Q.3.ASSERTION REASONING QUESTION
Answer these questions with appropriate options 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 and Reason is false
d. Assertion is false and Reason is true.
Assertion: Biogas can be used as an alternative to fossil fuel.
Reason: Biogas is produced by the microbial fermentation of only cow dung.
Ans- c. Assertion is true and Reason is false
4.Describe the reason of adding slurry of cattle dung (gobar)in the tank of a bio gas plant for the generation of biogas?
Ans- Slurry consisting of excreta (dung) of cattle commonly called gobar is rich in methanogenic bacteria. It is used for the generation of biogas. These bacteria called methane bacterium grow anaerobically and break down the cellulosic material releasing gases commonly called Biogas.
Q.5. Draw the well labelled diagram of the Biogas plant.

Ans- Any 6 correct labels



Q.6. Observe the diagram and answer the following questions:



(i) Identify a, b and c. (ii) State the significance of the product a.

(iii) Explain the sequence of events occurring in a biogas plant.

Ans-(i) a-Spent slurry, b-Gas holder, C-Sludge tank

(ii) a -is the spent slurry which is removed through another outlet and may be used as fertilizer.

(iii) The biogas plant tank is fed with slurry of dung. A floating cover is placed over the slurry which keeps on rising as the gas is produced in the tank due to the microbial activity of methanogens like Methanobacterium. Methanogens grow anaerobically on cellulosic material in cow dung to produce large amounts of methane, CO2 and H2. The biogas plant has an outlet, which is connected to a pipe to supply biogas. The spent slurry is removed through another outlet.

TOPIC-MICROBES AS BIOCONTROL AGENTS AND BIO FERTILIZERS

Q.1. Which of the following cyanobacteria could be used by farmers regularly in their fields to replenish soil nutrients:

a. *Anabaena* b. *Nostoc* c. *Oscillatoria* d. *All the above*.

Ans- d. *All the above*.

Q.2. IPM stands for

a) Indian premier match b) Integrated pest management

c) Integrated piece management d) Integrated post management

Ans-b) Integrated pest management

3. ASSERTION REASONING QUESTION

Answer these questions with appropriate options given below:
a. Both Assertion and Reason are true and Reason is the correct explanation of Assertion
b. Both Assertion and Reason are true and Reason is not the correct explanation of Assertion
c. Assertion is true and Reason is false
d. Assertion is false and Reason is true.
(i) Assertion: Tolerance to salinity, resistance to root-borne pathogens, and drought can be developed in higher plants.
Reason: Symbiotic association of fungi with plants induces certain special characters in plants.
Ans- a.
(ii) Assertion: Biofertilisers are organisms that enrich the nutrient quality of the soil.
Reason: Biofertilizers are like decomposers.
Ans- c
Q.4. State a free-living and a symbiotic bacterium that serve as biofertilizer. Why are they so called? **(2marks)**
Ans- Free living-*Azospirillum/Azotobacter* andSymbiotic- Rhizobium act as biofertilizers. They are so called because they enrich soil nutrients by nitrogen fixation.

5. Discuss the statement- Biofertilizers or biopesticides are preferred to chemical fertilizers or pesticides?

Ans-Biofertilizers or biopesticides are preferred to chemical fertilizers or pesticides

Because - (i) They do not cause any pollution.

(ii) They do not spoil the quality of the soil. Biopesticides are target specific.

(iii) They are less expensive and are biodegradable.

Q6. CASE BASED QUESTION:

Read the passage and answer any 4 out of the 5 questions given below:

In the foreseeable future, agricultural output will need to keep up high with the rising global population. There is presently a significant drive to create low-input, more sustainable agricultural methods, including alternatives to chemicals for pest and disease management, which is a major cause of agricultural output losses. Researchers are concentrating on possible biological control microorganisms as feasible options for the management of pests and plant diseases due to the negative effects of certain pesticides on human health, the environment, and other species.

1. Define a biocontrol agent
a) Living organisms to control drought b) Living organisms to control rain
c) Living organisms to control pests & disease in plants
d) Living organisms to cause a disease.
2. Baculoviruses are excellent candidate for controlling pests as they are
a) Broad spectrum, target specific b) Species specific, narrow spectrum
c) Non target specific d) None of these
3. Disadvantage of employing living organisms to control other harmful organisms attacking plants are:
a) Reduces the use of chemicals and other pesticides.
b) Keep the pest population under control.
c) They are environment friendly and with no side effects.
d) Doesn't completely destroy a pest
Q.4. Match column I with the items in Column II (1 Mark)

COLUMN I	COLUMN II
Lady Bird	1.Plant pathogens
Bacillus thuringiensis	2.Insects
Baculoviruses	3. Aphids,mosquitoes
Trichoderma Fungus	4. Caterpillars,cotton bollworms

Choose the correct options from the following:

a) A-2, B-4, C-3, D-1 (b) A-3, B-4, C-2, D- 1 c) A-4, B-1, C-2, D -3 d) A-3, B-2, C-1, D-4

Q.5. Which fungus is used in management of plant pathogens? (1Mark)

a) *Monascus sp*. b) *Saccharomyces sp*. c) *Trichoderma sp.* d) *Claviceps sp.*

Ans -1-c, 2- b 3- d 4- b 5- c

LONG ANSWER QUESTIONS

Q.7.(a) Describe how does the application of the fungi to the agricultural farm increases the farm output? (b)Why is Rhizobium categorized as a 'symbiotic bacterium'? How does it act as a biofertilizer?

Ans- (a)Fungi form symbiotic association with the roots of higher plants called mycorrhiza, eg. Glomus. The fungal hyphae absorb phosphorus from soil and pass it to the plant. Mycorrhiza shows the following benefits:

(i) Resistance to root-borne pathogens. (ii) Tolerance to salinity and drought. (iii) Overall increase in plant growth and development. Due to increased availability of phosphorus there is an increase in farm output.

(b) Rhizobium is present in the root nodules of leguminous plants. They have a symbiotic relationship in which the bacterium obtains food and shelter from the plant and the plant gets fixed nitrogen in return. These bacteria fix atmospheric nitrogen into organic forms, which is used by the plant as a nutrient.

2. LEARNING OUTCOME—APPLICATION OF KNOWLEDGE/CONCEPTS

TOPIC-MICROBES IN HOUSEHOLD PRODUCTS

Q.1. Show which microbe is responsible for the Particular flavour of 'Roquefort cheese'

a) Propionibacterium sharmanii b) *Penicillium roqueforti*

c) *Penicillium notatum* d) *Sachharomyces cerevisiae*

Ans- b) *Penicillium roqueforti*

Q.2. Fermentation of batter to produce dosa-idli is carried out by the microbe__

a) *Streptococcus* b) *Sachharomyces cerevisiae*

c) *Trichoderma polysporum* d) *Monascus purpureus*.

Ans- b) *Sachharomyces cerevisiae*

3.ASSERTION REASONING QUESTION

Answer these questions with appropriate options given below:

a. Both Assertion and Reason are true and Reason is the correct explanation of Assertion

b. Both Assertion and Reason are true and Reason is not the correct explanation of Assertion

c. Assertion is true and Reason is false

d. Assertion is false, and Reason is true.

(i) **Assertion**: Swiss cheese 'can be recognised by the presence of large sized holes.

Reason: Large holes in Swiss cheese 'is due to the activity of fungal microbe.

Ans- c. Assertion is true, and Reason is false.

(ii)**Assertion**: *Penicillium notatum* is used for making bread.

Reason: Fermentation carried out by yeast produces a large amount of carbon dioxide.

Ans- d. Assertion is false and Reason is true.

Q.4. Milk start to coagulate when Lactic Acid Bacteria (LAB) is added to warm milk as a starter. Mention any other two benefits that LAB provides.

Ans-(1) It increase nutritional quality by increasing Vit. B 12 content. (2) It checks the growth of pathogens in gut.

Q.5.Yeast is an important ingredient for making soft and spongy breads. Illustrate the process involved and the cause of sponginess of bread.

Ans-The process involved is fermentation during which lots of CO_2 is produced that causes the sponginess of bread.

Q.6. CASE BASED QUESTIONS

Read the passage and answer any four out of the following 5 questions:

In everyday life, microbes and their products are used in the preparation of idli, dosa, cheese, curd, yogurt, dough, bread, vinegar, etc., Bacteria like *Lactobacillus acidophilus, L. lactis* and *Streptococcus lactis* commonly called lactic acid bacteria (LAB) are probiotics which check the growth of pathogenic microbes in the stomach and other parts of the digestive tract.Cheese is a dairy product produced in a wide range of flavours, textures and is formed by coagulation of the milk protein, casein.Cheese is a dairy product produced in a wide range of flavours, textures and is formed by coagulation of the milk protein, casein.

1. Fermentation carried out by which microbe give the characteristic taste in dosa and idli
a) Bacteria b) Fungi c) Protozoa d) Cyanobacteria
Ans- b) Fungi
(2) Doctors are suggesting the use of probiotics because it
a) Improves digestion b) improves blood circulation c) Check growth of pathogenic microbes in stomach d)Improves respiration
Ans- c) Check growth of pathogenic microbes in stomach.
(3) The specialty of Swiss cheese-the holes is because of
(a) a protozoa. (b) a fungus producing carbon dioxide
(c) a fungus that produces alcohol. (d) a bacterium producing carbon dioxide
Ans- (d) a bacterium producing carbon dioxide.
(4) Show among the following the plant whose sap is used in making Toddy
a) Rice plants b) Wheat plants c) Sugarcane d) Palm plants
Ans-d) Palm plants.
(5) Different varieties of cheese are available which are known by their texture, flavors and taste. One of the variety of cheese is grown with a fungus.Explain the reason behind it.
Ans- The cheese is grown with a variety of fungus to give it its characteristic flavour enjoyed by many.
Long Answer Type Questions:
Q.7. (i)When a small amount of curd is added as a starter to milk and kept at suitable temperature, there are changes that occur in fresh milk. Explain the reason behind it.
(ii) Rita 's mother told her about the preservation of food like bamboo shoots, fish and soyabean with the help of microbes. Explain which property of microbes help in preservation of such kind of foods.
Ans-(i)When a small amount of curd is added as a starter to fresh milk, millions of Lactic Acid Bacteria (LAB) present in the starter grow in milk and convert it to curd. During this process, acids are produced by LAB that coagulate and partially digest the milk proteins (casein). LAB increases vitamin-B12 content along with other vitamins in the curd.
(ii)There are so many microbes that can help in preserving certain foods like soyabean, bamboo shoots and fish. They preserve by controlling pathogenic microbes and also produce

certain other desirable characteristics in these products that increases their flavour and taste. The primary mechanism through which these microbes are used in food preservation is the process of fermentation.

TOPIC-MICROBES IN INDUSTRIES

Q.1. The metabolic pathway adopted in making 'alcohol 'is

a. Lactic acid fermentation b. Alcoholic fermentation

c. Glycolysis d. All the above.

Ans- b. Alcoholic fermentation

Q.2. The most common substrate used in distilleries for the production of ethanol **(1mark)**

(a) Wheat. (b) Molasses (c) Ground gram. (d) corn

Ans- (b) Molasses

Q.3.The microbe that is used for production of citric acid

(a) *Aspergillus (*b) *Clostridium* (c) *Saccharomyces* (d) *Acetobacter aceti*

Ans-(a) *Aspergillus.*

Q.4. ASSERTION REASONING QUESTION

Answer these questions with appropriate options given below:

a. Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.

b. Both Assertion and Reason are true and Reason is not the correct explanation of Assertion

c. Assertion is true and Reason is false

d. Assertion is false, and Reason is true.

(i)**Assertion**: Distillation of the fermented broth results in the production of Wine and beer.

Reason: Alcoholic drinks are obtained only by fermentation and are always followed by the distillation process.

Ans- c. Assertion is true, and Reason is false.

(ii) **Assertion**: Alexander Flemming was the first to discover antibiotics.

Reason: Flemming's discovery was a chance discovery.

Ans- b. Both Assertion and Reason are true and Reason is not the correct explanation of Assertion.

Q.5.A patient suffered internal injuries during an accident and had many blood clots which is risking his life. Illustrate what the Doctor may have prescribed to remove these blood clots and from which organism it is extracted?

Ans- The Doctor must have prescribed -Streptokinase, clot buster obtained from *Steptococcus*.

Q6.Distinguish between the mode of action of Cyclosporin A and Statins.Show their source organisms.

Ans-Cyclosporin A is an immunosuppressant and used in patients who have undergone organ transplantation. It is obtained from *Trichoderma polysporum.*

Statins are used as blood cholesterol lowering agent. It is obtained from *Monascus purpureus.*

Q.7. CASE BASED QUESTIONS

Read the passage below and answer given questions:

Microbes are microscopic organisms. They are used in many large-scale industrial processes. Micro-organisms were used in industrial processes even before their existence was known. Choosing the appropriate expression systems is important for the enzyme production rate, and bacteria, filamentous fungi, and yeasts have been used to express recombinant enzymes. Biotechnological applications have increased in number due to the advantages of these species. The microorganisms secrete the enzymes into their nutrient medium to make better

use of it.

(a) Doctors prescribe a microbial enzyme to patients suffering from myocardial infarction. Show the effect of the enzyme along with its name.
Ans- Streptokinase. It helps in removing clots from the blood vessels of patients who have undergone myocardial infarction leading to heart attack.
(b) Is it possible to lower blood-cholesterol to prevent cardiac problems? If so how?
Ans-Yes by administering statins. It acts by competitively inhibiting the enzyme responsible for synthesis of cholesterol.
(c) An antibiotic called Wonder Drug was used to treat the wounded soldiers of America during World War-ll. Name the drug and the scientist who discovered it.
Ans- Penicillin is the wonder drug and it was discovered by Alexander Flemming.
(d) How fruit juice industries are making clearer fruit juices which is not possible at home? Illustrate their strategy.
Ans-Fruit Juice Industries are adding enzymes Pectinases and Proteases to clarify their juices.
(e) It is a well-known fact that if you use a good detergent, your clothes will be free from oily stains. Show which constituent enzyme plays a major role in this process.
Ans - Lipases are used to make detergents to clean the oily stains.

LONG ANSWER TYPE QUESTIONS

8. Fill in the blanks-a, b, c, d and e:

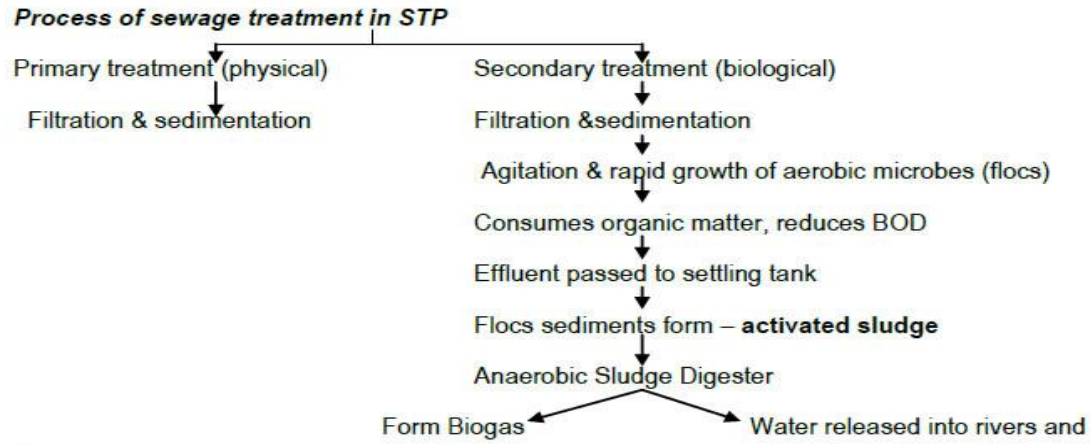
Name of the Microbe	Product	Purpose
Streptococcus	Streptokinase	a
Monascus purpureus	b	Lowers blood cholesterol
Saccharomyces cerevisae	c	Used in Medicines, Antiseptic.
Trichoderma polysporum	d	Immunosuppressive drug
e	Penicillin	Antibiotics

Ans- a– used as a 'clot buster'. b- Statins c-Alcohol
d- Cyclosporin A e-*Penicillium notatum*

TOPIC-MICROBES IN SEWAGE TREATMENT

Q.1.Show from the following in which stage of the purification of the sewage water microbes are used?
(a) Primary treatment (b) Secondary treatment
(c) Both (a) and (b) (d) None of these
Ans- (b) Secondary treatment
2. The ability to settle quickly should be the property of Activated sludge so that it can
a) Absorb pathogenic bacteria present in wastewater while sinking to the bottom of the settling tank
b) Be rapidly pumped back from sedimentation tank to aeration tank to be inoculum.
c) Be discarded and anaerobically digested
d)Absorb colloidal organic matter.
Ans- b) Be rapidly pumped back from sedimentation tank to aeration tank to be inoculum.
Q.3.ASSERTION REASONING QUESTION
Answer these questions with appropriate options given below:
a. Both Assertion and Reason are true and Reason is the correct explanation of Assertion
b. Both Assertion and Reason are true and Reason is not the correct explanation of Assertion
c. Assertion is true and Reason is false
d. Assertion is false and Reason is true.

(i) Assertion: Water fit for consumption should contain least or no organic matter.
Reason: Greater the BOD of water lesser is its polluting potential.
Ans-c. Assertion is true, and Reason is false.
(ii)Assertion(A): Methanogens are only present in the rumen of cattle.
Reason (R): The breakdown of cellulosic materials in the rumen is carried out by methanogens.
Ans-d. Assertion is false and Reason is true.
Q.4.Two water samples A and B are given having BOD 3ppm and 20 ppm. Ashish was asked to determine the sample which is less polluting and why?
Ans- Ashish's answer was Sample A as less BOD, less pollution.
Q.5. Explain why aerobic degradation of Sewage water is more important than anaerobic degradation for the treatment of large volumes of wastewaters rich in organic matter?
Ans- Aerobic degradation is more important as naturally occurring aerobic and facultative microbes (bacteria, fungi, Protozoa and others) in the waste water can rapidly oxidise soluble organic and nitrogenous compounds. Mechanical addition of oxygen makes the process faster and most of the pathogenic content of the effluent is removed.
Q.7.CASE BASED QUESTIONS
Read the passage below and answer any 4 questions out of the 5 questions:
Wastewater treatment, also called sewage treatment,is the removal of impurities from wastewater, or sewage, before it reaches aquifers or natural bodies of water such as rivers, lakes, estuaries, and oceans. Since pure water is not found in nature (i.e., outside chemical laboratories), any distinction between clean water and polluted water depends on the type and concentration of impurities found in the water as well as on its intended use. In broad terms, water is said to be polluted when it contains enough impurities to make it unfit for a particular use, such as drinking, swimming, or fishing. Water pollution, therefore, is caused primarily by the drainage of contaminated wastewater into surface water or groundwater, and wastewater treatment is a major element of water pollution control.
i) What is activated sludge?
(a)Masses of flocs (b) Masses of bacteria (c)Masses of Virus (d) Masses of fungi
ii) Explain the fate of activated sludge in the sludge digester.
(a) Converted to ammonia gas (b)converted to Nitrogen gas
(c) converted to CO2 gas (d) converted to Biogas
iii) What are flocs in STP?
Ans-Masses of bacteria associated with fungal filaments to form mesh like structures in aeration tank.
iv) Mention the role of flocs in STP.
Ans-These microbes consume the major part of the organic matter in the effluent and reduces the BOD.
v)Activated sludge formed in STP is used in
(a)Aeration tank to serve as inoculums (b) Anaerobic sludge digester.
(c) Used in aeration tank as well as anaerobic sludge digester **(**d) Used in sedimentation tank.
Ans-i) -a ii)-d v) -c
LONG ANSWER QUESTION
Q.8. Large quantities of sewage are generated every day in cities and towns, which is treated in Sewage Treatment Plants (STPs) to make it less polluted. Given below is the flow diagram



Observe the flow chart carefully and answer the questions that follow:

(i) For what purpose primary effluent is passed in large aeration tanks?
Ans-The primary effluent is passed in large aeration tanks for proper suspension of organic matter, for rapid growth of microbes and for rapid digestion of organic matter.
(ii) Explain how 'flocs' and 'activated sludge' help in sewage treatment?

Ans-Flocs are masses of aerobic bacteria associated with fungal filaments to form mesh like structures. These aerobic microbes consume the major part of the organic matter in the effluent. This significantly reduces Biological oxygen demand (BOD) of the effluent. A small part of the activated sludge is used as inoculum and pumped back to aeration tank. The remaining major part of the sludge is pumped into anaerobic sludge digesters where microbes or bacteria grow anaerobically to produce CH_4 or H_2S or CO_2, or biogas.

