

DIRECTORATE OF EDUCATION
Govt. of NCT, Delhi

SUPPORT MATERIAL
(2025-2026)

Class : XII

BIOLOGY

Under the Guidance of

Sh. Pandurang K. Pole

Secretary (Education)

Ms. Veditha Reddy

Director (Education)

Dr. Rita Sharma

Addl. DE (School & Exam.)

Coordinators

Mr. Parvinder Kumar
DDE (Exam)

Mrs. Ritu Singhal
OSD (Exam)

Mr. Krishan Kumar
OSD (Exam)

Mr. Tushar Saluja
OSD (Exam)

Production Team

Published at Delhi Bureau of Text Books, 25/2, Institutional Area, Pankha Road, New Delhi-58 by **Bijender Kumar**, Secretary, Delhi Bureau of Text Books and **Printed at:** Palak printers, 6, Mohkampur Phase-II, Delhi Road, Meerut -250004 (UP.)

पांडुरंग के. पोले, भा.प्र.से
सचिव (शिक्षा)

PANDURANG K. POLE, IAS
SECRETARY (Education)



राष्ट्रीय राजधानी क्षेत्र, दिल्ली सरकार
पुराना सचिवालय, दिल्ली-110054
दूरभाष: 011-23890187, 23890119

Government of National Capital Territory of Delhi
Old Secretariat, Delhi-110054
Phone: 23890187, 23890119
E-mail : sccyedu@nic.in

D.O. NO. : DF.5/2228/Exam/Message/
S.M/248/249
Date : 07/11/2025

MESSAGE

The Directorate of Education remains steadfast in its vision to achieve excellence in the academic domain and its commitment to develop meaningful, engaging, and child-friendly learning content.

Each year, the Directorate carefully reviews and updates the Support Material to ensure alignment with the latest CBSE guidelines and emerging academic developments.

The Support Material provides comprehensive academic support through well-structured practice questions and exercises that strengthen conceptual understanding and exam readiness and aims to nurture students' critical thinking, analytical abilities, and problem-solving skills. Through such sustained efforts, the Directorate of Education continues to guide students towards academic excellence and holistic growth.

This Support Material is intended to bridge classroom learning and examination preparation, enabling students to consolidate knowledge through systematic practice. It has been thoughtfully designed for students, with the belief that its effective use will strengthen their understanding and support them in achieving their learning goals with confidence.

I appreciate the dedication and collaborative effort of all those involved in the development of this material and extends my best wishes to all students—may this Support Material serve as an essential academic aid, enhancing students' confidence and preparedness for examinations.

Best wishes.


(Pandurang K. Pole)

VEDITHA REDDY, IAS
Director, Education & Sports



सत्यमेव जयते

Directorate of Education
Govt. of NCT of Delhi
Room No. 12, Old Secretariat
Near Vidhan Sabha,
Delhi-110054
Ph.: 011-23890172
E-mail :diredu@nic.in

MESSAGE

DE-5/228/Exam/Message/S.M/2018/
402
dated - 09/05/25

Education is the cornerstone of a progressive society, and providing students with the right learning resources is essential for their academic and personal growth. Keeping this in mind, the Directorate of Education, GNCT of Delhi, develops comprehensive Support Material every year for various subjects of Classes IX to XII.

The support material serves as an additional study resource to supplement textbooks by offering clear and easy-to-understand explanation of complex topics. Our dedicated team of expert faculty members has meticulously reviewed and updated this material, aligning it with the latest CBSE syllabus, question paper pattern and assessment guidelines. Our effort is to simplify difficult concepts and make them more accessible to students, helping them save time and effort with ready references for effective preparation.

As Ruskin Bond beautifully said, "Education must inspire the spirit of inquiry, Creativity and Joy" True learning goes beyond memorisation-it encourages curiosity, fosters creativity, and makes the learning process meaningful and enjoyable.

In alignment with the vision of NEP 2020, the CBSE framework now places emphases on competency-based assessments for 50% of the evaluation, highlighting the need for students to develop critical thinking and problem-solving skills. The Support Material is designed to help students analyse concepts deeply, think innovatively, and apply their knowledge affectively, ensuring they are well-prepared not only for exams but also for real-life challenges.

I appreciate the dedicated efforts of the entire team of subject experts in developing this valuable learning resource. I am confident that both teachers and students will make the best use of these material to enhance learning and academic success.

Wishing all students great success in their exam and a bright, fulfilling future ahead.


(VEDITHA REDDY, IAS)

Dr. RITA SHARMA
Additional Director of Education
(School/Exam)



Govt. of NCT of Delhi
Directorate of Education
Old Secretariat, Delhi-110054
Ph.: 23890185

D.O. No. **DE.S/228/Exam/Message/SM/**
2018/570
Dated: .. **02/07/2025**

MESSAGE

"Children are not things to be molded, but are people to be unfolded." -
Jess Lair

In line with this insightful quote, the Directorate of Education, Delhi, has always made persistent efforts to nurture and unfold the inherent potential within each student. This support material is a testimony to this commitment.

The support material serves as a comprehensive tool to facilitate a deeper understanding of the curriculum. It is crafted to help students not only grasp essential concepts but also apply them effectively in their examinations. We believe that the thoughtful and intelligent utilization of these resources will significantly enhance the learning experience and academic performance of our students.

Our expert faculty members have dedicated themselves to the support material to reflect the latest CBSE guidelines and changes. This continuous effort aims to empower students with innovative approaches, fostering their problem-solving skills and critical thinking abilities.

I extend my heartfelt congratulations to the entire team for their invaluable contribution to creating a highly beneficial and practical support material. Their commitment to excellence ensures that our students are well-prepared to meet the challenges of the CBSE examinations and beyond.

Wishing you all success and fulfilment in your educational journey.

(Dr. Rita Sharma)

DIRECTORATE OF EDUCATION
Govt. of NCT, Delhi

SUPPORT MATERIAL
(2025-2026)

BIOLOGY

Class : XII

NOT FOR SALE

PUBLISHED BY : DELHI BUREAU OF TEXTBOOKS

भारत का संविधान

भाग 4क

नागरिकों के मूल कर्तव्य

अनुच्छेद 51 क

मूल कर्तव्य - भारत के प्रत्येक नागरिक का यह कर्तव्य होगा कि वह -

- (क) संविधान का पालन करे और उसके आदर्शों, संस्थाओं, राष्ट्रध्वज और राष्ट्रगान का आदर करे;
- (ख) स्वतंत्रता के लिए हमारे राष्ट्रीय आंदोलन को प्रेरित करने वाले उच्च आदर्शों को हृदय में संजोए रखे और उनका पालन करे;
- (ग) भारत की संप्रभुता, एकता और अखंडता की रक्षा करे और उसे अक्षुण्ण बनाए रखे;
- (घ) देश की रक्षा करे और आह्वान किए जाने पर राष्ट्र की सेवा करे;
- (ङ) भारत के सभी लोगों में समरसता और समान भ्रातृत्व की भावना का निर्माण करे जो धर्म, भाषा और प्रदेश या वर्ग पर आधारित सभी भेदभावों से परे हो, ऐसी प्रथाओं का त्याग करे जो महिलाओं के सम्मान के विरुद्ध हों;
- (च) हमारी सामासिक संस्कृति की गौरवशाली परंपरा का महत्त्व समझे और उसका परिरक्षण करे;
- (छ) प्राकृतिक पर्यावरण की, जिसके अंतर्गत वन, झील, नदी और वन्य जीव हैं, रक्षा करे और उसका संवर्धन करे तथा प्राणिमात्र के प्रति दयाभाव रखे;
- (ज) वैज्ञानिक दृष्टिकोण, मानववाद और ज्ञानार्जन तथा सुधार की भावना का विकास करे;
- (झ) सार्वजनिक संपत्ति को सुरक्षित रखे और हिंसा से दूर रहे;
- (ञ) व्यक्तिगत और सामूहिक गतिविधियों के सभी क्षेत्रों में उत्कर्ष की ओर बढ़ने का सतत प्रयास करे, जिससे राष्ट्र निरंतर बढ़ते हुए प्रयत्न और उपलब्धि की नई ऊँचाइयों को छू सके; और
- (ट) यदि माता-पिता या संरक्षक हैं, छह वर्ष से चौदह वर्ष तक की आयु वाले अपने, यथास्थिति, बालक या प्रतिपाल्य को शिक्षा के अवसर प्रदान करे।



Constitution of India

Part IV A (Article 51 A)

Fundamental Duties

It shall be the duty of every citizen of India —

- (a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;
- (b) to cherish and follow the noble ideals which inspired our national struggle for freedom;
- (c) to uphold and protect the sovereignty, unity and integrity of India;
- (d) to defend the country and render national service when called upon to do so;
- (e) to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;
- (f) to value and preserve the rich heritage of our composite culture;
- (g) to protect and improve the natural environment including forests, lakes, rivers, wildlife and to have compassion for living creatures;
- (h) to develop the scientific temper, humanism and the spirit of inquiry and reform;
- (i) to safeguard public property and to abjure violence;
- (j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement;
- * (k) who is a parent or guardian, to provide opportunities for education to his child or, as the case may be, ward between the age of six and fourteen years.

Note: The Article 51A containing Fundamental Duties was inserted by the Constitution (42nd Amendment) Act, 1976 (with effect from 3 January 1977).

* (k) was inserted by the Constitution (86th Amendment) Act, 2002 (with effect from 1 April 2010).



भारत का संविधान

उद्देशिका

हम, भारत के लोग, भारत को एक ¹[संपूर्ण प्रभुत्व-संपन्न समाजवादी पंथनिरपेक्ष लोकतंत्रात्मक गणराज्य] बनाने के लिए, तथा उसके समस्त नागरिकों को :

सामाजिक, आर्थिक और राजनैतिक न्याय,
विचार, अभिव्यक्ति, विश्वास, धर्म
और उपासना की स्वतंत्रता,
प्रतिष्ठा और अवसर की समता
प्राप्त कराने के लिए,

तथा उन सब में

व्यक्ति की गरिमा और ²[राष्ट्र की एकता
और अखंडता] सुनिश्चित करने वाली बंधुता
बढ़ाने के लिए

दृढ़संकल्प होकर अपनी इस संविधान सभा में आज तारीख
26 नवंबर, 1949 ई. को एतद्वारा इस संविधान को
अंगीकृत, अधिनियमित और आत्मार्पित करते हैं।

1. संविधान (बयालीसवां संशोधन) अधिनियम, 1976 की धारा 2 द्वारा (3.1.1977 से) "प्रभुत्व-संपन्न लोकतंत्रात्मक गणराज्य" के स्थान पर प्रतिस्थापित।
2. संविधान (बयालीसवां संशोधन) अधिनियम, 1976 की धारा 2 द्वारा (3.1.1977 से) "राष्ट्र की एकता" के स्थान पर प्रतिस्थापित।

THE CONSTITUTION OF INDIA

PREAMBLE

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a ¹**[SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC]** and to secure to all its citizens :

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

FRATERNITY assuring the dignity of the individual and the ²[unity and integrity of the Nation];

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949 do **HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.**

1. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec.2, for "Sovereign Democratic Republic" (w.e.f. 3.1.1977)
2. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec.2, for "Unity of the Nation" (w.e.f. 3.1.1977)

CLASS — XII
BIOLOGY

REVIEW COMMITTEE (2024-25)

| | | | |
|----|--------------------------|-----------------------------|---|
| 1. | Mr. Pawan Kumar | Principal (Group Leader) | School of Excellence sec-17, Rohini, Delhi |
| 2. | Ms. Sushma Kumari | LECTURER BIOLOGY | School of Excellence Sec-17, Rohini, Delhi |
| 3. | Mr. Jitender Sharma | LECTURER BIOLOGY | RPVV Civil Lines Delhi |
| 4. | SADAF FATIMA MERCHANT | LECTURER BIOLOGY | RPVV Sector-11 Rohini, Delhi |

BIOLOGY

Subject Code – 044

Classes XI - XII (2025-26)

The present curriculum provides the students with updated concepts along with an extended exposure to contemporary areas of the subject. The curriculum also aims at emphasizing the underlying principles that are common to animals, plants and microorganisms as well as highlighting the relationship of Biology with other areas of knowledge. The format allows a simple, clear, sequential flow of concepts. It links the discoveries and innovations in biology to everyday life such as environment, industry, health and agriculture. The Biology curriculum is expected to enable the students to:

- develop capacities for observation, experimentation, documentation, and familiarity with quantitative reasoning and multi-disciplinary approaches.
- engender sensitivity towards biological issues (environment, health) in their surroundings and be aware of how citizens can contribute to their local communities and to science.
- be aware of bioethical concerns that arise in biology today.
- understand the integration of different fields of biology and highlight the interconnections between these fields.
- be exposed to diverse careers in the life sciences.

This curriculum of Biology will help in achieving the following curricular goals and competencies delineated in the National Curriculum Framework for School Education 2023:

| | |
|---|---|
| CG-3 Explores the structure and function of the living world at the cellular level | C-3.1 Explains the role of cellular components (nucleus, mitochondria, endoplasmic reticulum, vacuoles, chloroplast, cell wall), including the semi permeability of cell membrane in making cell the structural basis of living organisms and functional basis of life processes C-3.2 Analyses similarities and differences in the life processes involved in nutrition (photosynthesis in plants; absorption of nutrients in fungi; digestion in animals), transport (transport of water in plants; circulation in animals), exchange of materials (respiration and excretion), and reproduction C-3.3 Describes mechanisms of heredity (in terms of DNA, genes, chromosomes) and variation (as changes in the sequence of DNA) |
| CG-4 Explores interconnectedness between organisms and their | C-4.1 Applies the knowledge of cellular diversity in organisms along with the ecological role organisms play (autotrophic/ heterotrophic nutrition) to classify them into five-kingdoms |

| | |
|--|--|
| environment | <p>C-4.2 Illustrates different levels of organisations of living organisms (from molecules to organisms)</p> <p>C-4.3 Analyses different levels of biological organisation from organisms to ecosystems and biomes along with interactions that take place at each level</p> <p>C-4.4 Analyses patterns of inheritance of traits in terms of Mendel's laws and its consequences at a population level (using models and/or simulations)</p> <p>C-4.5 Analyses evidences of biological evolution demonstrating the consequences of the process of natural selection in terms of changes — in allele frequency in population, structure, and function of organisms</p> |
| CG-5 Draws linkages between scientific knowledge and knowledge across other curricular areas | C-5.3 Applies scientific principles to explain phenomena in other subjects (sound pitch, octave, and amplitude in music; use of muscles in dance form and sports) |
| CG-6 Understands and appreciates the contribution of India through history and the present times to the overall field of Science, including the disciplines that constitute it | C-6.1 Knows and explains the significant contributions of India to all matters (concepts, explanations, methods) that are studied within the curriculum in an integrated manner |
| CG-7 Develops awareness of the most current discoveries, ideas, and frontiers in all areas of scientific knowledge in order to appreciate that Science is ever evolving, and that there are still many unanswered questions | <p>C-7.1 States concepts that represent the most current understanding of the matter being studied — ranging from mere familiarity to conceptual understanding of the matter as appropriate to the developmental stage of the students</p> <p>C-7.2 States questions related to matters in the curriculum for which current scientific understanding is well-recognised to be inadequate</p> |
| CG-8 Explores the nature of Science by doing Science | <p>C-8.1 Develops accurate and appropriate models (including geometric, mathematical, graphical) to represent real-life events and phenomena using scientific principles and use these models to manipulate variables and predict results</p> <p>C-8.2 Designs and implements a plan for scientific inquiry (formulates hypotheses, makes predictions, identifies variables, accurately uses scientific instruments, represents data — primary and secondary — in multiple modes, draws inferences based on data and understanding of scientific concepts, theories, laws, and principles, communicates findings using scientific terminology)</p> |

It is expected that the students would get an exposure to various branches of Biology in the curriculum in a more contextual and systematic manner as they study its various units.