(iii) Differentiate between primary and secondary sewage treatment?
Ans-The difference between primary and secondary treatment of sewage is that primary treatment is the physical process of removing grit and large pieces of organic matter while secondary treatment is a biological process that involves digestion of organic matter by microbes.

TOPIC-MICROBES IN BIO GAS PRODUCTION

1.Select the incorrect statement from the following:
I. Biogas is a mixture of gases made of predominantly methane.
II. Biogas is an example of fossil fuel and causes air pollution.
III. Biogas is produced by the microbial activity of methanogens.
IV. Methanogens are only found in the rumen of the cattle.
V. Biogas may be used as manure.
(a) I, II and III. (b) II, IV and V c) III, IV and V (d) III and V.
2. This fuel is considered as a clean, green fuel and obtained from wastes
a) Petrol b) Coal c) Biogas d) CNG
Ans- 1—b 2-- c

3.ASSERTION REASONING QUESTION

Answer these questions with appropriate options given below:
a.Both Assertion and Reason are true and Reason is the correct explanation of Assertion
b. Both Assertion and Reason are true and Reason is not the correct explanation of Assertion
c. Assertion is true and Reason is false

d. Assertion is false and Reason is true.
Assertion: The microbe converting activated sludge to Biogas requires anaerobic conditions.
Reason: The sludge digester is a concrete structure buried deep in ground.
Ans-a. Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
Q.4. Show an eco-friendly and pollution free alternative source of energy for rural areas which is dependent on microbial activity. Name the microbe involved.
Ans-An eco-friendly and pollution free alternative source of energy for rural areas is Biogas.
Microbe involved-Methanogens/ methanobacterium.
Q.5.Explain how Biogas is produced from activated sludge?Name the microbe involved in the production of this cooking fuel and mention the chemical composition of it.

Ans-The anaerobic digestion of activated sludge results in production of Biogas; Microbe-Methanogens/ methanobacterium;Chemical composition- Methane, carbondioxide, Hydrogen etc.

6. CASE BASED QUESTION

Read the passage below and answer any 4 questions out of 5 questions:
Biogas is a well-established, sustainable source and widely popular source of energy globally by virtue of its production from waste, and available cattle dung. The biogas substitutes both fuel and fertilizer, the plant gives gas and at the same time enhances the fertilizer value of dung. It is estimated that out of the total dung available, 69 % is used as manure, 29 % as cakes for fuel and remaining 2 % is used for other purposes. Cattle dung is the main raw material used for biogas production. India has the largest population of livestock of over 300 million which produce about 980 million tons of dung. The entire quantity of available cattle dung is used for biogas generation, it could generate about 195 billion kW-h of energy annually.
(a) Give reason for adding cow dung in the biogas plant.
Ans-Cow dung contain methanogens and undigested residues of cellulose and hemicellulose that cattle consume. This makes excellent bioresource for biogas production.
(b) Mention the main constituents of biogas.
Ans- Biogas chiefly consists of Methane, carbon dioxide and Hydrogen sulphide.
(c) What is the use of spent slurry?
Ans-The spent slurry is used as manures in fields.
(d) Explain the need of a concrete sludge digester tanks for generation of Biogas.
Ans- Biogas is produced by anaerobic bacteria. So an Anaerobic condition, free from oxygen is required for these anaerobic bacteria to digest dung and release biogas.
(e) Explain the role of Methanogens.
Ans- Methanogens are microorganisms that produce methane as a metabolic byproduct in anaerobic conditions.

TOPIC-MICROBES AS BIOCONTROL AGENTS AND BIO FERTILIZERS

1.Baculoviruses are pathogens that
(a) kill useful insects (b)attack insect pests, (c) Attack viruses and bacteria, (d)Kill protozoa
2.Identify the organism which cannot fix atmospheric nitrogen.
(a)Spirogyra (b)Oscillatoria, (c)Azotobacter (d)Nostoc
Ans- 1- b 2- a
Q3.ASSERTION REASONING QUESTIONS
Answer these questions with appropriate options given below:

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

Assertion (A): Cyanobacteria like Nostoc and Anabaena are used as biofertilisers.

Reason (R): Cyanobacteria directly fix atmospheric nitrogen in soil and passes it to crops.

Ans-a.Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

4. How photosynthetic biofertilisers improve soil fertility?

Ans-Photosynthetic biofertilizers are Blue green algae like Nostoc, Anabaena. They have the ability to fix atmospheric nitrogen into soil and also add organic material to the soil thus improving soil fertility.

5.Illustrate the application of the fungi to the agricultural field and how it increases the farm output?

Ans-Fungi form symbiotic association with the roots of higher plants called mycorrhiza, eg., Glomus. The fungal hyphae absorb phosphorus from soil and pass it to the plant. Mycorrhiza shows the following benefits: 1x3

(a) Resistance to root-borne pathogens.
(b) Tolerance to salinity and drought.
(c) Overall increase in plant growth and development.

Due to increased availability of phosphorus, there is an increase in farm output.

6. CASE STUDY BASED QUESTION

Read the passage below and answer any 4 questions out of 5 questions:

Biological control is a great hope for reducing the overutilization of pesticides in agricultural soils. It often involves microorganisms or molecules produced by microorganisms that will be able to interact with either a plant or pathogens of this plant to reduce the growth of the pathogen and limit its negative impact on the host plant. When new biocontrol products are developed, strains were mostly selected based on their ability to inhibit a pathogen of interest under in vitro conditions via antagonistic effects. Biological control is an alternative source to manage the plant disease. Biological control is an extremely supportive approach for disease management, and it is exceptionally valuable to make an eco-friendly environment.

(i) An organic farmer controls pests in agriculture by
a) Chemical fertilizers b) Natural predation
c) Morphological method d) Physiological method

(ii) Dragonflies are used to get rid of which pests?
a) Bumble bees b) Mosquitoes c) Earthworms d) Honey bees

(iii) What are biocontrol agents for controlling butterfly caterpillars?
a) *Bacillus thuringiensis* b) *Lactobacillus*
c) *Acetobacter aceti* d) *Treponema pallidum*

(iv) How is *Bacillus thuringiensis* available to be sprayed on plants?
a) In the form liquid spray b) In the form of crystals
c) In the form of dried spores d) In the form of wet spores

(v) Baculoviruses are not the excellent candidates for which kind of applications?
a) Species-specific applications b) Narrow spectrum applications
c) Insecticidal applications d) Broad-spectrum applications

Ans- i) -b ii) –b iii)-a iv)- c v)- d

LONG ANSWER TYPE QUESTIONS (5Marks)

Q.7.a) How can you differentiate between biofertilisers and chemical fertilizers?
b) Explain the three categories of microbes that are used as biofertilisers.

Ans -a)

Biofertilisers	Chemical fertilizers
1.Biofertilizers are living organisms.	1.These are chemicals produced in factories.
2.These do not cause any harm to environment and ecosystem.	2.These can cause environmental pollution and even enter our food chains when used in excess amount.
3.Could be used in any amount.	3.Have to be used in limited amount.
4.Increase fertility of soil.	4.Consistent use reduce soil quality.

b) (i)Bacteria – symbiotic (Rhizobium) fix atmospheric nitrogen. Free living nitrogen fixers – Azospirillum and Azotobacter. (ii)Mycorrhizae –symbiotic association of fungi with roots of higher plants –any one role (absorb Phosphorus and pass it to plant, resistant to root borne pathogens, tolerance to salinity and drought. (iii) Cyanobacteria – Nostoc,Anabaena, Oscillatoria –can fix atmospheric nitrogen.

3. LEARNING OUTCOME—ANALYZE, EVALUATE AND CREATE MCQ

1.Anaerobic respiration by yeast produces
(a) CO2 (b) Wine and Beer (c) Alcohol (d) All of the above

2. The process involved in making — Toddy is
(a)Lactic acid fermentation, (b)Alcoholic fermentation (c)Distillation, (d)All the above

3. For industrial production of Alcohol very large vessels are used called
a) Beakers b) Round bottom flask c) Conical flasks d) Fermentors

4._____ and _____ are used to clarify juices available in markets.
(a)Pectinase and amylase (b)Protease and lipase,
(c)Protease and pectinase (d)Protease and amylase

5. Interpret the objective of Ganga action plan
a) To restore biodiversity along the course of river Ganga.
b) To control pollution and improve water quality
c) To install sewage treatment plants to reduce the harm caused by the direct release of sewage into the river Ganga. d) all of the above.

6. During secondary treatment of sewage water when activated sludge are taken for anaerobic digestion, the two gases that are produced includes
a) Methane and oxygen b) Methane and carbon dioxide
c)Carbon Dioxide and oxygen d) Methane and nitrogen.

7.The gas chiefly produced by the activity of an anaerobic bacteria on sewage
(a) Laughing gas (b) Propane (c) Mustard gas (d) Marsh gas

8.For biogas production substrate used is
a) Municipal and residential waste b) Biomedical waste
c) Chemical waste d) Gaseous effluents

9.The use of bio-control agents in farming will greatly reduce our dependence on
a) Pesticides b) Fertilizers c)Weedicides d) All of these

10. Select the incorrect statements about organic farming approach
I. Biodiversity Flourish
II.Insect pests are kept at manageable levels by a complex system
III.The eradication of the pest creatures is possible and desirable
IV. Develop an understanding about interaction between the field fauna and flora

V. Organic farming will greatly increase our dependence on toxic chemicals and pesticides.

a. I, II and III b. II, III and IV c. III and V d. I, II and IV

1	2	3	4	5	6	7	8	9	10
D	B	D	C	D	B	D	A	D	C

2 MARKS QUESTIONS

Q.2 How the spent slurry generated out of a Biogas plant is utilized? State the advantage of a floating gas cover over the tank containing slurry.

Ans. The spent slurry is taken out from another out after the generation of biogas and used in agricultural fields as manure. The advantage of a floating cover is that it keeps on rising as the gas is produced in the tank due to the microbial activity.

3 MARKS QUESTIONS

Q.3. Explain the changes that fresh milk undergoes with addition of a small amount of curd as a starter in it.

Ans- When a small amount of curd as a starter is added into fresh milk and a warm temperature is maintained then the Lactobacillus bacteria in the sample of curd start multiplying by utilizing the milk sugars and in the process release acids that coagulate the milk proteins and changes the nutritional property of the milk resulting in the formation of curd.

CASE BASED QUESTION (4marks)

Q.4 Read the passage below and answer the questions:

Sewage treatment plants are compulsory for all newly constructed residential apartments with many family accommodations. Sewage treatment aims to remove contaminants from sewage to produce an effluent that is suitable for discharge to the surrounding environment or can be reused for watering plants. Untreated sewage discharged into water bodies adversely affect the quality of water.

a)From the primary settling tank during sewage treatment the effluent is taken to

(i)Anaerobic sludge digester, (ii)Biogas plant

(iii)Natural water bodies (iv)Aeration tank .

Ans- (iv)Aeration tank

b)The two major categories of microbes which consume organic matter in the aeration tank and reduces its polluting potential.State them.

Ans -Aerobic bacteria and fungi.

c)Give reason for pumping a small part of activated sludge into an aeration tank.

Ans-The small part of activated sludge pumped act as inoculum and help in further growth of flocs in aeration tanks.

d)State the fate of activated sludge formed in STP.

Ans-The major portion of activated sludge is taken to anaerobic sludge digester tank for generation of Biogas and a small part of it pumped back to aeration tank for growth of flocs.

e) State the fate of primary sludge after the primary effluent is taken for secondary treatment in STP.

LONG ANSWER QUESTIONS (5 MARKS)

Q.5. (i)Alexander Fleming while working on Staphylococci bacteria, once observed a mould growing in one of his unwanted culture plate around which Staphylococci could not grow. Which was the mould that contaminated his culture plate. Mention the significance of this observation.

(ii) How has the discovery of antibiotics helped mankind in the field of medicine?

Ans- (i)Mould-*Penicillium notatum* , The chemical produced by the mould (*Penicillium*)

inhibited the growth of *Staphylococci*. This led to the discovery of Antibiotic – Penicillium.
(ii)Antibiotics have helped mankind in treating most of the deadly bacterial and fungal diseases of humans.Antibiotics have greatly improved our capacity to treat deadly diseases such as plague, whooping cough (kali khansi), diphtheria (gal ghotu) and leprosy (kusht rog), which used to kill millions all over the globe.

Q.6. What role can biogas plants play in the development of sustainable, emission-free organic agriculture and in counteracting the progressive process of global warming?State the microbes that are instrumental in the process of Biogas production.

Ans- a-Biogas plants, that generate energy from biogas can be produced from livestock manure.

b- Play an important role in bringing about a green transformation of agriculture to create sustainable, emission-free, climate- and environment-friendly organic agriculture.

c- Biogas plants can be set up by farmer within individual farms. In this way, farms can be self-sufficient in energy.

d-As they do not involve combustion process so CO_2 emission will not take place and that will counteract the process of global warming.

e-The microbes that are instrumental in Biogas production are anaerobic microbes mainly Methanogens.

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CHAPTER: 11 BIOTECHNOLOGY: PRINCIPLES AND PROCESSES

SUMMARY-

Core techniques of modern biotechnology

-Genetic engineering: The technique in which genetic material (DNA & RNA) is chemically altered and introduced into host organisms to change the phenotype.

-Bioprocess engineering: Maintenance of sterile ambience in chemical engineering processes for growing desired microbe/eukaryotic cell for the manufacture of antibiotics, vaccines, enzymes etc.

Basic steps in genetically modifying an organism

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:** A piece of alien DNA lacks *ori* gene (*Origin of replication)* which is needed for starting replication. Hence alien DNA is integrated into the recipient genome (it has *ori*). It multiplies & inherits along with host DNA.

The process of joining and inserting an alien / gene of interest/foreign piece of DNA into a host organism to produce new genetic combinations is called **recombinant DNA technology.**

· 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.*

TOOLS OF RECOMBINANT DNA TECHNOLOGY

1. Restriction Enzymes ('molecular scissors')

– The enzymes that cut DNA at a specific site (called restriction site) into fragments.

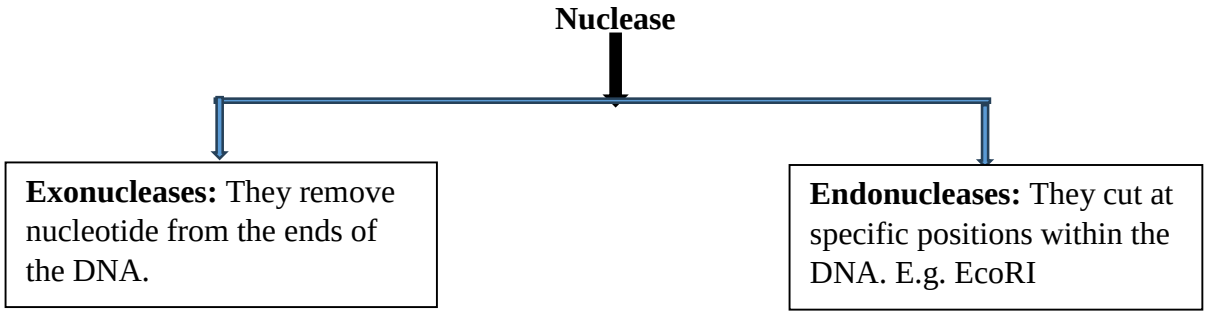
– More than **900 restriction enzymes** have been isolated from over **230 strains** of bacteria.

Naming of the restriction enzymes: e.g. "EcoRI'

First letter indicates **genus.**	Escherichia	E
The second two letters indicate **species.**	Coli	co
The third letter **strain.**	RY13	R
Roman numbers	I (isolated first)	I

the **order** in which the enzymes were isolated from that strain of bacteria).

Types of Restriction enzymes:



Restriction Endonuclease bind to specific recognition sequence of the DNA and cut the two strands at specific points This is called the **recognition sequence**

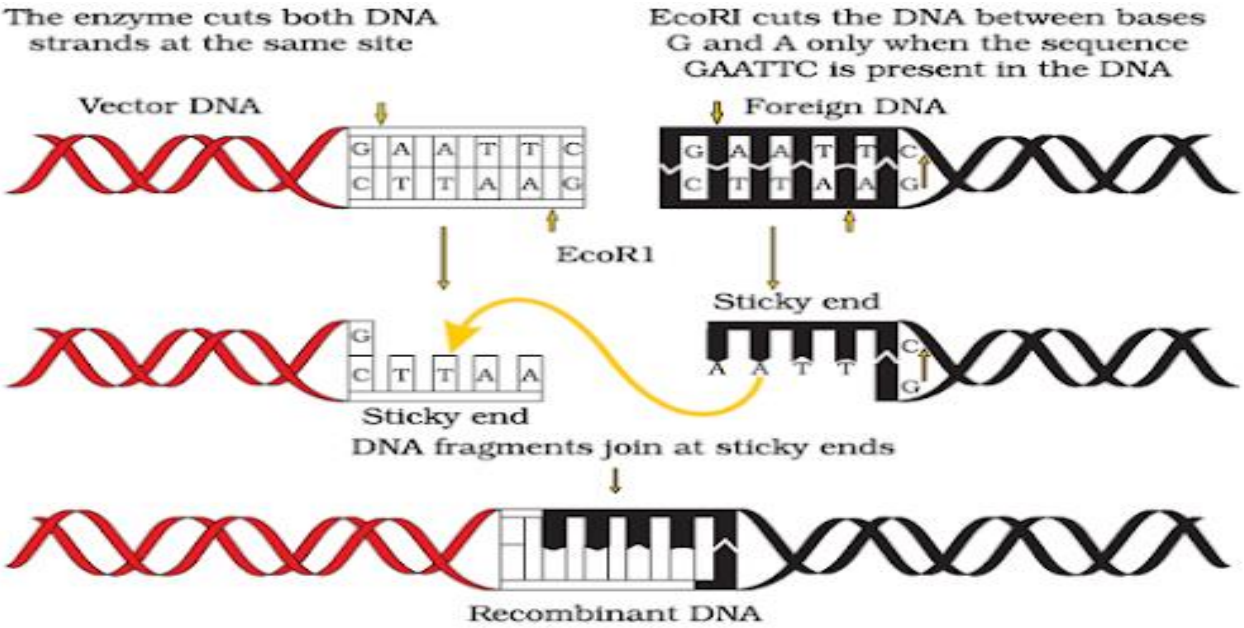
Restriction endonuclease recognizes a specific sequence called **palindromic nucleotide sequences** in the DNA. It is a sequence of base pairs that read the same on the two strands, E.g. Palindromic nucleotide sequence for EcoRI is

5‘ —— GAATTC —— 3‘

3‘ —— CTTAAG —— 5‘

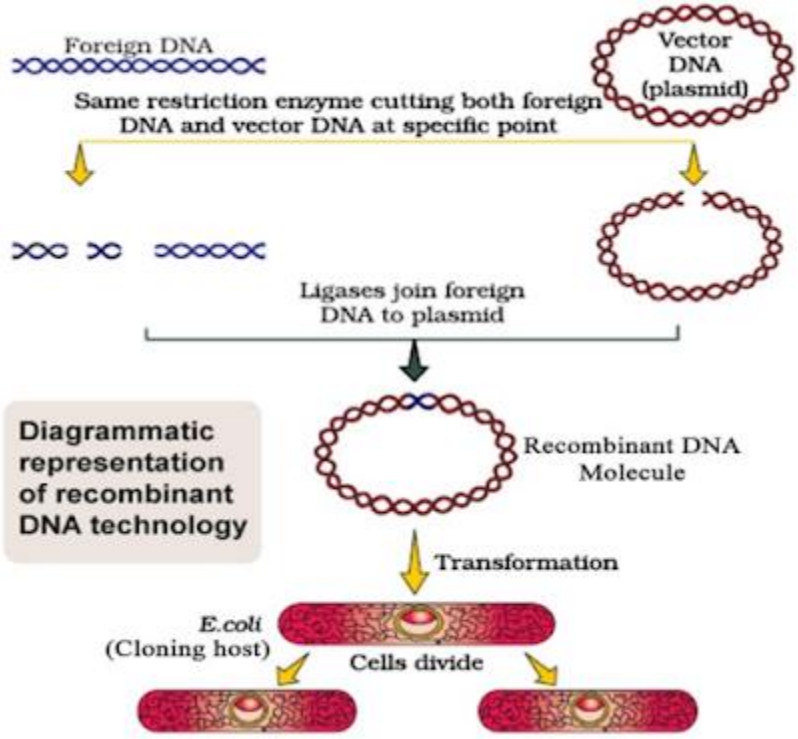
The first restriction endonuclease is **Hind II.** It cuts DNA molecules by recognizing a specific sequence of 6 base pairs.

Steps in formation of recombinant DNA by EcoRI



EcoRI cut the strand between the bases G-A of the palindrome sites of both the strands also cleaves the H-H bonds between the two strands. This leaves single stranded overhanging stretches at the ends called **sticky ends**.