(NCFSE-2023)

Attainment of the competencies shall be done through transaction of the curriculum using appropriate pedagogy; these shall be assessed through an integrated evaluation scheme.

COURSE STRUCTURE
CLASS XII (2025 - 26)
(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-1: Sexual Reproduction in Flowering Plants

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

Chapter-2: Human Reproduction

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

Chapter-3: Reproductive Health

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

Unit-VII Genetics and Evolution

Chapter-4: Principles of Inheritance and Variation

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

Chapter-5: Molecular Basis of Inheritance

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

Chapter-6: Evolution

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

Unit-VIII: Biology and Human Welfare

Chapter-7: Human Health and Diseases

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

Chapter-8: Microbes in Human Welfare

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

Unit-IX Biotechnology and its Applications

Chapter-9: Biotechnology - Principles and Processes

Genetic Engineering (Recombinant DNA Technology).



Chapter-10: Biotechnology and its Applications

Application of biotechnology in health and agriculture: Human insulin and vaccine production, stem cell technology, gene therapy; genetically modified organisms - Bt crops; transgenic animals; biosafety issues, biopiracy and patents.

Unit-X Ecology and Environment

Chapter-11: Organisms and Populations

Population interactions - mutualism, competition, predation, parasitism; population attributes - growth, birth rate and death rate, age distribution.

Chapter-12: Ecosystem

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

Chapter-13: Biodiversity and its Conservation

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

PRACTICALS

Time allowed: 3 Hours

Max. Marks: 30

| Evaluation Scheme | | Marks |
|--|---|-----------|
| One Major Experiment | 5 | 5 |
| One Minor Experiment | 2 & 3 | 4 |
| Slide Preparation | 1 & 4 | 5 |
| Spotting | | 7 |
| Practical Record + Viva Voce | (Credit to the student's work over the academic session may be given) | 4 |
| Investigatory Project and its Project Record + Viva Voce | | 5 |
| Total | | 30 |

A. List of Experiments

1. Prepare a temporary mount to observe pollen germination.
2. Study the plant population density by quadrat method.
3. Study the plant population frequency by quadrat method.
4. Prepare a temporary mount of onion root tip to study mitosis.
5. Isolate DNA from available plant material such as spinach, green pea seeds, papaya, banana etc.



B. Study and observe the following (Spotting):

1. Flowers adapted to pollination by different agencies (wind, insects, birds).
2. Pollen germination on stigma through a permanent slide or scanning electron micrograph.
3. Identification of stages of gamete development, i.e., T.S. of testis and T.S. of ovary through permanent slides (from grasshopper/mice).
4. Meiosis in onion bud cell or grasshopper testis through permanent slides.
5. T.S. of blastula through permanent slides (Mammalian).
6. Mendelian inheritance using seeds of different colour/sizes of any plant.
7. Prepared pedigree charts of any one of the genetic traits such as rolling of tongue, blood groups, ear lobes, widow's peak and colour blindness.
8. Controlled pollination - emasculation, tagging and bagging.
9. Common disease causing organisms like *Ascaris*, *Entamoeba*, *Plasmodium*, any fungus causing ringworm through permanent slides, models or virtual images or specimens. Comment on symptoms of diseases that they cause.
10. Models specimens showing symbiotic association in lichens, root nodules of leguminous plants, and parasitic mode of nutrition shown by *Cuscuta* on host.
11. Flash cards / models showing examples of homologous and analogous organs.

Practical Examination for Visually Impaired Students of Classes XI and XII**Evaluation Scheme****Time: 02 Hours****Max. Marks: 30**

| Topic | Marks |
|---|-----------|
| Identification/Familiarity with the apparatus | 5 |
| Written test (Based on given / prescribed practicals) | 10 |
| Practical Records | 5 |
| Viva | 10 |
| Total | 30 |

General Guidelines

- The practical examination will be of two-hour duration. A separate list of ten experiments is included here.
- The written examination in practicals for these students will be conducted at the time of practical examination of all other students.



- The written test will be of 30 minutes duration.
- The question paper given to the students should be legibly typed. It should contain a total of 15 practical skill based very short answer type questions. A student would be required to answer any 10 questions.
- A writer may be allowed to such students as per CBSE examination rules.
- All questions included in the question paper should be related to the listed practicals. Every question should require about two minutes to be answered.
- These students are also required to maintain a practical file. A student is expected to record at least five of the listed experiments as per the specific instructions for each subject. These practicals should be duly checked and signed by the internal examiner.
- The format of writing any experiment in the practical file should include aim, apparatus required, simple theory, procedure, related practical skills, precautions etc.
- Questions may be generated jointly by the external/internal examiners and used for assessment.
- The viva questions may include questions based on basic theory / principle / concept, apparatus / materials / chemicals required, procedure, precautions, sources of error etc.

Class XII

A. Items for Identification/ familiarity with the apparatus for assessment in practicals

(All experiments) Beaker, flask, petriplates, soil from different sites - sandy, clayey, loamy, small potted plants, aluminium foil, paint brush, test tubes, starch solution, iodine, ice cubes, Bunsen burner/spirit lamp/water bath, large flowers, Maize inflorescence, model of developmental stages highlighting morula and blastula of frog, beads/seeds of different shapes/size/texture *Ascaris*, Cactus/*Opuntia* (model).

B. List of Practical

1. Study of flowers adapted to pollination by different agencies (wind, insects).
2. Identification of T.S of morula or blastula of frog (Model).
3. Study of Mendelian inheritance pattern using beads/seeds of different sizes/texture.
4. Preparation of pedigree charts of genetic traits such as rolling of tongue, colour blindness.
5. Study of emasculation, tagging and bagging by trying out an exercise on controlled pollination.



6. Identify common disease causing organisms like *Ascaris* (model) and learn some common symptoms of the disease that they cause.
7. Comment upon the morphological adaptations of plants found in xerophytic conditions.

Note: The above practicals may be carried out in an experiential manner rather than recording observations.

Prescribed Books:

1. Biology, Class-XII, Published by NCERT.
2. Other related books and manuals brought out by NCERT (consider multimedia also).
3. Biology Supplementary Material (Revised). Available on CBSE website.

Question Paper Design (Theory)

Class XII (2025 -26)

Biology (044)

| Competencies | Total |
|---|-------|
| 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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Autogamy : When pollen grains of a flower are transferred from anther to stigma of the same flower.

Coleorhiza : A protective sheath of radicle in monocot seed.

Coleoptile : A protective sheath of plumule in monocot seed.

Perisperm : It is diploid persistent nucellus e.g. Black pepper, beet.

Nucellus : Multicellular tissue in the centre of ovule in which embryo sac is present.

Viability of Seed : Ability of seed to retain the power of germination.

| Structure of Microsporangium (Pollen Sac) | | |
|---|--|--|
| Sequence of layers | Name of Layer | Function |
| Outermost layers | Epidermis | Protection |
| Second layer | Endothecium | Protection |
| 2-4 layers of Cells | Middle layer | Protection |
| Innermost layer | Tapetum multinucleated DENSE cytoplasm | Nourishment of developing microspores (pollen grains) |

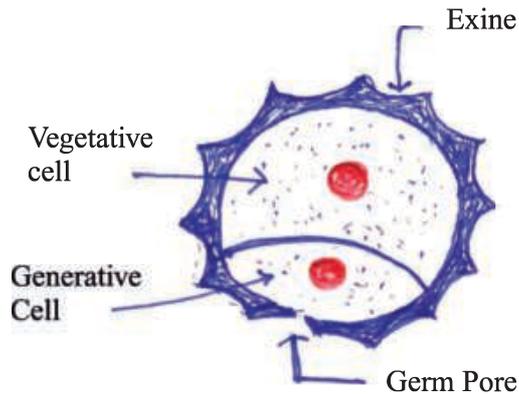
Microsporogenesis : Process of formation of microspores from a pollen mother cells.

Sporogenous tissue [Diploid] → Microspore mother cell-MMC [Diploid]

→ Microspore tetrad [Diploid] → 4 Microspores [Haploid] → 4 Pollen grains [Haploid]

| Pollen Grain (Male Gametophyte) | | |
|---------------------------------|-----------------|---|
| Layers and Contents | Name of Layers | Composition and Roles |
| Outer wall | Exine | Thick, hard, made of sporopollenin Due to sporopollenin, pollen grains found preserved in fossils |
| Inner wall | Intine | Thin, made of cellulose and pectin. It emerges out as pollen tube. |
| Large cell | Vegetative cell | Forms a pollen tube to deliver male gametes to embryo sac |
| Smaller cell | Generative cell | Forms 2 sperm cells or 2 male gametes |

Sporogenous Issue : Compactly arranged homogenous cells called as sporogenous tissue



Structure of Pollen Grain

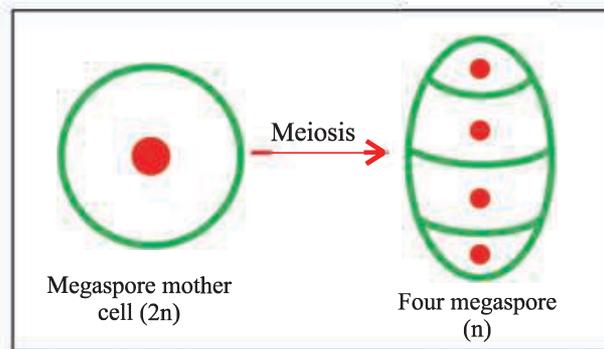
Sporopollenin is one of the most resistant organic substance. It is not affected by high temperature, strong acids or alkali. No enzyme can degrade it.

Pollen Products : Pollen grains are rich in carbohydrates, proteins and unsaturated fats. Their consumption is believed to increase performance of athlete and horses. They are used in the form of tablets and syrups.

Pollen Viability : Pollens of wheat and rice remain viable for 30 minutes. Pollen of some members of Rosaceae, Leguminoseae and solanaceae plant may remain viable for several months. Pollens can be cryopreserved in liquid Nitrogen (-196°C) in pollen banks.

Pollen of carrot grass (*Parthenium*), *Chenopodium*, *Amaranthus* etc. may cause pollen allergy.

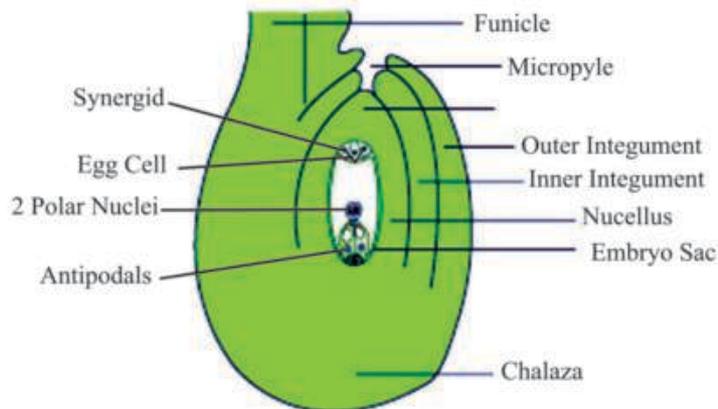
Megasporogenesis : Process of formation of haploid megaspores from megaspore mother cells



Megasporangium (Ovule) :

- The ovule is a small structure which is attached to the placenta by means of a stalk called funicle.

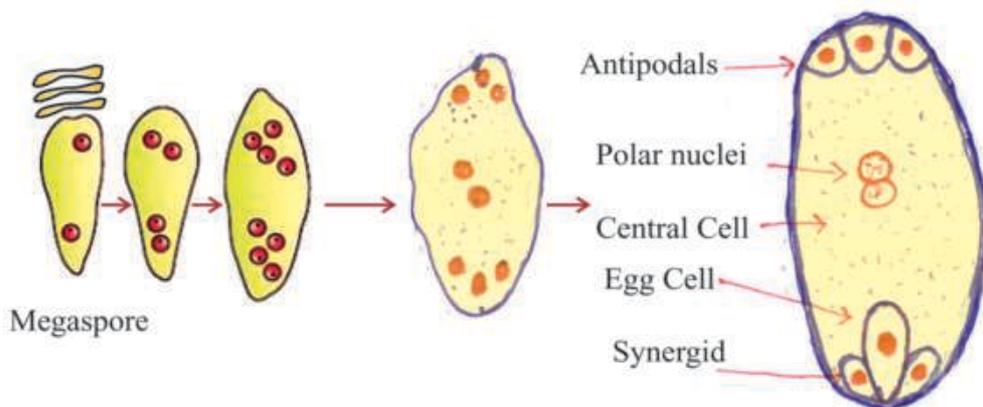
- The point of attachment of the body of the ovule to the funicle is known as hilum. The main body of the ovule is composed of parenchymatous cells known as nucellus.
- Each ovule has one or two protective integument, which encircle the ovule except at the tip having small opening called micropyle.
- Opposite to micropylar end is chalazal end
Generally a single embryosac or female gametophyte located in nucellus.
- Cells of nucellus have abundant reserve food material and provide nourishment to the developing embryo.



Female gametophyte (embryo sac) : In a majority of flowering plant out of four megaspores one of the megaspore is functional while other three degenerate, (monosporic development)

- The functional megaspore develops in embryo sac.
- The nucleus of the functional megaspore (n) undergoes three successive mitotic cell division which results the formation of eight nucleated stage of embryo sac (free nuclear division).
- The cell wall formation starts at eight nucleated stages. Three cells are grouped together at micropylar end to form the egg apparatus (2 synergids + 1 egg cell).
- Three cells are grouped at chalazal end they are, called antipodal cells.
- The remaining 2 nuclei are polar nuclei move to the centre of embryo sac, called central cell.

Thus, typical angiospermic embryo sac at maturity is 8 nucleate and 7 celled.



Development of Embryo Sac

| TYPES OF POLLINATION | | |
|----------------------|--|--|
| | Definition | Special Feature |
| Autogamy | Transfer of pollen grain from the anther to the stigma of the same flower. | Self Pollination |
| Geitonogamy | Transfer of pollen grains from the anther to the stigma of another flower of the same plant. | It is functionally cross-pollination involving a pollination agent and genetically it is similar to autogamy since the pollen grains come from the same plant. |
| Xenogamy | Transfer of pollen grains from anther to the stigma of a different plant. | Cross Pollination |

Agents of Pollination: Biotic and Abiotic agents help in pollination.

(a) Biotic Agents- Bees, flies, butterflies, wasps, moths, ants, birds, rodents, reptiles, and some primates.

(b) Abiotic Agents-Wind and water.

Types of Flowers : In some plants like Commelina, Oxalis and Viola have two types of flowers:

1. Chasmogamous Flower”

Flower remains open after maturity, both self pollination and cross pollination both can occur in the flower.