– When cut by the **same** restriction enzyme, the resultant DNA fragments have the same kind of sticky-ends and these are joined together by *DNA ligases.*



2. Cloning Vector

– It is a DNA molecule that can carry a foreign DNA segment and replicate inside the host cells. E.g. Plasmids, bacteriophages etc.
– **Plasmids** are autonomously replicating circular extra-chromosomal DNA of bacteria.
– **Bacteriophages** (high number per cell) have very high copy numbers of their genome within the bacterial cells.

Features required for cloning into a vector

a. Origin of replication (*ori*)- – This is a sequence where replication starts.
b. Selectable marker (marker gene)- gene that helps to select the **transformants** from **non-transformants.**

Selectable markers of *E. coli* include the genes encoding resistance to antibiotics like *ampicillin, chloramphenicol, tetracycline, kanamycin* etc. Normal *E. coli* cells have no resistance against these antibiotics.

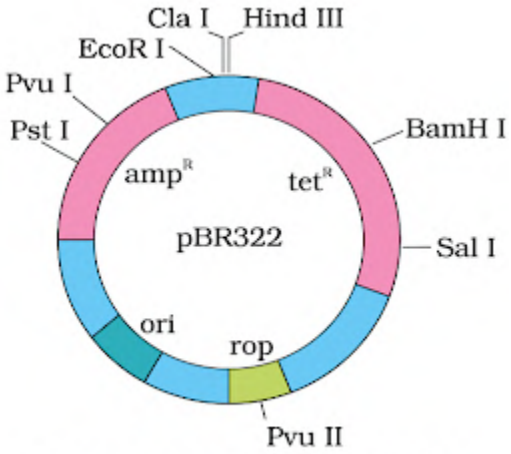
c. Cloning sites

– These are the **recognition sites** for restriction enzymes.

– To link the alien DNA, the vector needs a single **recognition sites. (**Since more than one recognition sites generate several fragments. It complicates the gene cloning.)

–Ligation (joining) of alien DNA is carried out at a restriction site present in one of the two **antibiotic resistance** genes.

E.g. In vector **pBR322,** foreign DNA is ligated at Bam H I site of tetracycline resistance gene. As a result, **recombinant plasmid** is formed. If ligation does not occur, it is called **non-recombinant plasmid.**



E.coli cloning vector pBR322

· **Restriction sites:** *Hind* III, *Eco*R I, *Bam*H I, *Sa*l I, *Pvu* II, *Pst* I, *Cla* I.

· ***ori* - Origin of replication**

· **Antibiotic resistance genes:** amp^R and tet^R.

· **Rop:** codes for the proteins involved in the replication of plasmid.

– But this type of selection of recombinants is a difficult as well as time consuming procedure So, alternative **selectable markers** have developed based on their ability to produce colour in presence of a **chromogenic substrate.**

Insertional Inactivation– In this, a recombinant DNA is inserted into the coding sequence (gene) of an enzyme, ***b-galactosidase.*** So, the gene is inactivated (insertional inactivation). Such colonies do not produce any colour. These are identified as recombinant colonies.

– If ***b-galactosidase*** gene is intact in the plasmid, it gives **blue coloure**d colonies in presence of chromogenic substrate indicates **non-transformants/ non-recombinants.**

d. Vectors for cloning genes in plants & animals

Vectors act as vehicles to transfer genetic material from one cell and introduce into a new cell E.g.

i) ***Agrobacterium tumefaciens*** (a pathogen of many dicot plants) the **tumor inducing (Ti) plasmid** is modified into a cloning vector which is not pathogenic but can use mechanisms to deliver genes of interest into plants.

ii) **Retroviruses** in animals can transform normal cells into **cancerous** cells. So, they are used to deliver desirable genes into animal cells.

3. Competent Host (For Transformation with Recombinant DNA)

– Since **DNA is a hydrophilic** molecule, it cannot pass through cell membranes. So bacterial cells are made 'competent' to take up alien DNA or plasmid as follows:

I) **Heat shock**

i. – Treat bacterial cells with a specific concentration of a divalent cation (e.g. calcium)
ii. → DNA enters the bacterium through pores in cell wall → Incubate the cells with recombinant DNA on ice → Place them briefly at **42^0C (heat shock)**
iii. → Put them back on ice → Bacteria take up recombinant DNA.

Other methods to introduce alien DNA into host cells

II) **Micro-injection:** In this, recombinant DNA is directly injected into the nucleus of an animal cell.

III) **Biolistics (gene gun):** In this, cells are bombarded with high velocity micro-particles of gold or tungsten coated with DNA. This method is suitable for plants.

IV) **'Disarmed pathogen' vectors:** They infect the cell and transfer the recombinant DNA into the host. E.g. *A. tumefaciens.*

PROCESSES OF RECOMBINANT DNA TECHNOLOGY

1. Isolation of the Genetic Material (DNA)

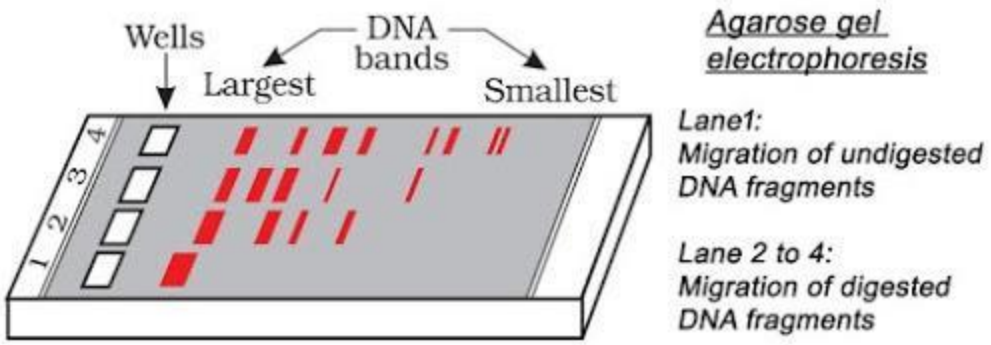
–Treat the bacterial cells/plant or animal tissue with enzymes like ***lysozyme*** (bacteria), ***cellulase*** (plants), ***chitinase*** (fungus) etc. The cell is broken releasing DNA & other macromolecules (RNA, proteins, polysaccharides & lipids).

– RNA is removed by treating with ***ribonuclease.*** Proteins are removed by treatment with ***protease.*** Other molecules are removed by appropriate treatments.

– When chilled ethanol is added, purified DNA precipitates out as a collection of fine threads in the suspension.

2. Cutting of DNA at Specific Locations

– Purified DNA is incubated with the **restriction enzyme.** As a result, **DNA digests.** These DNA fragments are separated by a technique called **gel electrophoresis**.



– **Agarose gel electrophoresis** is employed to separate the digested fragments on the basis of fragment size under electrical field . DNA is negatively charged, it moves towards the anode. Agarose gel (a polymer extracted from sea weeds) is used as matrix for separation.

The smaller sized fragment moves farther.

– DNA fragments can be seen as bright orange coloured bands when they are stained with **ethidium bromide** and exposed to UV radiation.

– DNA bands are cut out from agarose gel. It is called **elution.** The cut-out **gene of interest** and cut **vector** are mixed and ***ligase*** is added. It creates **recombinant DNA.**

3. Amplification of Gene of Interest using PCR

– **Polymerase Chain Reaction (PCR)** is the synthesis of multiple copies of the gene of interest *in vitro* using 2 sets of **primers** & the enzyme ***DNA polymerase.***

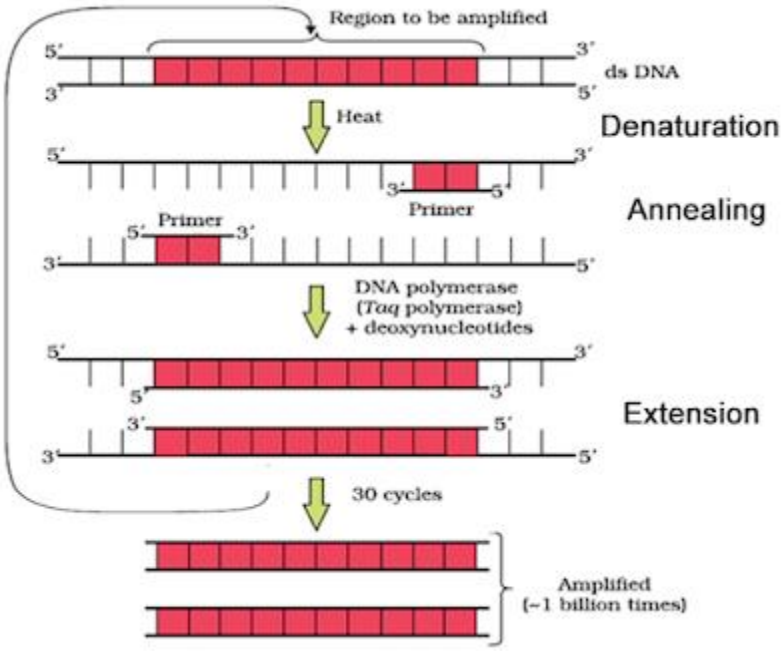
– Primers are small chemically synthesized oligonucleotides that are complementary to the regions of DNA.

Steps of PCR:

1. **Denaturation:** It is the heating of target DNA (gene of interest) at high temperature (94^0 C) to separate the strands. Each strands act as template for DNA synthesis.

2. **Annealing:** It is the joining of the two primers (at 52^0 C) at the 3' end of the DNA templates.

3. **Extension:** It is the addition of nucleotides to the primer using a thermostable *DNA polymerase* called ***Taq polymerase.*** It is isolated from a bacterium, ***Thermus aquaticus*****.** It remains active in high temperature during the denaturation of double stranded DNA.



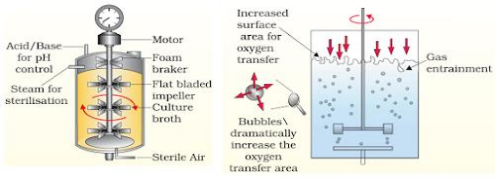
4. Insertion of Recombinant DNA into Host Cell (discussed earlier)

5. Obtaining the Foreign Gene Product

– The aim of recombinant DNA technology is to produce a desirable protein. If a protein encoding foreign gene is expressed in a heterologous host, it is called a **recombinant protein**.
– The cells can also be multiplied in a **continuous culture system,** where the used medium is drained out from one side while fresh medium is added from the other. It maintains the cells more physiologically active and so produces a larger biomass. It yields more desired protein.

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, vitamins, oxygen) to get desired product.
– The most commonly used bioreactors are of stirring type **(stirred-tank bioreactor).**



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

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

· An agitator system · An oxygen delivery system · A foam control system · A temperature control system, · pH control system · Sampling ports (for periodic withdrawal of the culture).

6. 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

KEYPOINTS:

1.	Recombinant DNA	Artificially made DNA strand, formed by the combination of two or more gene sequences
2.	ori	Origin of replication, site from where replication starts
3.	Plasmid	Autonomously replicating circular extrachromosomal DNA found in bacteria
4.	Restriction Enzymes	Enzymes which cuts the DNA at specific sites
5.	Vectors	A vector is usually a piece of DNA that carries a sequence of DNA (gene of interest) and introduces it into a new cell
6.	Gene Cloning	To produce multiple copies of gene in a host cell
7.	Nucleases	A class of enzymes which breaks the nucleic acids in to small fragment by hydrolysing the sugar phosphate backbone
8.	Exonucleases	They remove nucleotides from the ends of the DNA
9	Endonucleases	Enzymes that cleave the phosphodiester bond within a polynucleotide chain (DNA)
10.	DNA Ligase	Joins the DNA from two different sources to make recombinant DNA
11.	Palindromic Nucleotide Sequences	10. A sequence of Base pairs that read same on the two strands when orientation of the reading frame kept the same
12	Recombinants	cell that contains a combining genetic material with different origins
13	Gel Electrophoresis	A technique which is used to separate DNA fragments based on their sizes under electric field
14	Selectable Markers	These are the genes which are used to select transformants and recombinants. Eg Antibiotic Resistant gene
15	Transformants	A cell that has received additional genetic material
16	Recombinant protein	A protein made from the recombinant DNA in a host cell
17	PCR	Polymerase Chain Reaction used to produce multiple copies of the gene
18	Cellulase	Enzyme which breakdown plant cell wall made of cellulose
19	Lysozyme	Enzyme which breakdown bacterial cell wall.
20	Chitinase	Enzyme which breakdown fungal cell wall made of chitin
21	Downstream	Processing A series of processes like separation and purification of the product before it is ready for marketing
22	Bioreactors	A large vessels in which raw materials are biologically converted into specific products

MULTIPLE CHOICE QUESTIONS

1 The role of DNA ligase in the construction of a recombinant DNA molecule is
a Formation of phosphodiester bond between two DNA fragments
b Formation of hydrogen bonds between sticky ends of DNA fragments
c Ligation of all purine and pyrimidine bases d None of the above

2 While isolating DNA from bacteria, which of the following enzymes is not required?
a Lysozyme b Ribonuclease c Deoxyribonuclease d Protease
3 In agarose gel electrophoresis, DNA molecules are separated on the basis of their:
a Charge only b Size only c Charge to size ratio d All of the above
4 Which of the following steps are catalysed by *Taq* DNA polymerase in a PCR reaction?
a Denaturation of template DNA
b Annealing of primers to template DNA
c Extension of primer end on the template DNA d All of the above
5 Molecular scissor which cut DNA at specific site is
a Polymerase b Ligase c Exonuclease d Restriction endonuclease
6. Which of the given statement is correct in the context of observing DNA separated by agarose gel electrophoresis?
a DNA can be seen in visible light
b DNA can be seen without staining in visible light
c Ethidium bromide stained DNA can be seen in visible light
d Ethidium bromide stained DNA can be seen under exposure to UV light. **ANSWER-d**
7. The first restriction endonuclease enzyme discovered that cut ds DNA at specific site was
a Bam HI b EcoRI c Hind II d Sal

1	2	3	4	5	6	7
a	c	b	c	d	d	c

ASSERTION AND REASONING-

A) Both Assertion and reason are true and the reason is the correct explanation of Assertion
B) Both Assertion and Reason are true and Reason is not correct explanation of Assertion.
C) Assertion is true but Reason is false.
D) Assertion is false but Reason is true.

1 **Assertion:** Plasmids are double stranded extra-chromosomal DNA
Reason: Plasmids are usually present in eukaryotic cells.
2 **Assertion**: Heat shock enables bacteria to take up recombinant DNA.
Reason: DNA is hydrophilic.
3 **Assertion:** In gel electrophoresis, DNA fragments are separated.
Reason: DNA is negatively charged, so it moves towards anode under electric field.
4 **Assertion**: A gene from Bacillus thuringiensis is incorporated in plant genome to increase yield.
Reason: It is Bt toxin producing gene which kills larvae of insects
5 **Assertion:** Restriction enzymes EcoRI cut the strand of DNA to produce sticky ends.
Reason : Stickiness of the ends facilitates the action of the enzyme DNA polymerase
6. **Assertion:** In recombinant DNA technology, human genes are often transferred into bacteria (prokaryotes) or yeast (eukaryotes).

Reason: Both bacteria and yeast multiply very fast to form a huge population which express the desired gene.

7. **Assertion :** Restriction digestion is a process of cutting DNA by restriction enzyme.
   Reason: DNA ligase joins two DNAs

8. **Assertion:** Genetic engineering requires both nucleases and ligases.
   Reason: Ligases produce the nick in the recombinant DNA molecule.

1	2	3	4	5	6	7	**8**
c	**b**	**a**	**a**	**c**	**a**	**b**	**c**

2 MARKS QUESTIONS-

Q1 What is a palindrome sequence? How is this helpful in genetic engineering?

ANS Palindrome sequence: A palindromic sequence is a nucleic acid sequence in a double-stranded DNA or RNA molecule whereby reading in a certain direction (5‘ to 3‘) on one strand is identical to the sequence in the same direction (5‘ to 3‘) on the complementary strand. It is recognized by restriction endonucleases as their cutting site in DNA

Q2 State how was *Agrobacterium tumifaciens* been made as a useful cloning vector to transfer DNA to plant cells.

ANS Agrobacterium infects plants by transferring its plasmid T-DNA to the plant genome. T-DNA is modified as vector to transfer desired gene into plant host.

Q3 How does one visualise DNA on an agarose gel?

ANS Ethidium bromide stains DNA, which on exposure with ultra-violet, (UV) radiation gives orange light band of DNA. Hence, DNA fragments appear as orange band in the presence of ethidium bromide and UV light

Q4 Write any four ways used to introduce a desired DNA segment into a bacterial cell in recombinant technology experiments.

ANS Ways to introduce desired DNA into bacterial cell are

Microinjection, disarmed pathogen vectors , treatment of host cell by bivalent cation such as calcium followed by heat shock, biolistic or gene gun.

Q5 Describe the role of CaCl2 in the preparation of competent cells?

ANS. CaCl2 is known to increase the efficiency of DNA uptake to produce transformed bacterial cells. The divalent Ca2+ ions create pores on the bacterial cell wall by which the entry of foreign DNA occurs into the bacterial cells.

3 MARKS QUESTIONS-

Q1 Describe the roles of **heat, primers and the bacterium** *Thermus aquaticus* in the process of PCR.

ANS Heat: for **denaturation** of DNA, to make double stranded DNA into single stranded DNA

Primers: for extension of new strands of DNA ,

Thermus aquaticus: Taq polymerase is obtained which is thermostable enzyme.

Q2 Explain the process of gel-electrophoresis in biotechnology.

ANS Gel-electrophoresis is a technique for separating DNA fragments based on their size.

Steps- -The DNA is cut into fragments by restriction endonucleases.

-DNA being negatively charged can be separated by forcing them to move towards the anode under electric field through the medium agarose.

-DNA fragments separate out according to the size. Smaller fragments move further.

-They are visualized as orange bands after staining the DNA with ethidium bromide followed by exposure to UV radiation.
- They are cut out and extracted from the gel piece. This is called elution

Q3 DNA being hydrophilic cannot pass through the cell membrane of a host cell. Explain how does recombinant DNA get introduced into the host cell to transform the latter.

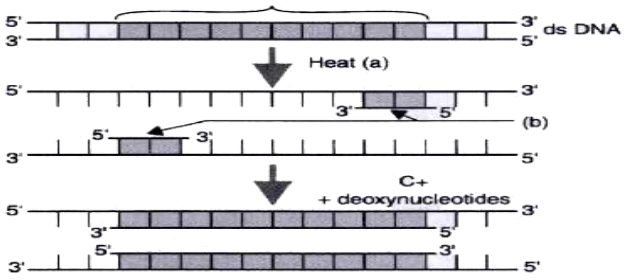
ANS Recombinant DNA is introduced into the host cell by the following methods:

(i) Heat shock method: In this method, DNA is treated with a specific concentration of a divalent cation, such as calcium, which increases the efficiency with which DNA enters the bacterium through pores in its cell wall. The rDNA is forced into the cell by incubating the cell with rDNA on ice, followed by placing them at 42°C (heat shock) and then putting them back on ice.

(ii) Micro-injection: In this method, the rDNA is directly injected into the nucleus of an animal cell.

(iii)Gene gun/Biolistics: In this method, cells are bombarded with high velocity micro-particles of gold or tungsten coated with DNA.

Q4 A schematic representation of polymerase chain reaction (PCR) upto the extension stage is given below. Answer the questions that follow:



i)Name the process 'a'.

ii) Identify 'b'

(iii) Identify 'c' and mention its importance in PCR.

ANS (i) a - Denaturation process

(ii) b - Primers

(iii) c - Taq DNA polymerase. Taq polymerase is a thermostable enzyme which remains active during the high temperature induced denaturation of DNA.

4 MARKS -CASE BASED QUESTIONS

1)**Case study** - When cut by the same restriction enzyme, the resultant DNA fragments have the same kind of 'sticky-ends' and these can be joined together (end-to-end) using DNA ligases The cutting of DNA by restriction endonucleases results in the fragments of DNA. These fragments can be separated by a technique known as gel electrophoresis. Since DNA fragments are negatively charged molecules they can be separated by forcing them to move towards the anode under an electric field through a medium/matrix. Nowadays the most commonly used matrix is agarose which is a natural polymer extracted from sea weeds. The DNA fragments separate (resolve) according to their size through the sieving effect provided by the agarose gel. Hence, the smaller

the fragment size, the farther it moves. The separated DNA fragments can be visualised only after staining the DNA with a compound known as ethidium bromide followed by exposure to UV radiation (you cannot see pure DNA fragments in the visible light and without staining) You can see bright orange coloured bands of DNA in an ethidium bromide stained gel exposed to UV light. The separated bands of DNA are cut out from the agarose gel and extracted from the gel piece. This step is known as elution. The DNA fragments purified in this way are used in constructing recombinant DNA by joining them with cloning vectors.

i) On the basis of ……..……., fragments of DNA get separated in the Gel electrophoresis.

a) Nucleotide b) Colour c) Shape d) Size

ii) …… is used to join sticky ends of DNA.

a) DNA Ligase b) DNA Host c) DNA restriction d) None of them

iii) After DNA fragment separation, DNA is stained by …… for the visualisation.

a) Toluidine b) Ethidium bromide c) Sulphuric acid d) Phloroglucinol

Ans- i) d ii) a iii) b

iv) Name the technique which is useful in the separation of fragments of DNA.