2. Cleistogamous Flower: Flower remain closed throughout their life, so, only self pollination (autogamy) occurs in such flowers. These flowers produce assured seed set even in the absence of pollinators

Out breeding Devices: Flowering plants have developed many devices called out breeding devices to discourage self pollination and to encourage cross-pollination. As continued, Self pollination leads to inbreeding depression . The types are:

| |
|--|
| (i) Non synchronization of pollen release and stigma receptivity |
| (ii) Position of anthers and stigma in such a way that pollen cannot come in contact of stigma of same flower. |
| (iii) Self-incompatibility |
| (iv) Production of Unisexual flowers |

Pollen—pistil interaction :

- The pistil has the ability to recognise the pollen grain, whether it is right type (Compatible) or of the wrong type (incompatible).
- If it is compatible then the pistil accepts the pollen grains.
- The pollen grains germinate on stigma to produce pollen tubes. The contents of the generative cell (or the two male gametes in those species whose pollen is liberated in the three celled stage), move into the pollen tube.
- Pollen tube grows through the tissue of stigma and style by secreting enzyme and enters the ovule, through micropyle via one of the synergid. Filiform apparatus guides the entry of pollen tube.

Double Fertilisation : The pollen tube releases two male gamete into the cytoplasm of synergid. One male gamete move towards egg cell and other male gamete towards the central cell.

- Syngamy : One male gamete + Egg cell \rightarrow Zygote ($2n$)
- Triple Fusion : Second male gamete + 2 polar nuclei \rightarrow PEN ($3n$)
- Since two types of fusion takes place in embryo sac, hence it is called as double fertilisation.

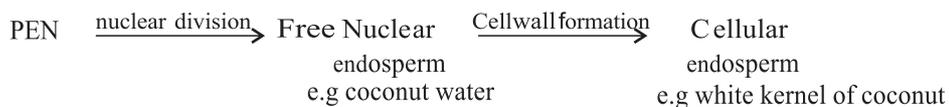
Post Fertilisation Events :

- (i) Endosperm and embryo development
- (ii) Maturation of ovule & ovary

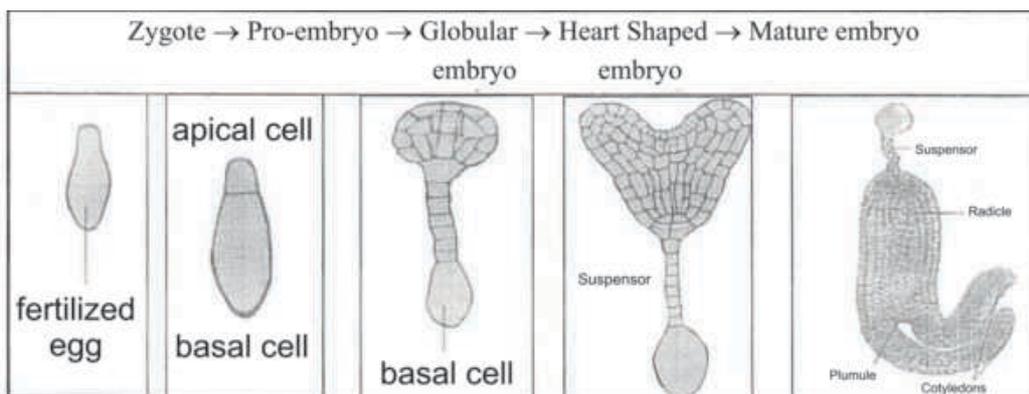
Fate of Floral Parts

| | | |
|-----------------------------|---|---|
| Ovary (2n) | → | Fruit |
| Ovary Wall (2n) | → | Pericarp |
| Ovule (2n) | → | Seed |
| Outer Integument (2n) | → | Testa |
| Inner integument (2n) | → | Tegmen |
| Zygote (2n) | → | Embryo |
| Primary Endosperm Cell (3n) | → | Endosperm |
| Sepals (2n) | → | Fall down |
| Petals (2n) | → | Fall down |
| Stamens (2n) | → | Wither away |
| Stigma, style (2n) | → | Wither away |
| Nucellus | → | Consumed/may be present as Perisperm |
| | | |
| Synergids (n) | | Degenerate |
| Antipodal Cells (n) | | Degenerate |

Development of Endosperm: The primary endosperm cell (PEC) in embryo sac divide again and again, and form triploid endosperm. The cells of endosperm are filled with reserve food material which is used for nourishment of the embryo during its development and also for the young seedling at the time of germination.



Development of Embryo: Embryo formation start after certain amount of endosperm is formed Following are the stages in development of a dicotyledonous embryo



Dicot Embryo : A typical dicot embryo consist of an embryonal axis and two cotyledons. The portion of embryonal axis above the level of cotyledons is the epicotyl and the portion below the level of cotyledons is hypocotyl.

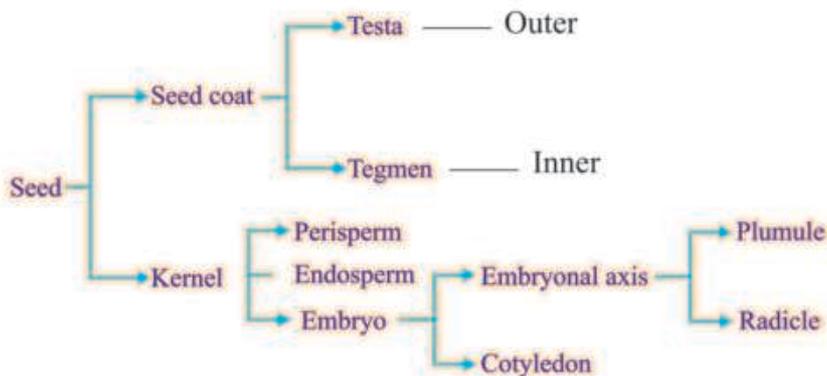
Monocot Embryo : Monocot (Rice, Maize etc.) has one cotyledon called Scutellum. The embryonal axis has the radicle and root cap enclosed by a sheath called Coleorrhiza.

The upper end (epicotyle) has plumule which is covered by hollow foliar structure called the coleoptile.

Polyembryony : Occurrence of more than one embryo in a seed, is known as polyembryony e.g. Orange, lemon, onion, mango, ground nut. It may be due to presence of more than one egg cell in the embryo sac or more than one embryo sac in the ovule.

Reasons of polyembryony : It is due to fertilisation of more than one egg cell in an ovule. The condition develop when an embryo sac contains more than one egg cell or ovule contain more than one embryo sac.

Seed : After fertilisation ovule mature into seed.



Non albuminous seed : Those seeds in which no residual endosperm is found because it is completely consumed during development of the embryo.
eg. pea, gram, ground nut.

Albuminous Seed : Those seeds, which retain a part of the endosperm because endosperm is not completely consumed by developing embryo.
eg. maize, wheat, sunflower, castor

Seed Dispersal : Seeds are dispersed to new habitat through agent like water, wind and animals.

Apomixis : Apomixis is a form of asexual reproduction that mimics sexual reproduction where seeds are formed without fertilisation.

Advantages of Apomictic Seed :

- No segregation of characters in hybrid progeny
- These seeds can be used to grow crop year after year
- These are economical as hybrid seed are not used to grow crops year after year.

Parthenocarpic fruits : The fruits which are formed (developed) without fertilisation are known as parthenocarpic fruit. Such fruits are seedless eg. Banana.

This phenomenon of development of fruit without fertilisation is known as parthenocarpy.