Ans Gel electrophoresis is the technique which is useful in the separation of fragments of DNA.

2)**Case study –**

Bioreactors are considered as vessels in which raw materials are biologically converted into specific products by microbes, plants and animal cells or their enzymes. They are used for large scale production as they provide optimum growth conditions such as temperature, pH, substrate, vitamins, oxygen and salts for obtaining desired product. Most commonly used bioreactors are of stirring type which include simple stirred tank bioreactor and sparged stirred tank bioreactor.

i)Which of the following is essential to obtain desired products in a bioreactor?

a) size of the bioreactor c) quantity of the raw material

b) sterile conditions d) all of these

ii) Bioreactors are useful in:

a) Amplifying a gene c) Processing large volume of culture

b) Isolation of genetic material d) Infecting DNA in a cell

iii) Vessels in which raw materials are biologically converted into specific products are

a) Bioreactors b) Fermenters c) Gene guns d) Both A & B

iv) Growth condition that could affect the quality of obtained product in a bioreactor are:

a) Temperature and pH only b) temperature and oxygen supply only

c) pH and oxygen supply only d) temperature, pH and oxygen supply

Ans- i)-b ii) – c iii) –d iv) - d

5 MARKS QUESTIONS-

Q1 How are the DNA fragments separated by gel electrophoresis visualised and separated for use in constructing recombinant DNA?

ANS Separation and isolation of DNA fragments:

(i) The cutting of DNA by restriction endonucleases results in the short fragments of DNA, which can be separated by a technique known as gel electrophoresis.

(ii) The DNA fragments are negatively charged and they can be separated by forcing them to move towards the anode under an electric field through a medium/matrix(agarose)

(iii) The DNA fragments separate out according to their size through sieving effect provided by the agarose gel. Hence, the smaller fragment moves farther .

(iv) The separated DNA fragments can be visualised after staining the DNA with ethidium bromide followed by exposure to UV radiation.

(v) The separated bands of DNA are cut out and extracted from the gel piece, this step is called elution. (vii) The purified DNA fragments are used to form recombinant DNA which can be joined with cloning vectors.

Q2 EcoRI is used to cut a segment of foreign DNA and that of a vector DNA to form a recombinant DNA. Show with the help of schematic diagrams.

(i) The set of palindronic nucleotide sequence of base pairs the EcoRI will recognise in both the DNA segments. Mark the site at which EcoRI will act and cut both the segments.

(ii) (ii) Sticky ends formed on both the segments where the two DNA segments will join later to form a recombinant DNA.

ANS

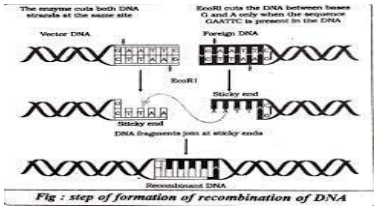


Fig : step of formation of recombination of DNA

Q3 AANS(i) Origin of replication (ori) This is a DNA sequence that is responsible for initiating replication. Any piece of DNA when linked to this sequence can replicate within the host cells. Ori also controls the copy numbers of the linked DNA.

(ii) Selectable marker It helps to select the host cells which contain the vector (transformants) and eliminate the non-transformants. Genes encoding resistance to antibiotics like ampicillin, chloramphenicol, tetracycline or kanamycin, are useful selectable markers for E. coli.

(iii) Cloning sites To link the alien DNA, the vectors require very few (mostly single) recognition sites for the restriction enzymes. More than one recognition sites within the vector, can complicate

the gene cloning as it will generate several fragments. Ligation of alien DNA can be carried out at a restriction site present in one of the two antibiotic resistance genes.

Q4 Why are restriction endonucleases so called? Explain their role as 'molecular scissors' in recombinant DNA technology.

ANS Restriction endonucleases are called so because they restrict the growth of bacteriophages by recognising and cutting DNA at specific sites. Following are the functions of restriction endonucleases:

-Every endonuclease inspects the entire DNA sequence for the palindromic recognition

On finding the palindrome, the endonuclease binds to the DNA.

-It cuts the opposite strands of DNA in the sugar–phosphate backbone; a little away from the centre of the palindrome sites but between the same bases on both strands.

-This results in the formation of single stranded overhanging stretches at the end of each strand are called sticky ends.

-The sticky ends facilitate the action of the enzyme DNA ligase by readily forming hydrogen bonds with complementary strands.

- In genetic engineering, DNA from different sources are cut with the same restriction enzymes so that both DNA fragments have same kind of sticky ends.

-These sticky ends are complementary to each other and thus can be joined by DNA ligase (end-to-end).

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Chapter 12: Biotechnology and its Application

A) Summary:

Biotechnology is the technology that utilizes biological systems, living organisms including microbes or parts of it to develop or create different products useful for human welfare.

This chapter deals with the achievement of biotechnology in various fields.

1. Genetically Engineered Crops

- Genetically engineered crops have desirable genes (as of insect/pest resistance, drought tolerant, giving high yield etc) incorporated in them.
- Genetically modified crops have
    - more tolerance to abiotic stresses such as cold, drought, salinity, heat, etc.
    - insect/pest resistance
    - reduced post-harvest losses
    - efficient mineral usage by plants
    - enhanced nutritional value (e.g., Vitamin A rich rice)

2. *Bt* Cotton

- *Bacillus thuringiensis* is a bacterium that produces proteins to kill certain insects such as lepidopterans (armyworm), coleopterans (beetles), and dipterans (flies/ mosquitoes). *B. thuringiensis* produces a protein crystal containing a toxic protein (inactivated state).
- Inactivated toxin —***Alkaline pH*** / ***(in the gut of insect)***→ Activated toxin

  Activated toxin binds to the epithelial cells in the midgut of insect and creates pores that cause lyses and swelling and eventually death of insect.
- This toxin is encoded by a gene called ***Cry* gene** in the bacterium. Genes coded by *Cry IAc* and *Cry II Ab* control cotton bollworms and those encoded by *Cry IAb* control corn borer.
- *Cry* genes are introduced into the cotton plants to produce *Bt* cotton, in order to make insect resistant variety of cotton.

RNA Interference (RNAi)

- RNAi is a method adopted to prevent infestation of roots of tobacco plants by a nematode *Meloidegyne incognitia*.
- In RNAi, a complementary RNA binds to mRNA to form a ds RNA, which cannot translate and hence, its expression is blocked (Silencing).
- This complementary mRNA may come from
    - infection by RNA viruses
    - transposons (mobile genetic elements)
- RNAi exists naturally in eukaryotes as a method of cellular defence.
- Nematode specific genes (DNA) were introduced in the host plant.
- The introduced DNA forms both sense and anti-sense RNA.
- Two strands being complementary to each other bend and form ds RNA, leading to RNAi.

- mRNA of nematode is silenced and the parasite cannot survive in the transgenic host.

Applications of Biotechnology in Medicine

Recombinant Therapeutics

- With the help of RDT, mass production of efficient therapeutic drugs can be accomplished.
- These are safe and do not induce unwanted immunological response.

Genetically Engineered Insulin

- Insulin is in great demand due to increase in number of patients with adult onset diabetes.
- Insulin extracted from animal source (example, slaughtered cattle and pigs) induce allergy in humans.
- Insulin as a pro-enzyme consists of 3 peptide chains − A, B, and C.
- Pro-enzyme insulin $\xrightarrow{\text{removal of C peptide}}$ Mature insulin
- Mature insulin consists of only two peptide chains − A and B.
- Genes coding for both these chains (A & B) were **separately isolated** and introduced in plasmids of *E. coli* , Cultured separately to produce insulin chains.
- Separately produced chains A and B were extracted and combined by creating a disulphide bond to form mature human insulin.

Gene Therapy

Gene therapy is an attempt to deal with genetic or congenital diseases.

- This aims at correction of a genetic defect by delivery of a normal gene into an individual or embryo to compensate the function of a non-functional gene.
- The first disease to have a gene therapy is ADA (Adenosine deaminase) deficiency. In this, the gene coding for enzyme ADA gets deleted leading to deficiency of ADA which leads to cause problems in immune system.
- ADA deficiency can also be treated with:
    - Bone marrow transplantation
    - Enzyme replacement therapy
- Gene therapy for ADA deficiency:
    - Lymphocytes isolated from patient's blood are cultured in-vitro.
    - Functional ADA cDNA are then introduced into the cultured lymphocytes using a retroviral vector.
    - These lymphocytes are returned back to the patient's body.
- Lymphocytes are not immortal. Therefore, repeated infusion of genetically engineered lymphocytes is required.
- Permanent cure − Introduction of gene isolated from bone marrow cells producing ADA into cells at early embryonic stages

Molecular Diagnosis

- Recombinant DNA technologies, PCR, ELISA (enzyme linked immuno sorbent assay) are some of the technologies of molecular diagnosis.
- Early diagnosis of bacteria and virus in body, when the concentration is extremely low, can be done by PCR since it amplifies the DNA several folds.
- PCR is used to detect HIV virus in suspected AIDS patients and mutations in genes

in suspected cancer patients.

- ELISA is based on antigen-antibody interactions. In the presence of an antigen, the antibody produced against it can be detected.
- Hybridisation with a radioactive probe − In this approach, gene is hybridized with a radioactive probe and autoradiography is used for detection. The regions where mutation is present in the gene will not appear in the photographic film since probe will not be able to bind with that part.

Transgenic Animals & Biopiracy

Transgenic Animals

- Animals that have their DNA manipulated to possess or express an extra gene are called transgenic animals.
- Till date, transgenic rats, rabbits, pigs, sheep, cows, and fish have been produced.

Reasons for Producing Transgenic Animals

- **Study of normal physiology**
  - Transgenic animals serve as models to study genetics, regulation and down regulation of genes, and their corresponding effects on physiology.
  - They give information about the biological role of a particular factor in the body.
- **Study of diseases**
  - They act as models to study genetic basis of diseases.
  - These studies aid in finding possible treatments of diseases.
  - Transgenic models exist of various human diseases such as cancer, cystic fibrosis, rheumatoid arthritis, Alzheimer's, etc.
- **Biological products**
  - Treatment of diseases often requires certain products that are expensive to make.
  - Transgenic animals can be produced that have genes, coding for that particular product.
  - Example − Human protein α-1-antitrypsim used to treat emphysema is isolated by this method.
- In 1997, first transgenic cow **Rosie** produced human protein enriched milk, (2.4grams per Litre) which contained human α-lactalbumin and was nutritionally more suitable for human babies.
- **Vaccine safety** tests
  - Transgenic mice are used to test vaccines for their safety before they are used for humans.
  - Example − Transgenic mice are used to check polio vaccines.
- **Chemical safety testing**
  - Transgenic animals contain genes that make them more sensitive to toxic substances than non-transgenic.
  - Toxicity testing in such animals helps us to obtain results in less time.

Ethical Issues Associated with Transgenic Animals

- Indian government has set up an organization GEAC (Genetic Engineering Approval Committee), which makes decisions regarding validity of GM

research and its use for public utility.

- Modification which may result in the loss of biological significance of animals cannot go beyond regulation.
- Unpredictable results may be observed, if these organisms are introduced in natural ecosystem.
- Patents for transgenic varieties also create problems as many indigenous varieties are claimed by multinational companies as their own inventions.
- For example − A new variety of Basmati was claimed by an American company through patenting. This new variety was actually derived by Indian farmers by crossing Indian Basmati with semi-dwarf varieties.
- Similarly, Neem and turmeric, which have been used for ages in Indian medicines, are also matters of dispute for patent rights.

Biopiracy

- Use of bio-resources by MNCs and other organisations without proper authorisation from countries and people concerned without compensatory payment
- Industrialized and developed nations are economically rich, but poor in biodiversity while opposite prevails for developing nations. Therefore, developed countries exploit traditional knowledge and resources of poor countries for commercialisation.
- This is a matter of injustice since inadequate compensation and benefit sharing is given to poor countries in return. Therefore, steps should be taken by developing countries to prevent this exploitation.
- The Indian parliament has recently introduced second amendment of Indian patents bill to deal with these issues.

B) KEYWORDS:

Tissue culture: Tissue culture is the cultivation of plant cells, tissues, or organs on nutrient media & under sterile conditions, an entire plant can be regenerated from a single cell in laboratory.

Green revolution : The Green Revolution is the term given to the use of high-yielding varieties (HYVs) of wheat and rice particularly during the 1960s to increase food crop production

Totipotency : Totipotency is the ability of a living cell to express all of its genes to regenerate a whole new individual under favourable condition. Plant cell show this ability in vitro.

Micropropagation: it is a method of plant propagation using extremely small pieces of plant tissue taken from a suitable part such as meristem, and growing these under laboratory conditions to produce new plants in large scale.

Explant : is a fragment of plant tissue (part of leaf or shoot) used as a starting material to grow a plant in tissue culture.

Somaclones : the plants that are produced through tissue culture are genetically identical to the parent since the explant is a somatic tissue

Somatic hybridization: Somatic hybridization is the process of creating a hybrid cell through the in vitro fusing of separate protoplasts of two different cells.

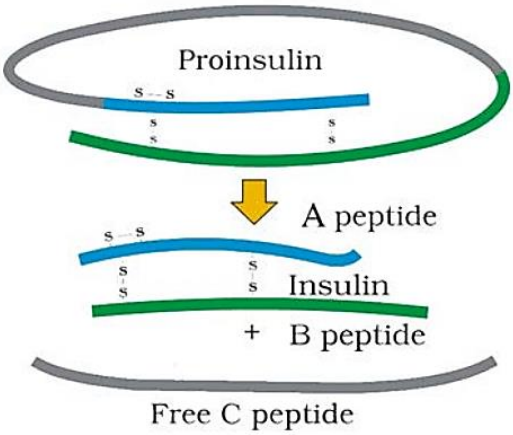
Biotechnology: The use of living organisms or biological systems to develop or create products or processes for specific applications, including medicine, agriculture, and industry.

Recombinant DNA technology: A technique that involves the manipulation and combination of DNA from different sources to create new genetic combinations or organisms.

Genetic engineering: The process of altering an organism's genetic material (DNA) to introduce specific traits or characteristics, often for practical purposes like improved crop yields or the production of pharmaceuticals.
Transgenic organisms: Organisms that contain genes from other species, inserted using genetic engineering techniques. This allows for the expression of specific traits or the production of desired proteins.
Gene therapy: The use of genetic engineering to treat or prevent genetic disorders by introducing or modifying genes within an individual's cells.
Genetically modified organisms (GMOs): Organisms whose genetic material has been altered using biotechnology to introduce specific traits, such as pest resistance or increased nutritional value, in crops.
Bioremediation: The use of microorganisms to remove or neutralize pollutants and contaminants from the environment, often in soil or water.
Stem cell therapy: The use of stem cells, which have the potential to differentiate into various cell types, for medical treatments and regenerative medicine.
Biosafety: The precautions and measures taken to ensure the safe handling and containment of genetically modified organisms and biotechnological processes.
Biotechnology in agriculture: The use of biotechnology to improve crop yield, resistance to pests and diseases, and the nutritional content of agricultural products.

C) IMPORTANT FIGURES/DIAGRAMS:

1. Structure of Insulin –



D) Multiple Choice Questions (MCQ's):

Q.1. Animals that have had their DNA manipulated to possess and express an extra (foreign) gene are known as _____
c) transgenic animals b) animals c) infected animals d) Bt animals
Answer- a
Q.2. Biological products can be created with the help of transgenic animals by the introduction of a portion of _____
d) protein b)gene c) carbohydrate d) fats **Answer- b**
Q.3. the biological product used to treat emphysema is…
a) Anti-pepsin b) α-1-antitrypsin c) Growth hormone d) Insulin **Answer- b**
Q.4. The milk produced by transgenic cow contained ……. protein.
a) human alpha-lactalbumin b) insulin c) human albumin d) casein
Answer- a
Q.5. Using of bio-resources without proper authorisation from countries or people concerned and without compensation is termed as

a) patent b) exploitation c) biopiracy d) both a and b **Answer- c**

Q.6. ELISA stands for _____

a) Enzyme Like Immuno-sorbent Assay b) Enzyme-Linked Immuno-sorbent Assay

c) Enzyme-Linked Immuno-similar Assay d) Enzyme-Linked Immuno-sorbent Array

Answer- a

Q.7.Low concentration of any pathogen can be detected by _____ of their nucleic acid.

a) cutting b) joining c) amplification d) denaturation **Answer- c**

Q.8.ELISA is based on the principle of _____ interaction.

a) antigen-antibody b) antigen-antigen c) antibody-antibody d) DNA-RNA

Answer- a

Q.9. The first ever human hormone produced by recombinant DNA technology is-

a. Thyroxine b. Insulin c. Growth Hormone d. Progesterone

Answer- b

Q.10. In Bt cotton, the Bt toxin present in plant tissue as pro-toxin in converted into active toxin due to -

a. Acidic pH of the insect gut b. Alkaline pH of the insect gut

c. Presence of conversion factors in insect gut d. Action of gut microorganisms

Answer- b

Q.11. The first transgenic crop was-

a. Tobacco b. Tomato c. Cotton d. Flax **Answer- c**

Q.12.Which one of the following is commonly used in transfer of foreign DNA into crop plants?

a. *Agrobacterium tumefaciens* b. *Penicillium expansum*

c. *Trichoderma harzianum* d. *Meloillogyne incognita* **Answer- a**

Q.13.The two polypeptides of human insulin are linked together by:

A. Phosphodiester bond B. Covalent bond

C. Disulphide bridges D. Hydrogen bonds **Answer- c**

Q.14. The organisation responsible for assessing the safety of introducing genetically modified organisms for public use is

A. Indian Council of Medical Research (ICMR)

B. Council for Scientific and Industrial Research (CSIR)

C. Research Committee on Genetic Manipulation (RCGM)

D. Genetic Engineering Appraisal Committee (GEAC) **Answer- d**

E) ASSERTION AND REASONING BASED QUESTIONS:

1. **Assertion**: Genetic engineering techniques involve the manipulation of an organism's genetic material.
   Reasoning: Genetic engineering is a process that involves the alteration of DNA to introduce specific traits or characteristics into an organism.

Answer: *The assertion is true, and the reasoning is also true.*

2. **Assertion:** Transgenic organisms are created by inserting genes from unrelated species.
   Reasoning: Transgenic organisms contain genetic material from the same species but with slight modifications.

Answer: *The assertion is generally true, whereas the reasoning is false.*

3. **Assertion:** Polymerase Chain Reaction (PCR) is a technique used to create recombinant DNA molecules.
   Reasoning: PCR amplifies specific DNA sequences by copying them multiple times in a laboratory setting.

Answer: *The assertion is false, while the reasoning is true.*

4. **Assertion**: Gene therapy involves the use of genetically modified organisms to treat genetic disorders.
   Reasoning: Gene therapy aims to correct or replace faulty genes in an individual's own cells to treat genetic disorders.

Answer: The assertion is true, and the reasoning is also true.

5. **Assertion**: GMOs (Genetically Modified Organisms) have no significant impact on agriculture.
   Reasoning: GMOs are engineered to have improved traits, such as resistance to pests and diseases or increased crop yield.

Answer: *The assertion is false, and the reasoning is true.*

F) SHORT-ANSWER BASED QUESTIONS:

1. What is biotechnology, and what are its primary applications?
   Answer: Biotechnology is the use of biological systems, organisms, or processes to develop products or applications for various fields, including medicine, agriculture, and industry. Its primary applications include genetic engineering, pharmaceutical production, agriculture (GMOs), and medical therapies (gene therapy).
2. What are GMOs, and how are they used in agriculture?
   Answer: GMOs (Genetically Modified Organisms) are organisms whose genetic material has been altered using biotechnology techniques. In agriculture, GMOs are used to create crops with improved traits, such as resistance to pests, diseases, and herbicides, as well as increased nutritional value and higher yields.
3. Explain the concept of gene therapy.
   Answer: Gene therapy is a medical technique that aims to treat or prevent genetic disorders by introducing functional genes into a patient's cells. This can involve replacing faulty genes with healthy ones or providing therapeutic genes to address specific genetic diseases.
4. Discuss the ethical considerations in biotechnology.
   Answer: Ethical considerations in biotechnology encompass concerns about the potential impact on the environment, the welfare of living organisms used in experiments, the consequences of genetic modification, and the societal implications of biotechnological advancements. Ethical guidelines aim to ensure responsible and safe practices in biotechnology.
5. How can biotechnology be applied in environmental conservation?
   Answer: Biotechnology can be applied in environmental conservation through techniques like bioremediation, where microorganisms are used to clean up pollutants in the environment, and the development of genetically modified organisms (GMOs) that are resistant to pests and diseases, reducing the need for harmful chemical pesticides.
6. What are some of the biosafety measures implemented in biotechnology laboratories?
   Answer: Biosafety measures in biotechnology laboratories include proper containment procedures, the use of personal protective equipment (PPE), adherence to sterile techniques, controlled access to sensitive areas, and the disposal of biohazardous waste in compliance with safety regulations.
7. Give an example of a transgenic organism and explain its application.
   Answer: One example of a transgenic organism is Bt cotton. Bt cotton has been genetically modified to produce a protein from the bacterium Bacillus thuringiensis (Bt) that is toxic to certain insect pests. This modification reduces the need for chemical insecticides in cotton farming, making it more environmentally friendly and economically viable.

G) CASE STUDY BASED

"The many applications of the neem tree did not escape the attention of an American firm that registered a patent in the United States for an insecticide whereas in 1994 the European Patent Office also granted a patent relating to fungicides.
Many Indian associations felt that these patents were confiscating ancestral knowledge as well as knowledge accumulated by farmers and Indian researchers over hundreds of years, depriving populations of a traditional plant material.
The technical board of appeal at the European Patent Office eventually revoked the patent in its entirety after ten years of legal proceedings (for a patent with a term of 20 years...). The annulment was based on the fact that the fungicidal effect of the neem seeds had been known in India and exploited on a large scale for centuries…."

From:- *https://www.health.belgium.be*

The manipulation of living organisms by the human race cannot go on any further, without regulation. Some ethical standards are required to evaluate the morality of all human activities that might help or harm living organisms. Going beyond the morality of such issues, the biological significance of such things is also important. Genetic modification of organisms can have unpredictable results when such organisms are introduced into the ecosystem. Therefore, every Government has to set up organizations, which will make decisions regarding the validity of GM research and the safety of introducing GM-organisms for public services. The modification/usage of living organisms for public services (as food and medicine sources, for example) has also created problems with patents granted for the same.

Q1. Name the organization set up by Indian Government to check safety of introducing transgenic animals for human services.
(A) WHO (B) NBRI (C) CDRI (D) GEAC **Answer- d**

Q2. Name the plant whose one popular variety was patented by an American company in 1997. This 'new' variety of plant had actually been derived from Indian farmer's varieties.
(A) Wheat (B)Turmeric and neem (C) Rice (D) Cotton **Answer- b**

Q3. **Assertion**: Biopiracy is the practice of commercially exploiting naturally occurring biochemical or genetic material, especially by obtaining patents that restrict its future use, while failing to pay fair compensation to the community from which it originates.
Reason: US patented turmeric and neem which is a case of biopiracy.
(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 **Answer- b**

Q4. Use of bio resources by multinational companies and organizations without authorization from the concerned country and its people is called
(A)Biodegradation B)Bio-infringement (C) Bio-piracy (D) Bio-exploitation
Answer- c

H) LONG-ANSWER BASED QUESTIONS:

Q1. Explain the process of creating genetically modified organisms (GMOs) and discuss their applications in agriculture.
Answer: Creating GMOs involves the genetic modification of organisms, typically plants, to introduce specific traits or characteristics. The process includes:

a) Identification of Desired Trait: Researchers identify a trait they want to introduce into a plant, such as pest resistance or increased nutritional value.

b) Isolation of Genes: Genes responsible for the desired trait are identified and isolated from another organism, often a bacterium or a closely related plant.
c) Insertion of Genes: Using recombinant DNA technology, the isolated genes are inserted into the genome of the target plant.
d) Selection and Regeneration: The modified plant cells are selected and grown into whole plants through tissue culture techniques.
e) Testing: The resulting plants are tested for the expression of the desired trait.

GMOs have several applications in agriculture:

a) Pest Resistance: GMOs like Bt cotton and Bt corn produce a protein toxic to certain insect pests, reducing the need for chemical pesticides.
b) Herbicide Tolerance: Some GMOs are engineered to tolerate specific herbicides, allowing farmers to control weeds more effectively.
c) Improved Nutritional Value: Golden rice, for example, is engineered to produce higher levels of vitamin A, addressing nutritional deficiencies.
d) Disease Resistance: GMOs can be engineered to resist diseases that affect crops, increasing crop yield and reducing losses.
e) Increased Yield: Certain GMOs can produce higher yields of crops, ensuring food security and economic benefits for farmers.

Q2. Discuss the significance of gene therapy in medicine and provide examples of genetic disorders that can be treated using this approach.

Answer: Gene therapy is a medical technique with the potential to treat or prevent genetic disorders by introducing functional genes into a patient's cells. It has significant importance in medicine:

a) Treatment of Genetic Disorders: Gene therapy holds promise for treating a wide range of genetic disorders, including cystic fibrosis, muscular dystrophy, and sickle cell anaemia. For example, in the case of cystic fibrosis, a functional gene can be introduced into the patient's cells to restore normal lung function.
b) Cancer Treatment: Gene therapy can be used to target cancer cells. cell therapy, for instance, modifies a patient's T cells to target and destroy cancer cells.
c) Inherited Blindness: Leber congenital amaurosis, an inherited form of blindness, has been successfully treated with gene therapy.
d) Hemophilia: Gene therapy can be used to introduce genes responsible for blood clotting factors in patients with hemophilia, reducing bleeding episodes.
e) Immunodeficiency Disorders: Severe combined immunodeficiency (SCID), also known as "bubble boy" disease, can be treated using gene therapy to restore a functional immune system.

Gene therapy offers the potential for long-term or permanent treatment of these disorders by addressing their genetic root causes.

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CHAPTER : 13 ORGANISMS AND POPULATION

SUMMARY

Ecology: Branch of Science which deals with the relationship between organisms & their physical & biological environment.

Population: Group of individuals living in a well defined area which share or compete for similar resources and can interbreed

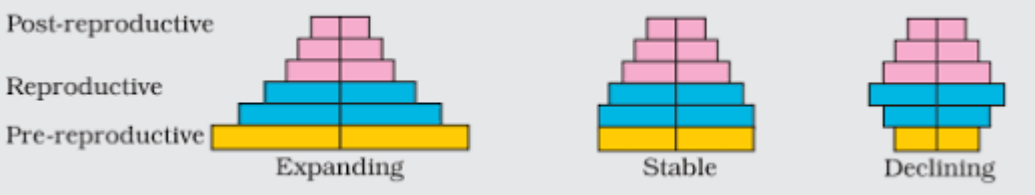
Example: Lotus plants in a pond, bacteria in a culture plate

Population attributes

1. **Birth rate**- Average number of young ones born in a period of time with reference to the members of the population.
2. **Death rates**- Average number of deaths in a period of time with reference to the members of the population.
3. **Sex Ratio**- No. of females and males per 1000 individuals
4. **Age pyramid**: Plot of age distribution

It reflects whether growth is

(i) Expanding
(ii) Stable
(iii) Declining



Population density: Number of individuals present per unit area at a given time.

Population growth:

Factors affecting change in population density

1. **Natality (B)** : Number of births during given period in the population that are added to the initial density
2. **Mortality (D)** : Number of deaths in the population during a given period.
3. **Emigration (E)** : Number of individuals of the population who left the habitat and went elsewhere during the given period
4. **Immigration (I)**: Number of individuals of the same species that have come into the habitat from elsewhere during the time under consideration.

If N is the population density at time‘t’, then its density at time‘t+1’

$$\mathbf{N_t+1 = N_t + [(B + I) – (D + E)]}$$

Population density will increase if (B+I) > (D+E)

Exponential growth: When resources are unlimited, each species realizes its innate potential to grow, population grows exponentially

N – Population size
b – Birth rates (per capita births)
d – Death rates (per capita deaths
dN/dt – increase/decrease in N during time t

Then, $dN/dt = (b – d)xN$

Let $(b – d) = r$, then

$dN/dt = r*N$

Where, r – intrinsic rate of natural increase

Integral form of exponential growth eq.

$N_t = N_0 e^{rt}$

Where N_t = Population density after t

N_0 =Initial population density

r = Intrinsic rate of natural increase

e = base of natural logarithms

Species growing exponentially under unlimited resources reaches enormous population density in short time.

Logistic growth: When a population has limited resources, a given habitat has enough resources to support a maximum possible number, beyond which no further growth is possible.

Carrying capacity (K) - Maximum population density a habitat's resources can support

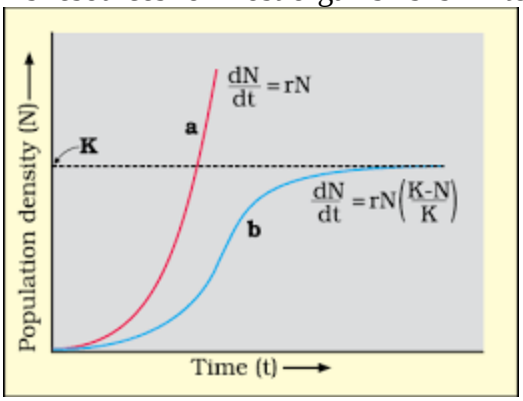
$dN/dt = rN [(K – N)/K]$

Where N = Population density at time t

r = Intrinsic rate of natural increase

K = Carrying capacity

As resources for most organisms is finite logistic growth is more realistic



Logistic and exponential growth curve

Life history variations

Examples:

1. Breed once in lifetime – pacific salmon fish ,Bamboo
2. Breed many times in life time – birds, mammals
3. Produce large no. of small sized offspring - Oysters, pelagic fishes
4. Produce small no. of large sized offspring - birds, mammals

Types of Interactions:

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

Predation

It is an interaction where one animal kills and consumes the weaker animal.

Roles of Predators

Transfer energy, keeping the prey population in check, biological control of pests; reduce interspecific competition of competing prey species

Predators are prudent as over exploitation of prey by the predators results in extinction of prey and predator.

Defense to lessen impact of predation

Insects and frog – camouflage
Monarch butterfly – poisons
Thorns- cactus and Acacia
Poisonous cardiac glycosides – Calotropis
Nicotine, Caffeine, Quinine, Strychnine, opium – against grazers & browsers

Competition

Interaction between individuals of the same species or between individuals of different species.
Occurs among closely related species but not unrelated species also compete- e.g. Flamingo & fish compete for zooplankton
Feeding efficiency of a species may reduce due to other species even if resources are plenty – e.g. Abingdon tortoise became extinct due to goats

Evidence for competition

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

Gause's competition exclusion principle - Two closely related species competing for the same resources cannot coexist as the competitively inferior one will be eliminated.

Resource partition- Two competing species avoid competition by different feeding and foraging patterns- e.g. Mc Arthur experiment on foraging habits of warblers

Parasitism

It is the interaction where one species (parasite) depends on the other species (host) for food and shelter in which the host is harmed.
Parasites reduce the survival of the host, reduce growth and reproductive rate and render the host vulnerable to its predators by making them weak.

Adaptations of parasites

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

Types of parasite

Ectoparasite- Parasites that feed on the external surface of the host organism. e.g. head lice on humans, ticks on dogs
Endoparasite- Parasites that live inside the body of the host organism e.g. Liverfluke
Brood parasitism - the parasitic bird lays its eggs in the nest of its host and lets the host incubate them

Commensalism

This is the interaction in which one species benefits and the other is neither harmed nor benefited.
Examples - Orchid growing as an epiphyte on a mango branch, barnacles growing on the back of a whale, cattle egret and grazing cattle

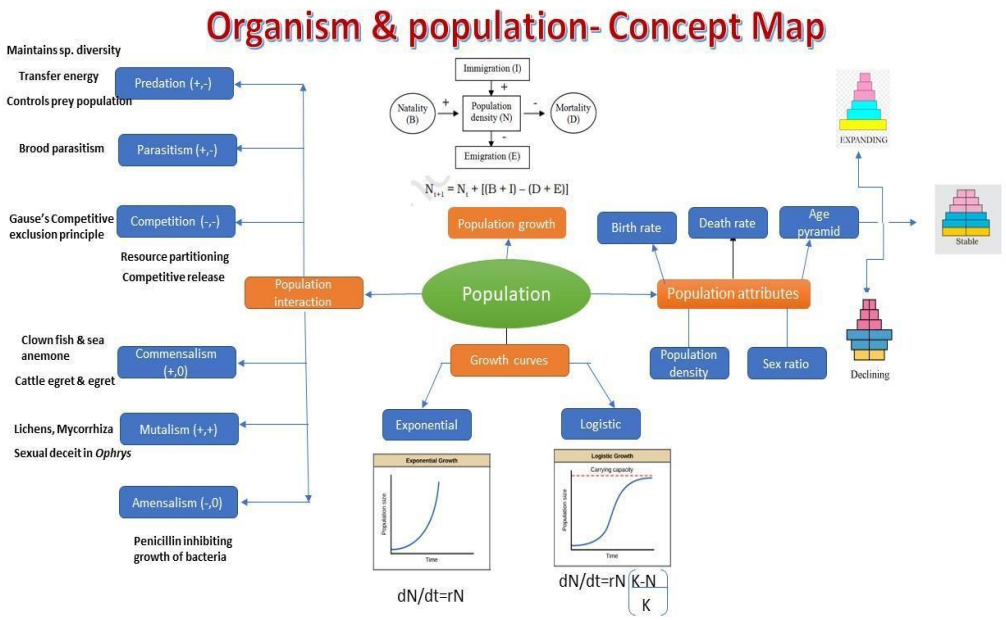
Mutualism

It is interaction in which both the interacting species are benefited
Examples- Lichen (fungi and algae), mycorrhizae –(fungi and roots of higher plants), Pollination of plants by insects

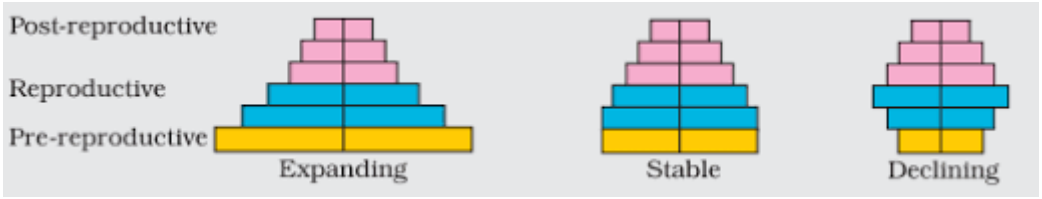
Mediterranean orchid employs sexual deceit for pollination. One petal of its flower appears as a female bee. The male bee pseudo copulates and thus pollinates the flower.

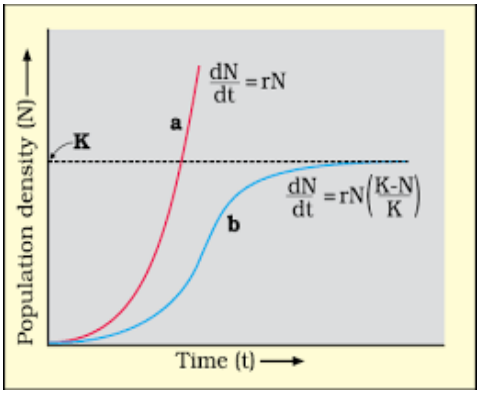
KEY CONCEPTS

CONCEPTS	MEANING
Ecology	The branch of science which deals with the relationship between organisms & their physical & biological environment.
Population	Group of individuals living in a well-defined area which share or compete for similar resources and potentially interbreed
Age pyramid	If the age distribution is plotted for the population such that the pre-reproductive age group forms the base, reproductive in the middle and post-reproductive at the top, the resulting structure is an age pyramid. Expanding, Stable, Declining
Exponential growth	When resources are unlimited, each species realizes its innate potential to grow in number , population grows exponentially
Logistic growth	When a population has limited resources, a given habitat has enough resources to support a maximum possible number, beyond which no further growth is possible.
Carrying capacity (K)	The maximum number of individuals that can be supported with enough resources by an environment.
Predation	The predator is benefitted and the prey is harmed
Cardiac glycosides	Chemical defense in *Calotropis*
Competition	Both the interacting species are harmed
Gause's Competitive exclusion principle	Two closely related species competing for the same resources cannot coexist as the competitively inferior one will be eliminated."
Competitive release	A species whose distribution is restricted to small geographical areas because of presence of competitively superior species, is found to expand its distributional range when the competitively superior species is experimentally removed.
Resource partition	Two competing species avoid competition by different feeding and foraging pattern
Parasitism	Parasite is benefitted and the host is harmed
Ectoparasite	Lives on the body of the host-Ticks, mites, copepods, *Cuscuta*
Endoparasite	Lives inside the body of the host-*Ascaris, Plasmodium*
Brood parasitism	Parasitic bird lays egg in the nest of host bird- Cuckoo and crow
Commensalism	One species is benefited and the other is neither benefited or harmed Cattle egret & cattle
Mutualism	Both the interacting species are benefitted Lichens, Mycorrhiza, fig and wasp
Floral reward	Fees for the service of pollination of plants- pollens, nectar, oviposition (Moth and fig)
Sexual deceit	Male bumble bee pseudo-copulates the Mediterranean orchid *Ophrys*



IMPORTANT DIAGRAMS

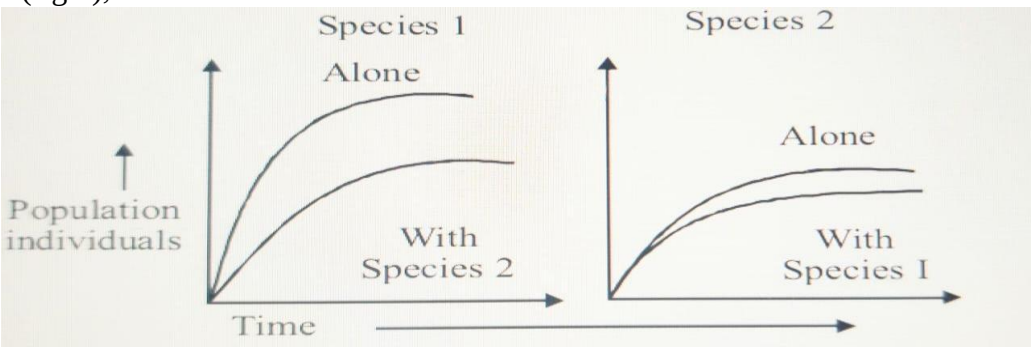




Multiple Choice Questions

1. Which of the following is not an example of commensalism?
   a. An orchid growing as an epiphyte on a mango branch
   b. Barnacles growing on the body of whales
   c. Cattle egret and grazing cattle
   d. Wasp and fig plant **Ans - d**
2. If a new habitat is just being colonized, which of the following would contribute more to population growth?
   a) Birth rate b) Growth rate c) Immigration d) Emigration **Ans - c**

3. In a laboratory experiment, two species of Paramecium were first grown alone and then in the presence of the other species. The following graphs show growth of the Species 1 (left) and species 2(right), both alone and when in mixed culture.



Interpretation of the graphs show that:

a.Competitive exclusion occurred in these experiments.

b. Both species are affected by the interspecific competition but species 1 is less affected.

c. Both species are affected by the interspecific competition but species 2 is less affected.

d. Both species are affected equally by interspecific competition. **Ans - c**

4. Which of the following statements is not correct while measuring population size?

a.Tiger census is done based on pug marks and fecal pellets.

b. The number of fish caught per trap can measure the density of fish in a river.

c. For *Chlamydomonas* in a pond, population size is measured in numbers of species.

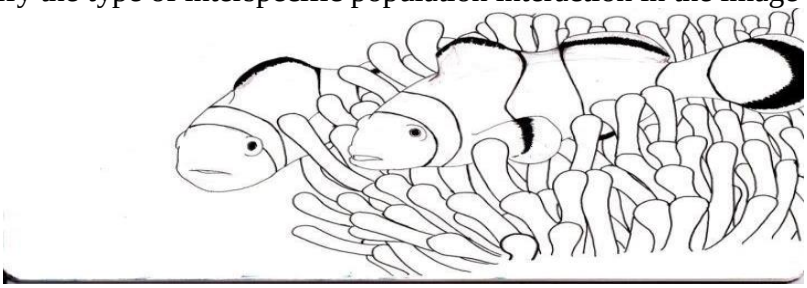
d. Population size of Siberian cranes at Bharatpur wetlands can be measured in numbers.