Chapter-2 Sexual Reproduction in Flowering Plants

Questions

VSA

(1 Marks)

1. Give the scientific name of a plant which came to India as a contaminant with imported wheat and causes pollen allergy.
2. Which characteristic of water pollinated species of pollen grains protect them from water?
3. Why are pollen grains produced in enormous quantity in maize ?
4. In some species of Asteraceae and grasses, seeds are formed without fusion of gametes. Mention the scientific term for such of reproduction.
5. If the diploid number of chromosomes in an angiospermic plant is 16. Mention number of chromosomes in the endosperm and antipodal cell.
6. Among the terms listed below, those that are not technically correct names for a floral whorl are:
(i) Androecium (ii) Carpel (iii) Corolla (iv) Sepal
(a) (i) and (iv)
(b) (iii) and (iv)
(c) (ii) and (iv)
(d) (i) and (ii)
7. Embryo sac is to ovule as..... is to an anther
(a) Stamen
(b) Filament
(c) Pollen grain
(d) Androecium
8. In a typical complete, bisexual and hypogynous flower, the arrangement of floral whorls on the thalamus from the outermost to the innermost is
(a) Calyx, corolla, androecium and gynoecium
(b) Calyx, corolla, gynoecium and androecium
(c) Gynoecium, androecium, corolla and calyx
(d) Androecium, gynoecium, corolla and calyx

9. A dicotyledonous plant bears flowers but never produces fruits and seeds. The most probable cause for the above situation is
- (a) Plant is dioecious and bears only pistillate flowers
 - (b) Plant is dioecious and bears both pistillate and staminate flowers
 - (c) Plant is monoecious
 - (d) Plant is dioecious and bears only staminate flowers
10. The outermost and innermost wall layers of microsporangium in an anther are respectively
- (a) Endothecium and tapetum
 - (b) Epidermis and endodermis
 - (c) Epidermis and middle layer
 - (d) Epidermis and tapetum
11. **Assertion:** More than one embryo may also occur in a seed.
Reason: It may be due to presence of more than one egg cell in the embryo sac or more than one sac in the ovule.
- (a) Both assertion and reason are true, and reason is the correct explanation of assertion.
 - (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 - (c) Assertion is true but reason is false.
 - (d) Both assertion and reason are false.
12. **Assertion:** Apomixis is a form of asexual reproduction that mimics sexual reproduction where seeds are formed without fertilisation.
Reason: Apomictic seeds cannot be used to grow crop year after year.
- (a) Both assertion and reason are true, and reason is the correct explanation of assertion.
 - (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 - (c) Assertion is true but reason is false
 - (d) Both assertion and reason are false.

SA-I

(2 Marks)

13. Fruits generally develop from ovary, but in few species thalamus contributes to fruit formation.

Name the two categories of fruits and give one example of each.

14. Among the animals, insects particularly bees are the dominant pollinating agents. List any four characteristic features of the insect-pollinated flower.

15. Differentiate between geitonogamy and xenogamy.

16. In the given figure I of a dicot embryo, label the parts (A) and (B) and give their function.

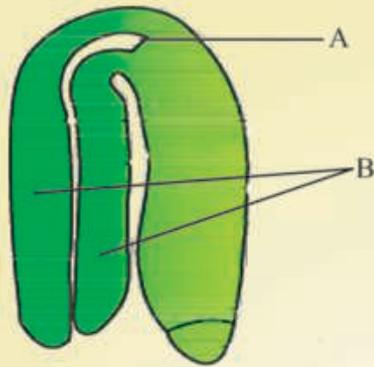


Figure 1

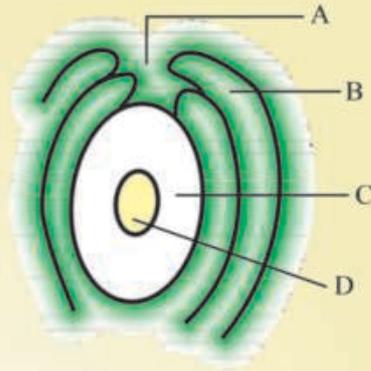
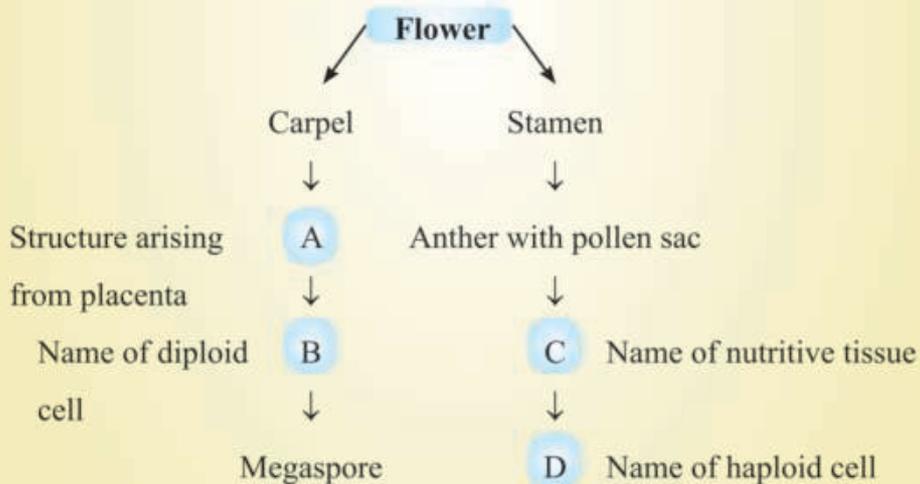


Figure 2

17. Name the parts A, B, C and D of the anatropous ovule (Figure 2) given above.
18. Given below is an incomplete flow chart showing formation of gamete in angiospermic plant. Observe the flow chart carefully and fill in the blank A, B, C and D.



19. Even though each pollen grain has two male gametes. Why are at least 10 pollen grains and not 5 pollen grains required to fertilise 10 ovules present in a particular carpel ?

SA-II

(3 Marks)

20. Continued self pollination lead to inbreeding depression. List three devices, which flowering plant have developed to discourage self pollination ?
21. Differentiate between microsporogenesis and megasporogenesis. What type of cell division occurs during these events ? Name the structure formed at the end of these two events.

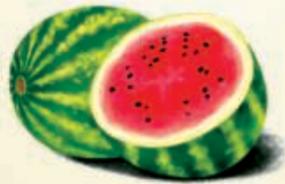
LA

(5 Marks)

- 22.(a) Draw the embryo sac of a flowering plant and label the parts :
- (i) Which guides the entry of pollen tube ?
 - (ii) Which develops into endosperm ?
 - (iii) Which fuses with male gamete to form zygote ?
- (b) What will be the fate of antipodal cells after fertilisation ?
- (c) Name the cell that develops into embryo Sac. How many embryo sacs are formed from one megaspore mother cell?

Case Based Questions

23. Observe the given fruit and answer the questions



- (a) How the above fruit get formed? Write term used for such development.
 - (b) Write one advantage & one disadvantage of such fruits
 - (c) Weather the development of given fruit is natural? Explain.
 - (d) Give an example of a fruit develop in same manner naturally.
24. A flower of tomato plant following the process of sexual reproduction produces 120 seeds. Based on the above information answer the following questions:

- (a) How many pollen grains and ovules involved?
- (b) How many microspore mother cells & megaspore mother cells involved in formation of male & female gametophytes?
- (c) How many meiotic divisions involved in formation of 120 seeds?
- (d) How many male gametes participated in fertilization process?

25. Aman visited a nursery, where he observed many of the flowers of flowering plants were covered with butter paper as shown in picture. He asked for his queriesto his biology teacher. What answers you expect for the following questions:



- (a) Name the process shown in the picture? Write its advantage.
- (b) In bisexual flowers which additional process is required before covering flowes?
- (c) How the above steps followed by the gardener are helpful in developing plants?
- (d) In which plant the above steps were followed by Mendel to explain the inheritance?

Answers

VSA

(1 Mark)

1. *Parthenium hysterophorus* (carrot grass)
2. Presence of mucilagenous covering
3. To ensure pollination because Maize is pollinated by wind.
4. Apomixis
5. 24 Chromosomes in endosperm and 8 chromosomes in antipodal cells.