Ans - c

5.Which of the following is not an adaptation in endoparasites?

a) Presence of sense organs like eyes
b) Presence of adhesive organs or suckers
c) High reproductive capacity
d) Loss of digestive system **Ans - a**

6.Identify the type of interspecific population interaction in the image below:



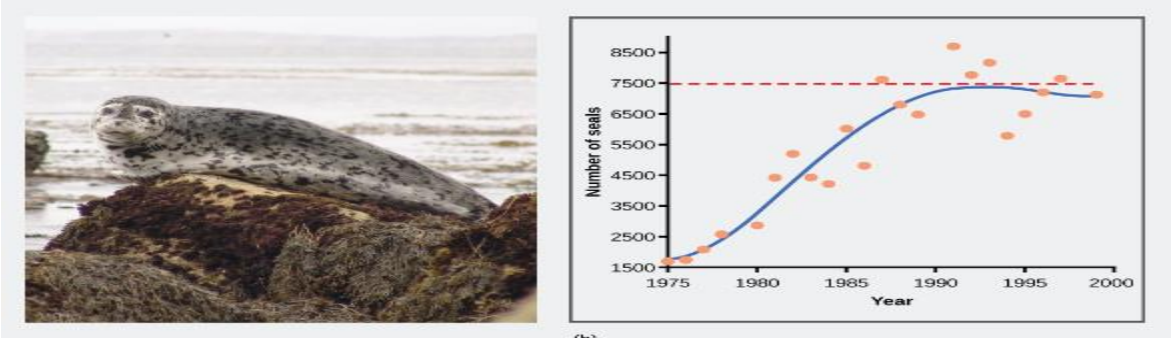
. Commensalism b) Mutualism c) Amensalism d) Parasitism **Ans - a**

7. Which of the following statement(s) are related to 'resource partitioning?

i. Different times of feeding or foraging behavior.
ii. Avoiding competition by resource sharing
iii. Eliminating the competitively inferior one by the superior one.
iv. Increase in distribution of the inferior species when the superior species is removed.

. I, II, III. are correct b) I and II are correct c) I, II and IV are correct d) Only I is correct **Ans - b**

8. If the major food source of the seals declines due to pollution or overfishing, which of the following would likely occur?



a) The carrying capacity of seals would decrease, as would the seal population.
b) The carrying capacity of seals would decrease, but the seal population would remain the same.
c) The number of seal deaths would increase but the number of births would also increase, so the population size would remain the same.
d) The carrying capacity of seals would remain the same, but the population of seals would decrease. Ans –a

9. Swathi was growing a bacterial colony in a culture flask under ideal laboratory conditions where the resources are replenished. Which of the following equations will represent the growth in this case? (Where population size is N, birth rate is b, death rate is d, unit time period is t, and carrying capacity is K).

. dN/dt = KN (b) dN/dt = r N (c) dN/dt = r N(K-N/K) (d) dN/dt = r N(K+N/K) **Ans - b**

10. If '+' sign is positive interaction and '-'sign is detrimental, then which type of population interaction will be shown by (-) (-)

. Predation b) Amensalism c) Parasitism d) both a and c **Ans - c**

Assertion-reason type questions

Question No. 11 to 15 consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:

. Both A and R are true and R is the correct explanation of A.
a. Both A and R are true and R is not the correct explanation of A.
b. A is true but R is false.
c. A is false but R is true.

11. Assertion: The eggs of Koel have evolved to resemble the crow's egg in size and colour.
Reason: This reduces the chances of the host bird detecting the foreign eggs and ejecting them from the nest. **Ans - a**
12. Assertion: An orchid grows as an epiphyte on a mango branch.
Reason: Both are benefited in this interaction. **Ans - c**
13. Assertion: All the cormorants in a wetland constitute a population
Reason: Individuals resulting from asexual reproduction are also considered a population for the purpose of ecological studies. **Ans - b**
14. Assertion: Population size of Siberian cranes in Bharatpur wetland can be determined by absolute population density.
Reason: Absolute population density measures the actual number of individuals in a population **Ans - a**
15. Assertion: Herbivores in a broad ecological context are considered as predators.

Reason: Herbivores act as the channel to transfer the energy to higher trophic level.
Ans - a

SECTION B (2 marks Questions)

1. Provide an instance where the population size of a species can be estimated indirectly, without actually counting them or seeing them.
   Answer: Tiger census in National parks and Tiger reserves was done on the basis of counting pug marks/faecal pellets
2. It is generally believed that competition occurs when closely related species compete for the same resources, like cows and buffaloes compete for the grass. However totally unrelated species can also compete for the same resources. -Justify using example.
   Answer: In some shallow South American lakes, visiting flamingoes and the resident fish compete for the common food-zooplankton in the lake.
3. Mention two features that help the parasite to survive in host?

Answer: Loss of unnecessary sense organs , Hooks and sucker, Loss of digestive system High Reproductive capacity (any two)

4. The roots of leguminous plants have nodules in their roots formed by the soil bacterium *Rhizobium.*Name the type of interspecific interaction between the two? How have the two species benefited from each other?

Answer: Mutualism, The bacterium helps in fixing atmospheric Nitrogen and makes it available to plant . In turn the plant provides the bacteria shelter and food.

5. If in a pond there were 30 lotus plants last year and through reproduction 6 new plants are added, calculate the birth rate of lotus plants in that time period?

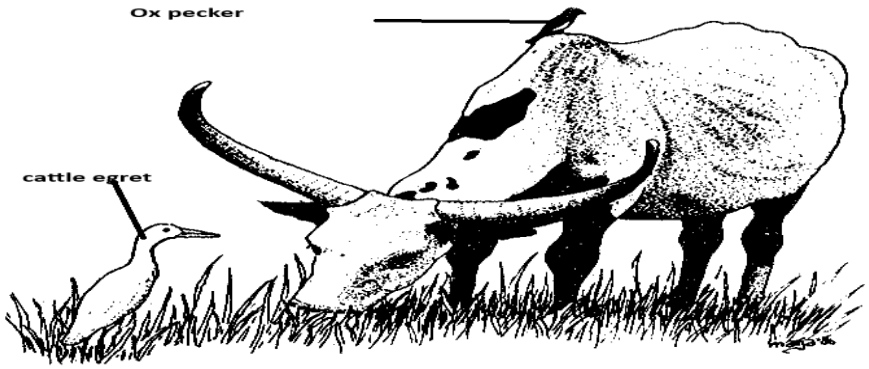
Answer: 6/30=0.2 offspring per lotus plant per year.

6. Why can one never see any cattle or goats browsing on *Clatropis?*
   Answer: The plant produces highly poisonous cardiac glycosides as a method of chemical defense against grazing animals.
7. What is brood parasitism? How does the parasitic bird prevent its eggs from being discarded from the host's nest?

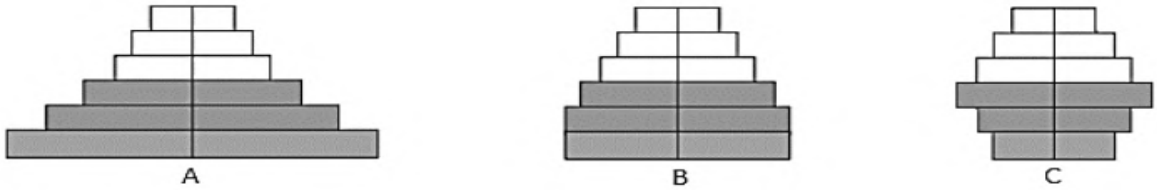
Answer: The parasitic bird lays its eggs in the nest of the host bird and lets the host incubate them. During the course of evolution, the eggs of the parasitic bird evolved to resemble the host's egg in size and colour

SECTION C (3 marks)

1.Study the image and answer the question that follows:



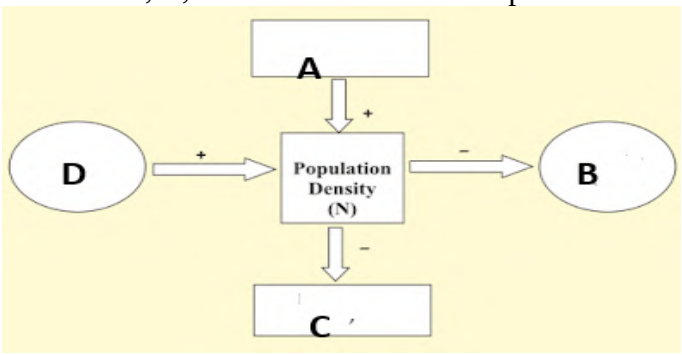
a. Identify the association between the Cattle egret and buffalo and mention the nature of benefit both the species derive.
b. The ox-pecker eats the insects on the body of the buffalo and helps the buffalo to get rid of parasites. What type of interaction do they show?
Answer: a) Commensalism- as the cattle move, they stir up and flush out the insects from the grass which are fed upon by the cattle egret. **b)** Mutualism
2. What is an age pyramid? Identify the age pyramids-A, B, C. How does analysis of age pyramids can provide inputs for long term planning strategies?



Answer: If the age distribution is plotted for the population such that the pre-reproductive age group forms the base, reproductive in the middle and post-reproductive at the top, the resulting structure is an age pyramid.
A= Expanding, B- Stable, C= Declining
Age pyramids can provide us the inputs to find ways to control population size in case of an expanding population. eg- family planning measures.

3. When certain exotic species are introduced into a geographical area, they become invasive and grow at the expense of the native species because of absence of natural predators. – Explain citing examples.
Mention any two roles of predators in the ecosystem.
Answer: The prickly pear cactus introduced into Australia in the early 1920s caused havoc by spreading into millions of hectares of rangeland. Finally, the invasive cactus was brought under control after a cactus feeding moth (its predator) from its natural habitat was introduced into the country.
Roles of Predators
Keep prey population under control, maintain diversity of prey population by decreasing competition among prey species.

4. What does the letters- A, B, C and D denote with respect to affecting population density?



Which factor contributes to rise in population density in case of a new island just colonised?
Answer: A= Natality, B= Mortality, C= Emigration, D= Immigration
For a newly colonised land immigration may contribute significantly to population growth.

5. With the decline in the population of fig species it was noticed that the population of wasp species also started to decline. What is the relationship between the two and what could be the possible reason for decline of wasps? Does the fig plant derive any benefit from the wasp? Comment.

Answer: Mutualism. The fig plant has a tight one-to-one relationship with the wasp species. The wasp uses the fig fruit to lay eggs and the developing larvae feeds on the seeds of the fig . The Fig plant in turn is pollinated by the wasp species.

CASE BASED QUESTIONS

1. Read the passage and answer the questions that follows:

At the most basic level, predators kill and eat other organisms. Conventionally parasites are thought not to kill their hosts. micro predators are small animals that, like predators, feed entirely on other organisms; theyinclude fleas and mosquitoes that consume blood from living animals, and aphids that consume sap from living plants. However, since they typically do not kill their hosts, they are now often thought of as parasites.Animals that graze on phytoplankton or mats of microbes are predators, as they consume and kill their food organisms; but herbivores that browse leaves are not, as their food plants usually survive the assault. When animals eat seeds (*seed predation* or *granivory*) or eggs (*egg predation*), they are consuming entire living organisms, which by definition makes them predators. Scavengers, organisms that only eat organisms found already dead, are not predators, but many predators such as the jackal and the hyena scavenge when the opportunity arises. Among invertebrates, social wasps (yellow jackets) are both hunters and scavengers of other insects.

1. Mention the difference between predation and parasitism.
2. Why is a bird eating seeds considered a predator whereas an herbivore grazing on the leaves of a plant is not considered predation?
3. Mention two animals that can be classified both as predator and scavenger.
4. Can a mosquito feeding on blood be considered as a parasite or a predator? -Justify.

Answer:

1. Predators generally kill and eat the prey whereas the parasites conventionally do not kill the host.
2. A bird eating a seed kills the entire organism i.e. that baby plant within the seed while eating it However, herbivores that browse leaves are not, as their food plants usually survive the assault.
3. Jackal and hyena
4. If you're to define that a parasite needs to live on its host, then a mosquito is *not* a parasite and is thus a predator that feeds on the blood of a host. However, to be a true predator the predator should kill the prey and devour it. Hence is broad sense it cannot be considered a predator too.

2. Study the table below and answer the questions that follows:

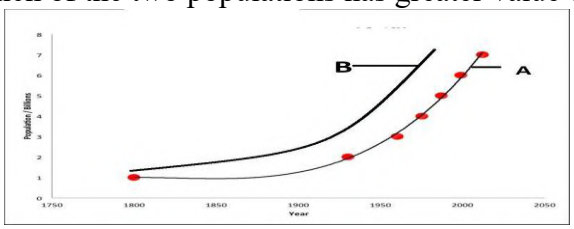
Intrinsic rate of increase (r)* calculated for populations of species that differ greatly in their potential for the rate of population growth

species	intrinsic rate of increase (r)
elephant seal	0.091
ring-necked pheasant	1.02
field vole	3.18
flour beetle	23
water flea	69

. If the birth rate of a population is 1.05 and its death rate is 1.025, what is the value of 'r' for the population?

a. If the value of 'r' of a population is zero, what does it signify?

b. Which of the two populations has greater value of 'r' A or B. Justify.



d. Of the given species in the table which one has the least and which one has the maximum biotic potential?

Answer:

. r is calculated as the difference between the birth rate and the death rate.

r =(b-d), =1.05-1.025=0.025

b. r value zero indicates that the population growth is in equilibrium i.e the death rate and the birth rate have the same values.

. Population 'B' has the greater value of 'r'. More the steepness of the curve more is the value of 'r'

. The maximum biotic potential is that of water fleas and least is that of elephant seals. Higher the value of 'r' higher is the biotic potential.

5 marks Questions

0. In the figure, a population of *Paramecium* in a small laboratory depression slide is pictured. In this population the individuals divide once per day. So, starting with a single individual at day 0, we expect, in successive days, 2, 4, 8, 16, 32, and 64 individuals in the population. On any particular day, the number of individuals in the population is simply twice what the number was the day before, so the number today i.e

N(today) = 2*N*(yesterday).

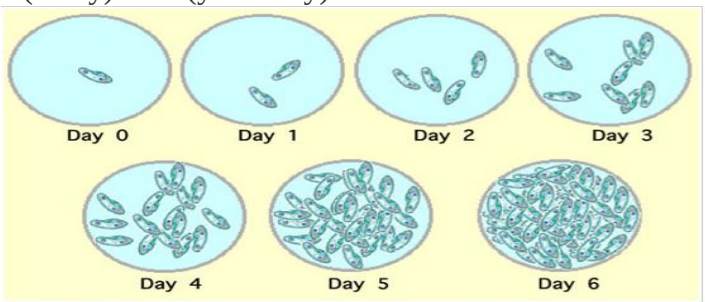


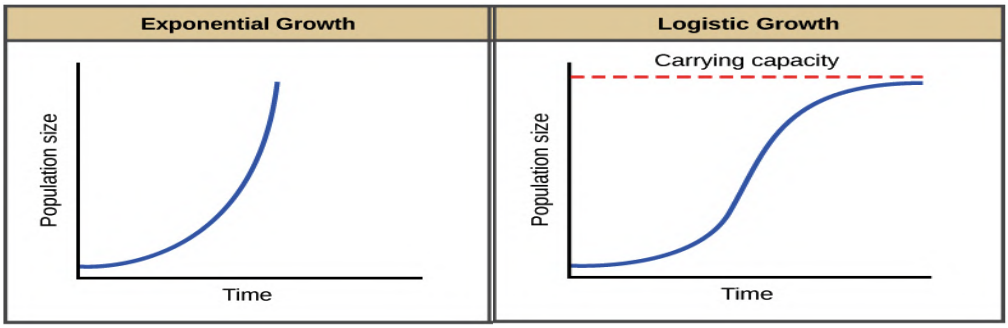
Figure 1: Changes in a population of Paramecium over a six day period
Each individual in the population divides once per day.

. Draw the population growth curve of the *Paramecium* in the above experiment provided food and space are replenished and write the equation of the curve obtained.

a. How would the growth curve vary in a natural setting? Give the graphical representation and mention the cause of such a growth curve.

b. What does the letter 'K' represent in the equation of Logistic growth curve?

Answer:



.

dN/dt=rN

b.

Limited resources, interspecific competition, outbreak of disease

c. The maximum number of individuals of a population that can be supported with resources by an environment.

0. Insect pollinators are paid 'fees' by the plants in the form of pollens, nector or oviposition. But some plants like Mediterranean orchid *Ophrys* employs 'sexual deciet' to get pollinated by a species of bumble bee.

. Elaborate how the orchid employs 'sexual deceit' to the bee species.

a. What would happen if there is any change in the morphology of the flower of the orchid?

b. What fees are paid by the fig plant to a wasp species to bring about pollination of it?

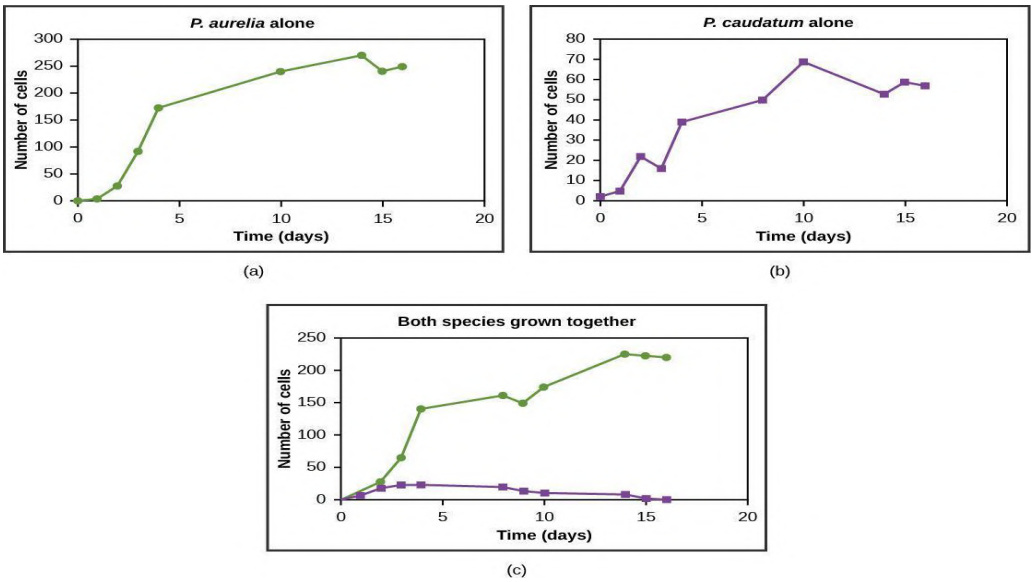
Answer:

. One of the petals of Ophrys bears an uncanny resemblance to that of the female bee in size, colour and markings. The male bee pseudo-copulates with the flower, and during that process the pollen is dusted. When the same bee pseudo-copulates with another flower, transfer of pollen takes place.

a. Any change in the pattern of the petal for any evolution, the success of pollination will be reduced unless co-evolution takes place to maintain the resemblance of its petal.

b. The fig plant offers its fruit for laying eggs and the developing larvae of the wasp are fed on the seeds of fig.

0. Georgy Gause formulated the law of competitive exclusion based on laboratory competition experiments using two species of *Paramecium*, *P. aurelia* and *P. caudatum*. Although *P. caudatum* initially dominated, *P. aurelia* recovered and subsequently drove *P. caudatum* extinct via exploitative resource competition. However, Gause was able to let the *P. caudatum* survive by differing the environmental parameters (food, water). Thus, Gause's law is valid only if the ecological factors are constant.



. State Gause's Competitive exclusion principle.

a. In the above experiment which species of Paramecium is competitively superior and why?

b. Using examples explain how two closely related species can avoid competition and co-exist?

Answer:

. Gause's competitive exclusion principle states that two closely related species competing for the same resources cannot coexist indefinitely and the competitively inferior one will be eliminated eventually.

a. *P. aurelia* is competitively superior over *P. caudatum.* This may be because of its higher efficiency in capturing food and greater value of intrinsic value of natural increase.

b. Two closely related species can avoid competition and co-exist by resource partitioning. MacArthur showed that five closely related species of warblers living on the same tree were able to avoid competition by behavioral differences in their foraging activities.

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CHAPTER : 14 ECOSYSTEM
SUMMARY

ECOSYSTEM: - The functional unit of nature, where living organisms interacts among themselves and with the surrounding physical environment.

An Ecosystem has two components:

Abiotic Components: These include non-living factors like temperature, light, water, soil, and minerals.

Biotic Components: These include living organisms such as plants, animals, microorganisms, and humans.

Ecosystem structure

Stratification: This is the vertical distribution of different species occupying different levels. The levels are called strata.

Ecosystem function

1. **Productivity**

The rate of synthesis of organic matter (biomass) during a given period of time. It is measured as weight (g-2) or as energy (kcal m-2).

Primary productivity:

It is the amount of biomass produced per unit area in a given time period by plants during Photosynthesis.

GPP – R = NPP

GPP-Gross Primary Productivity

NPP-Net Primary Productivity

R - Respiration

Secondary productivity

It is the amount of biomass produced at any of the consumer levels in a given period of time.

2. **Decomposition**

It is the process of breaking down of dead organic matter into smaller organic molecules and inorganic molecules by Decomposers (bacteria, fungi)

Detritus: Dead remains of plants and animals are called detritus.

Detritivores: Animals that feed on decaying organic matter (detritus). Example: earthworms

Mechanism of Decomposition:

Fragmentation: Detritivores (e.g., earthworm) break down detritus into smaller particles.

Leaching: Water soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts.

Catabolism: Bacterial and fungal enzymes degrade detritus into simpler inorganic substances

Humification: Formation of dark coloured amorphous substance called humus that is highly resistant to microbial action and undergoes decomposition at an extremely slow rate

Mineralisation: The humus is further degraded by some microbes and release of inorganic nutrients

Factors affecting rate of Decomposition:

Chemical composition - decomposition rate will be slow when detritus is rich in lignin and chitin and rate increases when detritus is rich in nitrogen and water soluble substances like sugars.

Climatic conditions – warm and moist environment favour decomposition and low temperature and inhibit decomposition.

3. **Energy flow**

Energy flows through an ecosystem in a unidirectional manner, from producers to consumers and decomposers.

The energy flow follows the 10% rule, where only about 10% of energy is transferred from one trophic level to the next as there are losses in the form of heat.

Food chain: A linear sequence of organisms showing the transfer of energy from one trophic level to the next.

Food Web: A network of interconnected food chains.

Grazing food chain (GFC)

Primary source of energy - Sun

First trophic level is plants/algae

Grass Goat Man

Detritus food chain (DFC)

· Primary source of energy – decomposition of detritus

· First trophic level is detritus

4. **Ecological pyramids**

Pyramids are an expression of the relationship between organisms at different trophic levels in terms of their number, biomass or energy.

Three types of pyramids:

Pyramid of Number: The relationship between producers and consumers in an ecosystem can be represented in the form of a pyramid in terms of number called pyramid of number.

Pyramid of Biomass: The relationship between producers and consumers in an ecosystem can be represented in the form of a pyramid in terms of biomass called pyramid of biomass.

Pyramids of number and biomass can be both upright and inverted.

Pyramid of energy: The relationship between producers and consumers in an ecosystem can be represented in the form of a pyramid in terms of flow of energy called pyramid of energy. It is always upright.

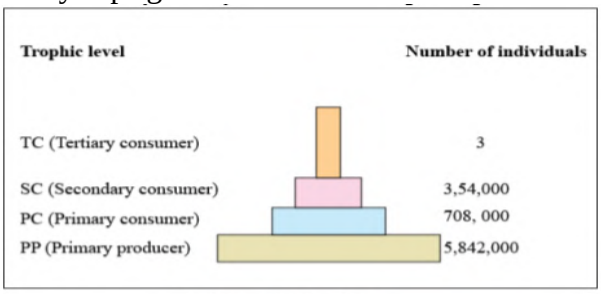
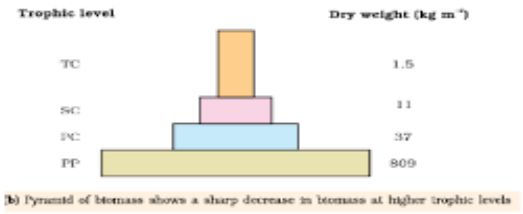


Fig: The pyramid of numbers



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

(c) Inverted pyramid of biomass-small standing crop of phytoplankton supports large standing crop of zooplankton

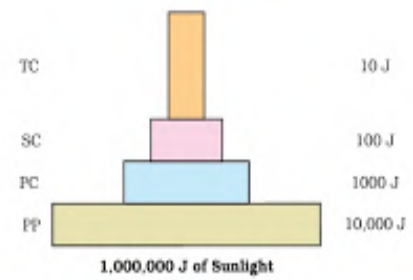


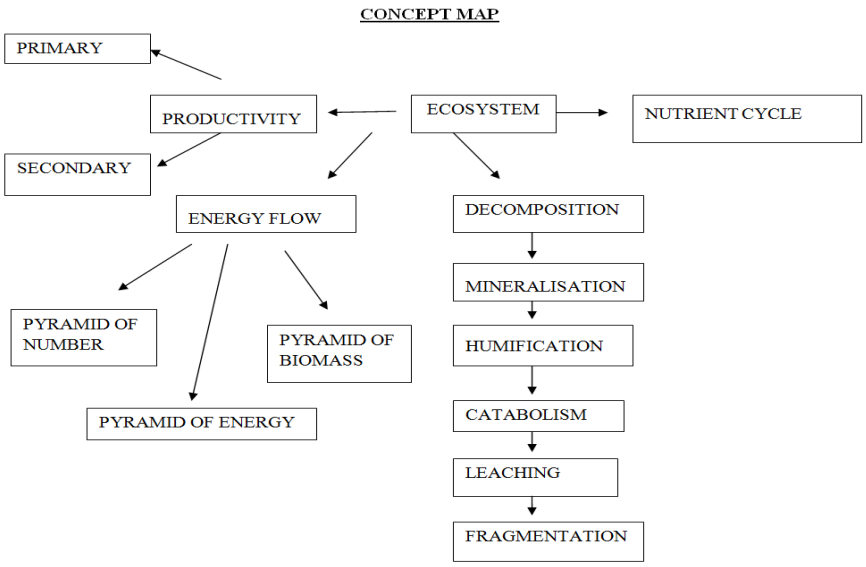
Figure 14.4 (d) An ideal pyramid of energy. Observe that primary producers convert only 1% of the energy in the sunlight available to them into NPP

Limitations of Ecological Pyramids:

- It does not consider the same species belonging to two or more trophic levels.
- It is based on simple food chains, which hardly exist. it does not accommodate food webs.
- Saprophytes are not given any place in the ecosystem even though they play a vital role.

KEY CONCEPTS

Productivity	The rate of synthesis of organic matter (biomass) during a given period of time
Primary productivity	It is the amount of biomass produced per unit area in a given time period by Plants during Photosynthesis.
Secondary productivity	It is the amount of biomass produced at any of the Consumer levels in a given period of time
Decomposition	It is the process of breaking down of dead organic matter into smaller organic molecules and inorganic molecules by Decomposers (bacteria, fungi)
Detritus	Dead remains of plants and animals
Detritivores	Animals that feed on decaying organic matter
Fragmentation	Detritivores (e.g., earthworm) break down detritus into smaller particles.
Leaching	Water soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts.
Catabolism	Bacterial and fungal enzymes degrade detritus into simpler inorganic substances
Humification	Formation of dark coloured amorphous substance called humus that is highly resistant to microbial action and undergoes decomposition at an extremely slow rate
Mineralisation	The humus is further degraded by some microbes and release of inorganic nutrients
Pyramid of Number	show the number of organisms at each stage in a food chain
Pyramid of Biomass	show the mass of organisms at each stage in a food chain
Pyramid of energy	indicates the amount of energy flow at each level
Food chain	A linear sequence of organisms showing the transfer of energy from one trophic level to the next
Food Web	A network of interconnected food chains.



MCQ TYPE QUESTIONS

1. Photosynthetic active radiation (PAR) has the following range of wavelengths

a. 340-450 nm b) 400-700nm c) 500-600nm d) 450-950nm **Ans: b**

2. Pyramid of energy in aquatic ecosystem is

a. Always upright b) Bell shaped c) Always inverted d) None of these **Ans: a**

3. Mass of living matter at a trophic level in an area at anytime is called

a. Standing crop b) Detritus c) Humus d) Standing state **Ans: a**

4. Identify the possible link 'A' in the following food chain:

Plant insect frog 'A' Eagle

a. Rabbit b) Wolf c) Cobra d) Parrot **Ans: c**

5. Which one of the following is not a functional unit of an ecosystem?

a. Energy flow b) Decomposition c) Productivity d) Stratification **Ans: d**

6. If 20 J of energy is trapped at producer level, then how much energy will be available to peacock as food in the following chain?

a. 0.02 J b) 0.002 J c) 0.21 J d) 0.0002 J **Ans: b**

7. Energy transferred from one tropic level to another at

a. 5% b) 10% c) 15% d) 20% **Ans: b**

8. Which of the following is called a detrivore?

a. An animal feeding on decaying organic matter b) An animal feeding on a planc

c) A plant feeding on an animal d) An animal feeding on another animal **Ans: a**

9. These belong to the category of primary consumers -

a. Insects and cattle b) Eagle and snakes c) Water insects d) Snakes and frogs

Ans: a

10. Maximum productivity is found in

a. Grassland b) Desert c) Ocean d) Tropical rainforest **Ans: d**

ASSERTION-REASON TYPE QUESTIONS

The following questions consist of two statements: Assertion(A) and Reason(R). To answer these questions, mark the correct alternative as directed below:

a. If both A and R are true and R is the correct explanation of A
b. If both A and R are true and R is not the correct explanation of A
c. If A is true but R is false
d. If both A and R are false

11. A- Productivity generally increases from polar regions toward the tropics
R- It is due to increasing sunlight and temperature towards the tropics
Ans: a

12. A network of food chains existing together in an ecosystem is known as food web
R- An animal like a kite cannot be a part of a food web.
Ans: c

13. A- Deforestation is one of the main factors contributing to global warming.
R- Besides CO2, two other gases methane and CFCs are also included under green house gases **Ans: b**

14. A- most food chains or webs have only about 4 or 5 trophic levels.
R- Trophic efficiencies are generally only about 10% in different ecosystems
Ans: a

15. A- Biosphere is a closed system for energy
R- Biosphere receives a lot of material from outside. **Ans: d**

(2 Marks questions)

16. What are decomposers? Write their function.
Ans: Decomposers are the microorganisms which break down the dead organic matter into inorganic substances like CO2, water and nutrients.
Function:i) It helps in breaking down complex organic matter into simpler ones
ii) Help in the recycling of nutrients by breaking down the dead organic matter and solubilizing with the soil

17. Why is the length of a food chain in an ecosystem generally limited to 3-4 trophic levels?
Ans: The transfer of energy follows 10% law. At higher trophic levels, the residual energy is decreased to such an extent that no further trophic level can be supported by its transfer. Hence, the length of a food chain is limited to 3-4 trophic levels.

18. What is primary productivity? How is it different from net primary productivity?
Ans: The amount of biomass or organic matter produced per unit area over a period of time by the plants during photosynthesis is called primary productivity.
Gross primary productivity minus respiration loss is called the net primary productivity.
NPP= GPP-R

19. Differentiate between food chain and food web.

Food chain	**Food web**
Transfer of food energy from the producers through a series of organisms.	A number of interconnected food chains
Organism belonging to higher trophic level can feed upon only one type of organism of lower trophic level	Organism belonging to higher trophic level can feed upon only several types of organism of lower trophic level

20. What is the shape of a pyramid of biomass in the sea? Why?

Ans: Inverted, because the biomass of fishes far exceeds that of phytoplankton

21. The pyramids of energy are upright in all ecosystems. Give reasons.

Ans: Energy at lower trophic levels is always more than at higher levels because of the 10% law.

22. Differentiate between DFC and GFC. What is the major conduit of energy in a terrestrial and in an aquatic ecosystem?

Ans:

Detritus food chain(DFC)	Grazing food chain(GFC)
It is the food chain where transfer of energy starts from decaying organic matter	It is the food chain where transfer of energy starts from producers

Terrestrial ecosystem- DFC Aquatic ecosystem- GFC

(3 Marks type questions)

23. Define decomposition? Briefly describe the process of decomposition.

Ans: The process of breakdown of complex organic matter into inorganic substances.

Steps involved in the process of decomposition:

i)Fragmentation ii) Leaching iii) Catabolism iv) Humification v) Mineralisation

(Brief explanation of each steps)

24. Explain the factors affecting the rate of decomposition.

Ans: Factors affecting the rate of decomposition are:

i. If detritus is rich in lignin and chitin , decomposition is slow
ii. Decomposition is faster if detritus is rich in nitrogen and water soluble substances like sugars.
iii. Warm and moist environment favours decomposition
iv. Low temperature and anaerobic conditions inhibit decomposition.

25. Define ecological pyramids. Describe with examples, pyramid of number and biomass.

Ans: The food or energy relationship among organisms at different trophic levels can be expressed in terms of number, biomass or energy. The expression assumes the shape of a pyramid called ecological pyramids.

All pyramids (number, biomass and energy) are upright. However there are some exceptions, e.g. i. insects feeding on a tree- represent an inverted pyramid of number

ii. The pyramid of biomass in sea is inverted where the biomass of fish far exceeds that of phytoplankton.

26. Explain the ten percent law with the help of a diagram.

Ans: Ten percent law states that only 10% of energy is transferred to each trophic level from the lower trophic level.

Diagram NCERT textbook fig 14.3

27. Construct a pyramid of biomass starting with phytoplankton. Label the trophic levels. Is the pyramid upright or inverted? Why?

Ans: Diagram NCERT Textbook fig. 14.4

The pyramid is inverted, because the biomass of zooplanktons exceeds the phytoplankton and that of fishes far exceeds the zooplanktons in a given area.

Aquatic ecosystem- GFC

CASE BASED QUESTIONS

28. Read the passage and answer the following questions:

Primary production is defined as the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis. It is expressed in terms of weight (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 to compare the productivity of different ecosystems. It can be divided into gross primary productivity (GPP) and net primary productivity (NPP). Gross primary productivity of an ecosystem is the rate of production of organic matter during photosynthesis. A considerable amount of GPP is utilised by plants in respiration. Gross primary productivity minus respiration losses (R), is the net primary productivity (NPP). GPP – R = NPP Net primary productivity is the available biomass for the consumption of heterotrophs (herbivores and decomposers). Secondary productivity is defined as the rate of formation of new organic matter by consumers. 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.

1) In the ecosystem, the …… is expressed in terms of gm^{-2} yr^{-1}.

(a) Energy flow (b) Productivity (c) Decomposition (d) Cycle of nutrients

Ans: **b) Productivity**

2) Complete the following equation of Net primary productivity.

NPP= GPP ___ _____.

(a) + P (b) +R (c) –P (d) –R

Ans: **(d) –R.**

3) Productivity is defined as the rate of …… production.

(a) Net primary (b) Biomass (c) Inorganic matter (d) All of them

Ans: **(b) Biomass.**

4) Explain the factors on which primary productivity is dependent?

Ans: Availability of nutrients, environmental factors, plant species, and photosynthetic capacity of plants these are the factors on which primary productivity is dependent.

29. Read the passage and answer the following questions:

The consumers that feed on these herbivores are carnivores, or more correctly primary carnivores (though secondary consumers). Those animals that depend on the primary carnivores for food are labelled secondary carnivores. A simple grazing food chain (GFC) is depicted below:

Grass	Goat	Man
Producer	Primary consumer	Secondary consumer

The detritus food chain (DFC) begins with dead organic matter. It is made up of decomposers which are heterotrophic organisms, mainly fungi and bacteria. They meet their energy and nutrient requirements by degrading dead organic matter or detritus. These are also known as saprotrophs (sapro: to decompose). Decomposers secrete digestive enzymes that breakdown dead and waste materials into simple, inorganic materials, which are subsequently absorbed by them. In an aquatic ecosystem, GFC is the major conduit for energy flow. As against this, in a terrestrial ecosystem, a much larger fraction of energy flows through the detritus food chain than through the GFC. Detritus food chain may be connected with the grazing food chain at some levels: some of the organisms of DFC are prey to the GFC animals, and in a natural ecosystem,

some animals like cockroaches, crows, etc., are omnivores. These natural interconnections of food chains make it a food web.

1) …… is the beginning of Detritus' food chain.

(a) Living organic matter (b) Producers (c) Dead organic matter (d) Consumers

Ans: **(c) Dead organic matter.**

2) The meaning of 'sapro' word in the saprotrophs is

a) To produce (b) To divide (c) To consume (d) To decompose

Ans: (d) To decompose.

3) GFC is a ……..

(a) Global food chain (b) Grazing food chain (c) Global food consumers

(d) Grazing form chain

Ans: **(b) Grazing food chain.**

4) What is 'Food web'.

Ans: The normal interconnection of the food chain is known as Food web.

5 Marks type questions

30. Describe the major components of the ecosystem.

Ans: The ecosystem components are of two types: abiotic and biotic

The abiotic components include the physical factors such as soil, air, water, light and temperature.

The biotic components are: producers, consumers and decomposers.

Producers: the green plants in an ecosystem are producers.

Consumers: all animals that depend on plants for their food are consumers

Decomposers: the bacteria and fungi that decompose dead organic matter of plants and animals are called decomposers.

31. Name any four ecosystem services. Who gave the price tags on nature's support services? Which are the most important ecosystem services provided to us?

Ans: Forest ecosystems provide the following services:

- Purify air and water
- Mitigate droughts and floods
- Cycle nutrients
- Generate fertile soils
- Provide wildlife habitat
- Maintain biodiversity
- Provide aesthetic, cultural and spiritual values (any four)

Robert Constanza gave price tags to ecosystem services

Most important services provided to us: soil formation.

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CHAPTER 15:
BIODIVERSITY AND CONSERVATION
SUMMARY

Biodiversity can be defined as combined diversity at all the levels of biological organisation.

- Biodiversity can be studied at-
  1. Genetic diversity
  2. Species diversity
  3. Ecological diversity

1. **Genetic diversity**
   - A single species might show high diversity at the genetic level.
   - Rauwolfia vomitoria shows genetic variation in terms of concentration and potency of chemical reserpine
   - There are more than 50,000 varieties of rice and nearly 1000 varieties of mangoes.
2. **Species diversity**
   - The diversity at the species level.
   - The Western Ghats have a greater diversity of amphibian species than the Eastern Ghats.
3. **Ecological diversity**
   - At the ecosystem level, India has greater ecosystem diversity than Scandinavian countries.
   - India has several biomes like alpine meadows, rain forests, deserts, wetlands etc.

How Many Species are there on Earth and How Many in India?

According to the IUCN (2004) the total number of plant and animal species is about 1.5 million. A more conservative and scientifically sound estimate has been made by Robert May; it puts the global species diversity at about seven million.

More than 70% of the species recorded are animals and plants account for about 22%;
70% of the animals are insects.

Biodiversity in India

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

PATTERNS OF BIODIVERSITY

Latitudinal Gradients

Species diversity decreased from equator towards poles.

The tropics harbour more species than temperate and polar regions.

What is so special about tropics that might account for their greater biological diversity?

- Speciation is generally a function of time, unlike temperate regions subjected to frequent glaciations in the past, tropical latitudes have remained relatively undisturbed for millions of years and thus, had a long evolutionary time for species diversification,
- Tropical environments, unlike temperate ones, are less seasonal, relatively more constant
- and predictable. Such constant environments promote niche specialisation and lead to a greater species diversity and

- There is more solar energy available in the tropics, which contributes to higher productivity; this in turn might contribute indirectly to greater diversity.

Species-Area Relationship

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

log S = log C + Z log A

S – Species Richness
Z – Slope of the line (regression coefficient)
A – Area
C – y-intercept

- Ecologists have found that Z value ranges between 0.1 & 0.2 irrespective of the taxonomic group or the region. In very large areas like continents, Z value ranges between 0.6 & 1.2.

Importance of species diversity to ecosystem - The communities with more species tend to be more stable than those with less species.

Attributes of a stable community-

It shall not show too much of variations in the year-to-year productivity.
It must be either resistant or resilient to seasonal disturbances.
It must be resistant to alien species invasion.

David Tilman's ecology experiments-

The plots with more species showed less year-to-year variation in the total biomass.
Plots with increased diversity showed higher productivity.

The 'rivet popper hypothesis'

This was proposed by Stanford ecologist Paul Ehrlich. Like an airplane, where all parts are joined together using thousands of rivets, an ecosystem is made of many species. If a species becomes extinct, it may not affect proper functioning of the ecosystem initially, but over a period of time, it may become critical.

Loss of biodiversity:

The colonisation of tropical Pacific Islands by humans has led to the extinction of more than 2000 species of native birds. At present 31% gymnosperms, 32%amphibians,12% bird species and 23% of mammals face the threat.

Loss of biodiversity in a region leads to:

- Decline in plant production.
- Less resistance to environmental disturbances such as droughts.
- Increases variability in ecosystem processes like plant productivity, water usage, pest and disease cycles etc.

The IUCN Red List (2004) documents the extinction of 784 species (including 338 vertebrates, 359 invertebrates and 87 plants) in the last 500 years. Some examples of recent extinctions include the dodo (Mauritius), quagga (Africa), thylacine (Australia), Steller's Sea Cow (Russia) and three subspecies (Bali, Javan, Caspian) of tiger.