Answer of Multiple-Choice Question :

6. (c) 7. (c) 8. (a) 9. (d) 10. (d) 11. (b) 12. (c)

Answer of Assertion-Reason Question :

11.(a) 12. (c)

SA-I

(2 Marks)

6. Two categories of fruits are :

- (i) True fruits *e.g.*, Mango
- (ii) False fruit *e.g.*, Apple

7. (i) Flowers are large

- (ii) Colourful petals of flowers
- (iii) Presence of fragrance
- (iv) Rich in nectar

| 15. | Geitonogamy | Xenogamy |
|-----|---|---|
| | 1. Transfer of pollen grains from the anther to stigma of another flower of the same plant. | Transfer of Pollen grains from anther to Stigma of different plant. |
| | 2. Does not provide opportunity for genetic recombination. | Provide opportunity for genetic recombinations |

16.A = Plumule — To form shoot system

B = Cotyledons — Storage of food

17.A = Micropyle, B = Outer integument, C = Nucellus, D = Embryo sac

18. A = Ovule/megasporangium, C = Tapetum

B = Megaspore mother cell, D = Pollen grains

19. Because only one male gamete is involved is syngamy, *i.e.*, fusion of male gamete with egg cell.

SA-II

(3 Marks)

20.(a) Release of pollen and stigma receptivity is not synchronised in some species

(b) Anther and stigma are at different position/heights in some plants

(c) Self-incompatibility (a genetic mechanism).

21. • Microsporogenesis–Process of formation of microspore from a Pollen mother cell.

• Megasporogenesis–Process of formation of megaspore from megaspore mother cell.

• Meiotic division in both.

Microsporogenesis results in the formation of pollen grain while megasporogenesis results in the formation of megaspore.

LA

22.(a) Refer to figure 2.8(c) page 26 NCERT book.

(i) Filiform apparatus (ii) Central cell (iii) Egg cell

(b) They degenerate after fertilization.

(c) Functional megaspore, one megaspore develops to form one embryo sac.

23. (a) Without fertilisation, parthenocarpy

(b) Advantage: seedless fruits easy to eat/no need of pollinators
Disadvantage: no seeds available for dispersal/ new variations do not occur/induced parthenocarpy leaves the impact of chemicals

(c) No, it is induced by chemicals

(d) Banana.

24. (a) Pollen grains – 120, ovules – 120

(b) Microspore mother cells – 30, Megaspore mother cells – 120

(c) Meiotic divisions = $120 \times \frac{1}{4} + 120 = 150$ divisions

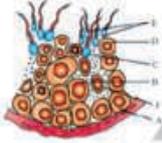
(d) Male gametes involved – $2 \times 120 = 240$.

25. (a) Bagging, prevent pollination with unwanted pollens

(b) Emasculation-removal of anthers/stamen at bud stage.

(c) Enable to develop plants with desirable characters/leads to controlled pollination.

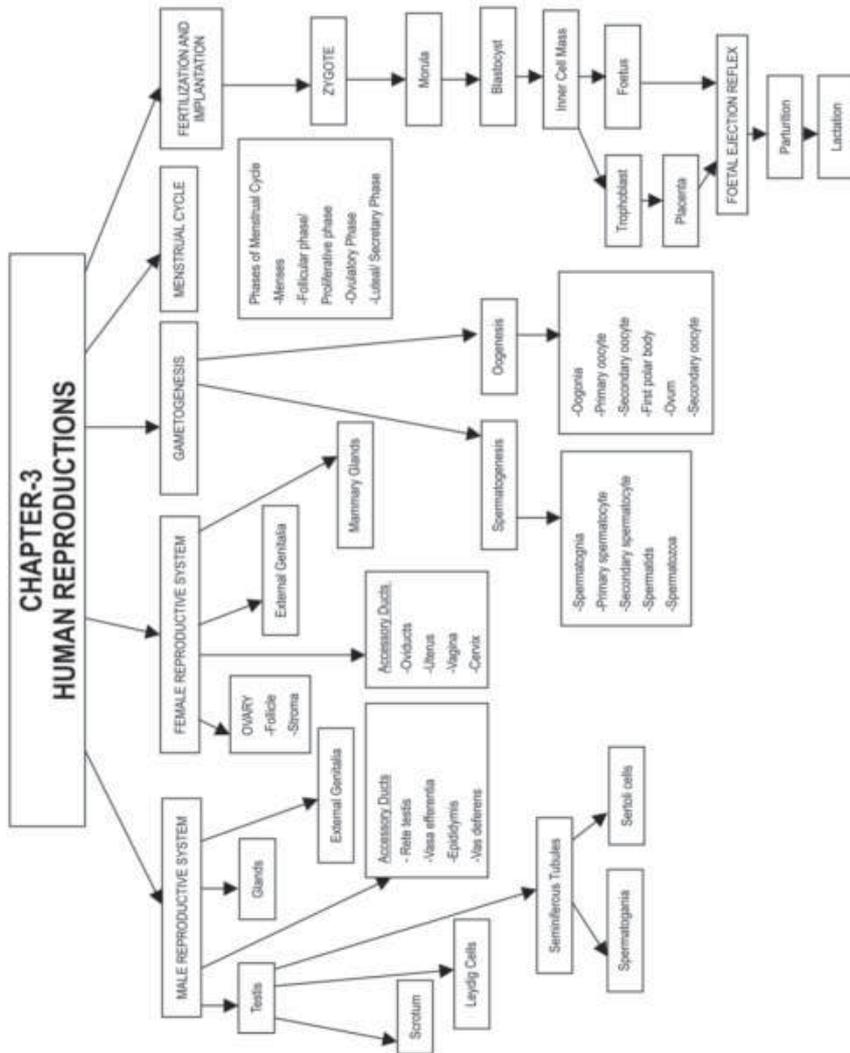
(d) In sweet pea (*Pisum sativum*)



Chapter - 2

Human

Reproduction



Blastula : A stage of embryogenesis which comes after morula and has a hollow fluid filled space called blastocoel.

Gestation Period : A period between fertilisation of ovum and the birth of a baby.

Implantation : Fixing of embryo/fertilised egg in uterus. It leads to pregnancy.

Menarche : The beginning of first menstruation in female on attaining puberty.

Menopause : Permanent cessation of menstrual cycle in female. It occurs between the age 45 to 50 years in human female.

Ovulation : Process of release of mature ovum (Secondary oocyte) from the ovary.

Parturition : Process of delivery of the foetus (Child birth), through birth canal.

Puberty : A stage at which immature reproductive system of boy or girl becomes mature. Period of puberty is 10-14 years in girls and 13-16 years in boys.

Spermiogenesis : Transformation of spermatids into sperms.

Spermiation : A process by which spermatozoa are released from the seminiferous tubules.

Spermatogenesis : Process of formation of sperm from male germ cell in the testes.

Colostrum : The fluid secreted by mammary glands soon after birth is called colostrum. It contains proteins, lactose and antibodies (e.g.IgA). This provides nutrition and help the new born baby to develop resistance for healthy development.

Ootid (Ovum) : A haploid cell formed by meiotic division of a secondary oocyte, especially the ovum, as distinct from the polar bodies.

Cleavage : The mitotic division in which the zygote undergoes to form morula and then blastocyst.

Insemination : The process in which the male transfers the sperms into the genital tract of the female.

Leydig Cells : (Interstitial Cells)—Present in connective tissue outside the seminiferous tubules. They are endocrine in nature and produce androgens e.g. testosterone.

Sertoli Cells : (nurse cells) : Present in the lumen of the seminiferous tubules. They provide nutrition and help in differentiation of cells undergoing spermatogenesis. They also secrete ABP (Androgen Binding Proteins) and inhibin.