Causes of biodiversity losses.

I. **Habitat loss and fragmentation**

- This is the most important cause driving animals and plants to extinction.

- The Amazon rainforest also called ‘‘the lungs of the planet’’ is being cut and cleared for cultivating soya beans and for conversion to grasslands for raising beef cattle.
- When large sized habitats are broken or fragmented due to human settlements, buildings or roads etc, animals requiring large territories and some animals with migratory habitats are badly affected.

ll. **Over-exploitation**

Humans greed has lead to over -exploitation of natural resources, Many species extinctions in the last 500 years (Steller’s sea cow, passenger pigeon) were due to overexploitation by humans

III. **Alien species invasions**.

- When alien species are introduced unintentionally or deliberately for whatever purpose, some of them turn invasive, and cause decline or extinction of indigenous species.
- The Nile perch introduced into Lake Victoria in east Africa led eventually to the extinction of 200 species of cichlid fish in the lake.
- Threat posed to our native species by invasive weed species like carrot grass (Parthenium), Lantana and water hyacinth (Eicchornia)
- Introduction of African catfish for aquaculture purposes is posing a threat to the existing species of catfishes of Indian rivers.

IV. **Co-extinctions**

When a species becomes extinct, the plant and animal species associated with it in an obligatory way also become extinct. For example, if the host fish species becomes extinct, all those parasites exclusively found on it will also become extinct.

Biodiversity conservation

1. **Narrowly utilitarian**

- Humans derive a number of economic benefits from nature like food, firewood, fibres, medicines etc
- More than 25% of the drugs are derived from plants and more than 25,000 species of plants are used by natives for medicine.
- Bioprospecting - exploring molecular, genetic and species-level diversity for products of economic importance

2. **Broadly utilitarian**

- Biodiversity plays a major role in many ecosystem services that nature provides.
- Amazon forest contributes 20% of the total oxygen in the atmosphere on earth.
- Pollination of plants by pollinators -bees, birds and bats etc..

3. **Ethical**

The ethical argument for conserving biodiversity relates to what we owe to millions of plant, animal and microbe species. We need to realise that every species has an intrinsic value, even if it may not be of current or any economic value to us.

CONSERVATION OF BIODIVERSITY

I. **In situ conservation**:

- Biodiversity hotspots- the areas / regions of high endemism and very high levels of species richness. There are 34 hot spots in the world, of which three are in India; namely Western Ghats and Sri Lanka, Indo-Burma and Himalaya.
- India now has 14 biosphere reserves, 90 national parks and 448 wildlife sanctuaries.
- Sacred groves:In many cultures, tracts of forest were set aside, and all the trees and wildlife within were venerated and given total protection. It includes a number of rare,

endangered and endemic species. Ex. Western Ghats, Khasi and Jaintia Hills in Meghalaya, Aravalli Hills of Rajasthan etc

II. **Ex situ conservation**:

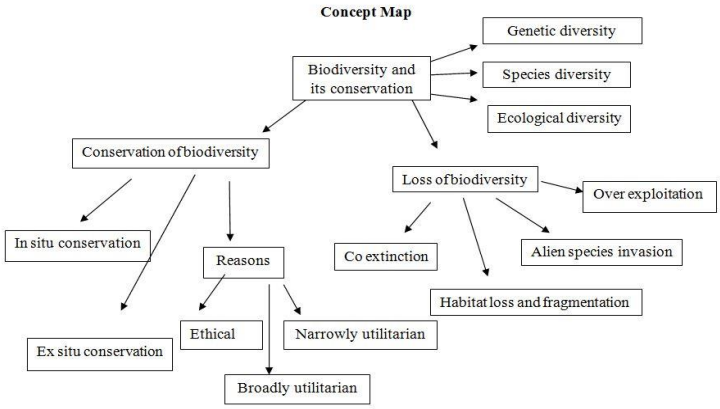
- Botanical gardens, Zoological parks, wildlife safaris.
- Cryopreservation - sperms, eggs, animal cells, tissues and embryos can be stored for a long period
- Plants are propagated by using tissue culture methods.

CONVENTIONS ON BIODIVERSITY

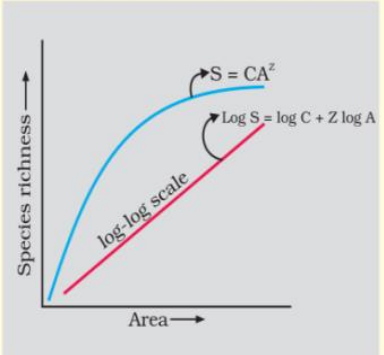
- The Earth Summit-Rio de Janeiro, 1992 - conservation of biodiversity and sustainable utilisation of its benefits
- The World Summit, South Africa 2002 - significant reduction in the current rate of biodiversity loss at global, regional and local levels.

KEY CONCEPTS

Biodiversity	combined diversity at all the levels of biological organisation
Species Area Relationship	Alexander Von Humboldt has observed that within a region species richness increased with increasing explored area, but only up to a limit.
Fragmentation	When large sized habitats are broken or fragmented due to human settlements, buildings etc
Over exploitation	Many species extinctions in the last 500 years (Steller's sea cow, passenger pigeon) were due to overexploitation by humans
Alien species invasion	When alien species are introduced unintentionally or deliberately for whatever purpose, some of them turn invasive, and cause decline or extinction of indigenous species
Co extinction	When a species becomes extinct, the plant and animal species associated with it in an obligatory way also become extinct.
Bioprospecting	exploring molecular, genetic and species-level diversity for products of economic importance
In situ conservation	protecting an endangered plant or animal species in its natural habitat
Ex situ conservation	relocation of endangered or rare species from their natural habitats to protected areas equipped for their protection and preservation



IMPORTANT DIAGRAMS



MULTIPLE CHOICE QUESTIONS

Q1.The most important cause of biodiversity loss is

a. Over exploitation of economic species b)Habitat loss and fragmentation

c) Invasive species d) Breakdown of plant-pollinator relationships

Ans: b

Q2. Organisation responsible for maintaining RED DATA BOOK is

a. IUCN b) BNHS c) IBWL d) WWF **Ans: a**

Q3. Which is an example of ex situ conservation?

a. National park b) Zoological park c) Wildlife sanctuary d) Biosphere reserves

Ans: b

Q4.Which of the following regions of our country are biodiversity hotspots?

a. Western ghats and Eastern Himalaya b) Western ghat and Deccan Plateau

c) Eastern Himalaya and Gangetic plain d) Trans Himalayas and Deccan Peninsula

Ans: a

Q5. The historic convention on biological diversity held in Rio De Janerio in 1992 is known as

a. CITES convention b) The Earth summit c) G-16 summit d) MAB Programme

Ans: b

Q6. Germplasm conservation at liquid nitrogen temperature is called

a. Stratification b) Scarification c) Cryopreservation d) None of the above

Ans: c

Q7. Which one of the following pairs of organisms are exotic species introduced in India?

a. *Lantana camara*, water Hyacinth b) Water hyacinth, *Prosopis cineraria*
c) Nile Perch/*Ficus religiosa* d) *Ficus religiosa/ Lantana camara* **Ans: a**

Q8. Genetic diversity in agricultural crops is threatened by
a. Intensive use of pesticides b)Extensive intercropping
c)Intensive use of fertilizer d) Introduction of high yielding varieties **Ans: d**

Q9. Species-area relationship is represented on a log scale as
a. Hyperbola b) Rectangular hyperbola c) Linear d) Inverted
Ans: c

Q10. A collection of plants and seed having diverse alleles of all the genes of a crop is called
a. Herbarium b)Germplasm c) Gene library d) Genetic drift
Ans: b

ASSERTION-REASONING

Question No 11 to 15 consists of two statements-Assertion(A) and Reason(R) Answer these questions selecting the appropriate option given below:

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true and R is not the correct explanation of A.
c. A is true but R is False
d. A is false but R is true

Q11. **A-** In ex situ conservation, threatened animals and plants are taken out from their natural habitat and placed in special setting where they can be protected and given special care

R- In-situ conservation refers to the conservation of endangered species in their natural habitats.

Ans: b

Q12. A: Tropical regions have got a long evolutionary time for species diversification as compared to temperate regions.

R-Temperate regions have undergone frequent glaciations in the past whereas tropical regions have remained relatively undisturbed for million of years

Ans: a

Q13. A -The Nile perch introduced into lake Victoria in East Africa lead to extinction of more than 200 species of cichlid fish in the lake.

R -When alien species are introduced deliberately for economic or other uses they often become invasive and cause extinction of indigenous species.

Ans: a

Q14. A-If the species-area relationships are analysed among very large areas like entire continents, the value of Z i-e slope of line lies in the range of 0.1 to 0.2**.**

R- The value of Z i-e slope of line of species area relationships lies in the range of 0.6 to 1.2 when analysis is done among frugivorous birds of tropical forest. Thus the larger the explored area the more steep it is.

Ans: d

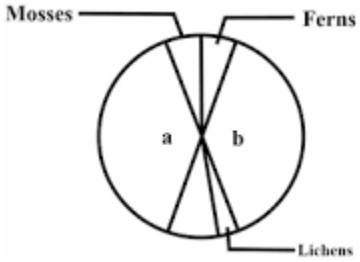
Q15. A- Threatened species are those living species which have been greatly reduced in their number and are liable to become extinct if the causative factors continue.

R-IUCN is an international organisation which maintains the IUCN Red list of threatened species, to assess the conservation status of different species.

Ans: b

VERY SHORT ANSWER QUESTIONS(2M)

Q16. Name the unlabelled areas 'a' and 'b' of the pie chart representing the biodiversity of plants showing their proportionate number of species of major taxa.



Ans: (a) Fungi (b) Angiosperm

Q17. Where would you expect more species biodiversity- In tropics or in polar regions? Give reasons in support of your answer.

Ans: More biodiversity is found in tropics

Reasons- In tropics frequent glaciation is absent /Tropics are less seasonal and more constant.

Q18. Justify with an example where a deliberate attempt by humans by invasion of an alien species has led to the extinction of a particular species.

Ans: The Nile perch introduced into Lake Victoria in east Africa led eventually to the extinction of an ecologically unique assemblage of more than 200 species of cichlid fish in the lake.

Q19. The Amazon rainforest is referred to as 'lungs of planet' Mention any two human activities which causes loss of Biodiversity in this region.

Ans: Human activities causing loss of biodiversity in Amazon rainforest are-

a. Many plants are cut for cultivation of Soybean.

b. Forest is converted to grasslands for raising beef cattle.

Q20. Why are sacred groves highly protected?

Ans: Sacred grooves are patches of forest with special religious importance. They help in protection of rare, endangered and endemic species.

Q21. Mention the kind of biodiversity represented by more than1000 varieties of mangoes in India. How is it possible?

Ans: Genetic diversity

Greater the genetic diversity among the organism of a species, the more sustenance it has against environmental disturbances.

Q22. Differentiate between *in situ* and *ex situ* approaches of biodiversity conservation

Ans:

Differences between

In situ	**Ex situ**
Onsite conservation	Offsite conservation
Conservation of species in their natural habitat	Conservation of endangered species in man made habitat

Q23. What is mass extinction? Give an example.

Ans: Study of fossil record shows large scale loss of species has also occurred before human appeared on the scene. There have been five episodes of mass extinction during the long period of more than 3 billion years.

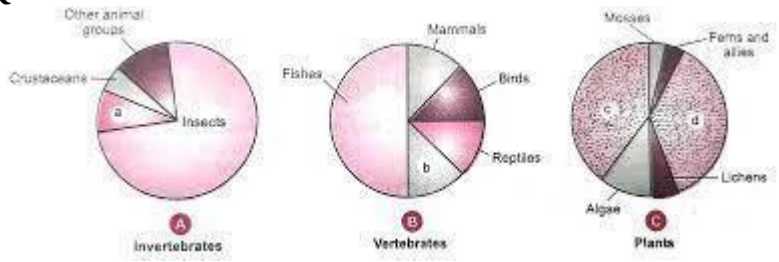
Example- Extinction of Dinosaurs.

Q24. What is the significance of the slope of Regression in a species area relationship?

Ans: Slope of regression represents the changes in the species richness with the area. Species richness decreases with decrease in area.
Value of 'Z' lies in between 0.1 to 0.2 in a country regardless of taxanomic group or the region.
Value of 'Z' increases to 0.6 to 1 if the area increases like the area of the continent. 'Z' becomes steeper.
Q25. List any four techniques where the principles of ex-situ conservation of biodiversity has been employed.
Ans: Four technique of ex situ conservation are
a. Tissue culture b) Cryopreservation c) botanical garden d) Zoological park

SHORT ANSWER TYPE QUESTIONS (3 MARKS)

Q26.



In the pie chart given above write the group of organism would you name in 'a'
'b' 'c' and 'd'. In which kind of Habitat would you find these kinds of organism.?
Ans:
a) Mollusca b) Amphibian c)Fungi d) Angiosperm
Q27.

In a study comparing two continents Antartica and Asia, the species -area relationship was investigated using the following data:

PARAMETER	ANTARCTICA	ASIA
Area	$14x10^6$sq km	$44x10^6$ sq km
Regression coefficient	1	1
Y intercept	5	10

a. Calculate the species richness value for each region.
b. Based on (a), which continent will have greater biodiversity and why?

Ans: (a)
$S=CA^z$
S= Species richness
C=Y intercept
Z=Regression coefficient
A= Area
Antartica- $S= 5*(14*10^6) =70*10^6$
Asia- $S= 10*(44*10^{6)} = 440 * 10^6$
Asia is having greater biodiversity
Q28. Explain the concept of co-extinction by taking two examples.
Ans: Coextinction-When a species become extinct, then plant and animals

dependent on it also became extinct.
Examples a)if a Fish gets extinct ,parasites dependent on fish will also die.
b) Flower-pollinator relationship

Q29. Bio-diversification of life started to occur 3 billion years ago. Since then new species are evolving and disappearing en-masses from earth.

a. How many episodes of mass extinction of species have already taken place and which one is in progress in the current era?

b. How are current episodes in progress different from the previous episodes and why? Explain.

Ans:

a. Five mass extinctions had already occurred.
Sixth is in progress

b. Sixth extinction is faster. 100 to 1000 times faster

Human activities like industrialisation, loss of habitat ,over exploitation etc

Q30. Explain' Rivet-Popper Hypothesis'. Name the scientist who proposed it.

Ans: Rivet popper hypothesis

- Proposed by Paul Ehrlich
- In an aeroplane all parts are joined together using thousands of rivets
- If every passenger travelling in it starts popping a rivet to take home, it may not affect the flight safety initially but when many rivets are out the flight safety will be affected.
- In the same way loss of one species or two will not affect biodiversity initially but when loss of species increases it will affect the functioning of the ecosystem.

Q31. List the advantages of the "ex-situ"approach to conservation of biodiversity .

Ans: The advantages of ex-situ approach are

- Threatened species can be protected
- Gametes can be preserved using cryopreservation techniques.
- Eggs can be fertilised in vitro by tissue culture technique.
- Seeds can be stored in seed banks for a long period of time

Q32. Compare narrow utilitarian and broadly utilitarian approaches to conserve biodiversity with suitable examples.

Ans: Narrowly utilitarian approach- Direct economic benefits from nature/Medicines etc
Broadly Utilitarian approach- Ecological services

(CASE BASED QUESTION) 4 MARKS EACH

Read the following passage and answer the question below

Q33 CASE-1

The Kakapo is the world's largest and heaviest parrot, found only in New Zealand. It is unusual in that it is nocturnal, flightless and ground-dwelling. It is an excellent climber of trees, has strong legs that allow it to "jog" several kilometres. The Kakapo is also critically endangered as of now, there are only few known living individuals left.

All known surviving Kakapo have been relocated by the New Zealand government to three predator-free islands, where they are monitored year round by staff and volunteers to ensure that the birds are safe, healthy and well-fed. The extremely low population of Kakapo is a hurdle to the species becoming viable in the long term, despite such dedicated conservation efforts. When humans started to settle in New Zealand, they took with them non-native animals, including mammals such as cats, dogs and stoats.

Answer the following questions-

A) Which could be the possible reason for Kopako to be well adapted to its environment prior to the arrival of humans in New Zealand?

a) Kakapo was active only in the night when its potential predator would not be out hunting.
b) Kakapo would likely be well camouflaged among the forest foliage.
c) It was able to effectively hunt for food in the night. d) All of these

Ans: d) All of these

B). Write the two possible reasons from the passage by which the human settlement has likely contributed to a near decimation of Kapako populations in New Zealand.

Ans: As humans settled in New Zealand, they would have cleared the land to make way for their own needs e.g., farmland, hence shrinking the natural habitats of the Kakapo.

The new mammals that were introduced by humans into the Kakapos habitats might have out-competed the Kakapo for the limited food resources available.

C) By which conservation method do you think Kokako has been conserved in New Zealand

Ans: Ex situ conservation

Q34. **CASE-2**

Wetlands are called Ramsar sites because the first international convention on their conservation was held in Ramsar in Iran in 1971. Wetlands or Ramsar sites are low lying marshy areas which get filled up during rains due to runoff and overflow from other water bodies. They are often considered to be waste lands which are used as dumping area and filled up to recover land for various constructions activities. As a result, a large number of wetlands have disappeared.

i. RAMSAR convention protects

a. Water bodies b) Wetlands c) Waste lands d) Islands **Ans**: **b**

ii. Why do wetlands need to be conserved?

a. They are very few left b) They are rich in biodiversity
c) They are dumping areas d) They are filled up for construction **Ans**: **b**

iii. Why are a large number of wetlands disappearing nowadays?

Ans: Due to use it as dumping land/ construction sites etc

iv. Why are wetlands called Ramsar sites?

Ans: Wetlands are called Ramsar sites because the first international convention on their conservation was held in Ramsar in Iran in 1971.

LONG ANSWER QUESTIONS TYPE (5 MARKS EACH)

Q35. The ' Evil Quartet' describes the rates of species extinction due to human activities.

a. Explain how the population of organisms is affected by fragmentation of the habitats.

b. Introduction of alien species has led to environmental damage and decline of indigenous species. Give any one example of how it has affected the indigenous species.

c. Could the extinction of Steller's sea cow and passenger pigeon be prevented? Give reasons to support your answer.

Ans:

a. When a large habitat is broken into smaller fragments i.e fragmentation, certain animals like mammals and birds requiring large territories and animals with migratory habitats are badly affected leading to population decline.

b. Nile perch introduced into lake Victoria. Water hyacinth/Lantana

c. Humans have exploited natural resources leading to extinction of animals. Sustainable harvesting could have prevented extinction. 2+2+1

Q36. (a) What are the two types of desirable approaches to conserve biodiversity? Explain with examples.

b. How would the association between bumblebee and its favourite orchid Ophrys be affected by a change in colour of bee or extinction of any one of them?

Ans:

a. Two basic approaches for conservation of biodiversity are-

1. In-situ conservation includes- Biodiversity hotspots/protected areas/Ramsar sites/ sacred grooves.
2. Ex-situ conservation- Cryopreservation/tissue culture methods/botanical gardens/zoological parks etc.

b. Ophrys employs sexual deceit to get pollination by certain species of bee as petals of its flower bear resemblance to female bees in size, colour and marking. If female bee colour patterns change due to any reason during evolution, pollination will be reduced unless the orchid flower co-evolves. As both are dependent on each other, extinction of one will lead to the extinction of another also.

Q37. How is biodiversity important for ecosystem functioning?

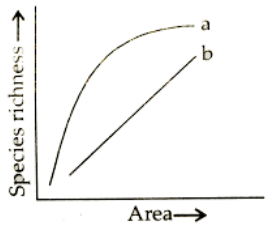
Ans: Biodiversity is very important for ecosystem functioning. More diverse ecosystems are considered more stable. Stable communities are resilient to change. Higher the biodiversity lower the rate of extinction.

Extinction of even one key -species has a negative impact on the entire ecosystem.

A stable community shows following characteristics

- It does not show too much variation in the year to year productivity.
- Resistant to occasional disturbance.
- Resistant to invasion by alien species.

Q38.



The graph shows species-area relationships.

a. If b denotes the relationship on log scale-Describe 'a' and 'b'

How is slope represented? Give the normal range of slope.

What kind of slope will be observed for frugivorous birds and mammals in a tropical forest?

b. Species diversity of plants(22%) is much less than that of animals(72%). Analyse the reasons for the greater diversity of animals as compared to plants.

Ans: a) 'a' is $S= CA^{z"}$

'b' is $\log S= \log C + Z \log A$.

Slope is Z (regression coefficient) Normal value ranges from 0.6 to 1.2

In frugivorous birds and mammals, the value of Z=1.15.

b) Reasons for greater diversity of animals are- Animals are mobile and can avoid predator or unfavorable event

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