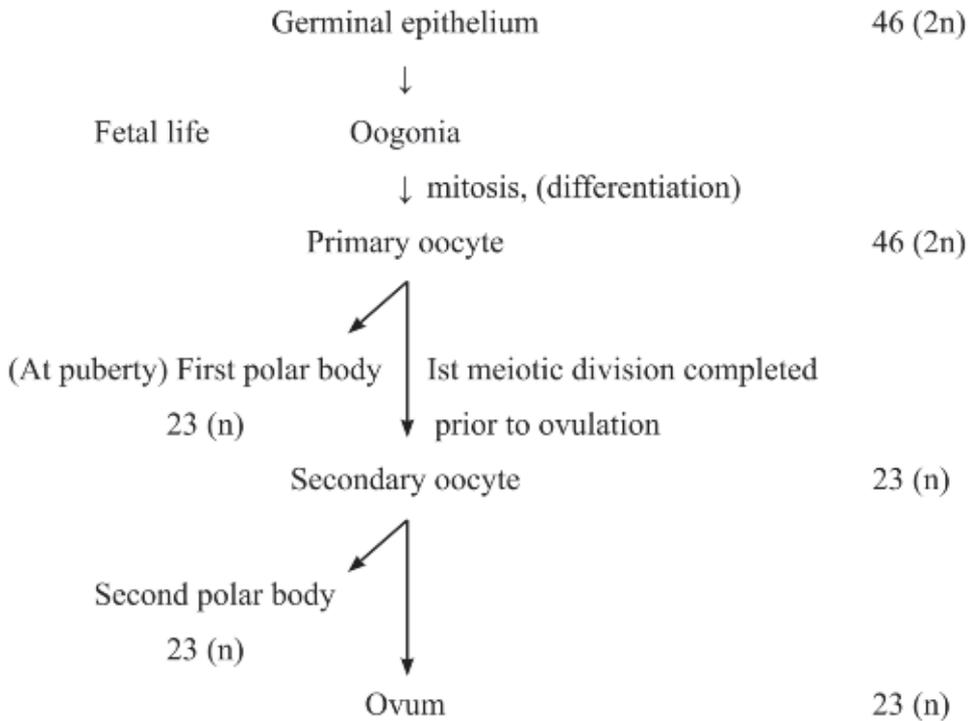
Accessory Male Genital Glands :

- Seminal Vesicles—Produce seminal fluid which forms 60-70% of semen. The fluid activates the sperms and have fructose, citrate, inositol and proteins for nutrition of sperms.
- Prostate Gland : The gland secretes thin, milky and alkaline secretion which neutralises the acidic secretion in female vagina.
- Cowper's Gland : (Bulbourethral gland)—helps in secretion of mucus which provides lubrication of urinogenital tract.

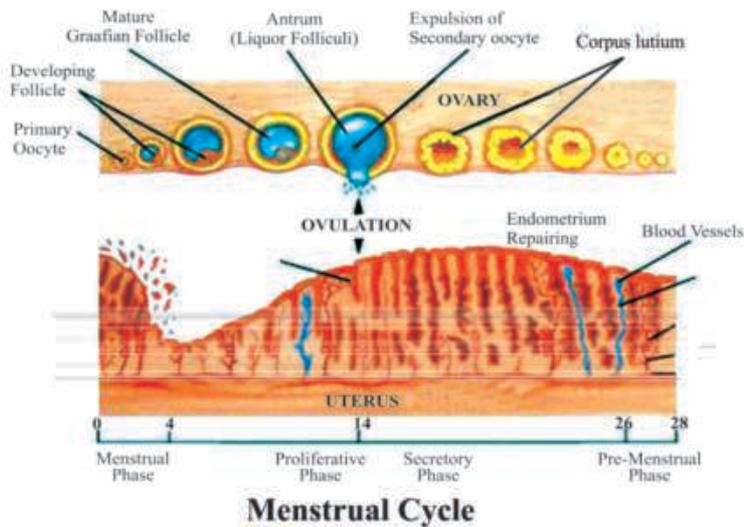
Spermatogenesis : Process of formation of sperms in testis.

| | |
|---------------------------|---------|
| Germinal epithelium | 46 (2n) |
| differentiation ↓ Mitosis | |
| Spermatogonia | 46 (2n) |
| ↓ Mitosis | |
| Primary spermatocyte | 46 (2n) |
| Ist Meiotic division ↓ | |
| Secondary spermatocyte | 23 (n) |
| 2nd meiotic division ↓ | |
| Spermatid | 23 (n) |
| Spermiogenesis ↓ | |
| Spermatozoa/sperm | 23 (n) |

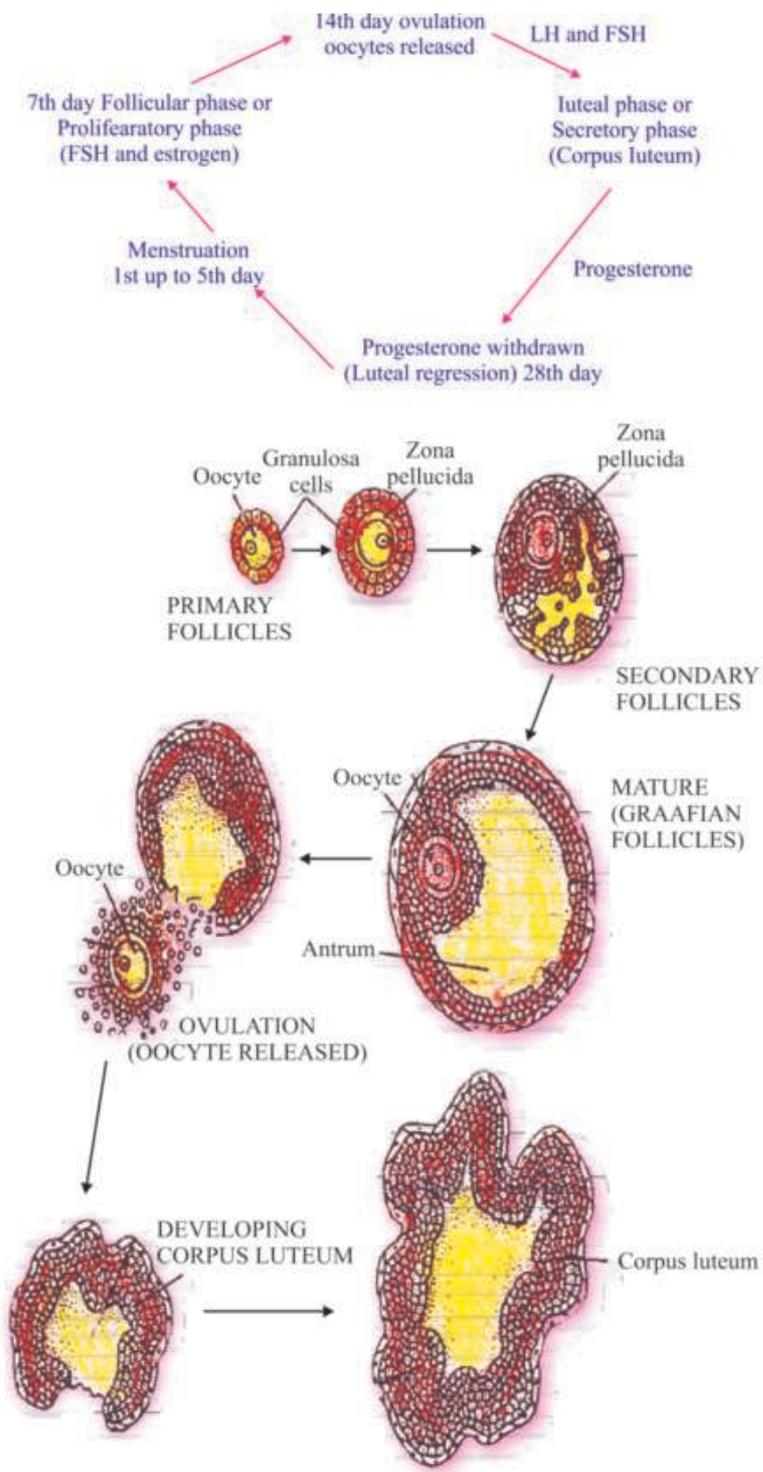
Oogenesis : Process of formation of ova in ovary.



Phases of Menstrual Cycle : Menstrual phase, Follicular (Proliferative) Phase, ovulatory phase and Luteal (secretory) phase



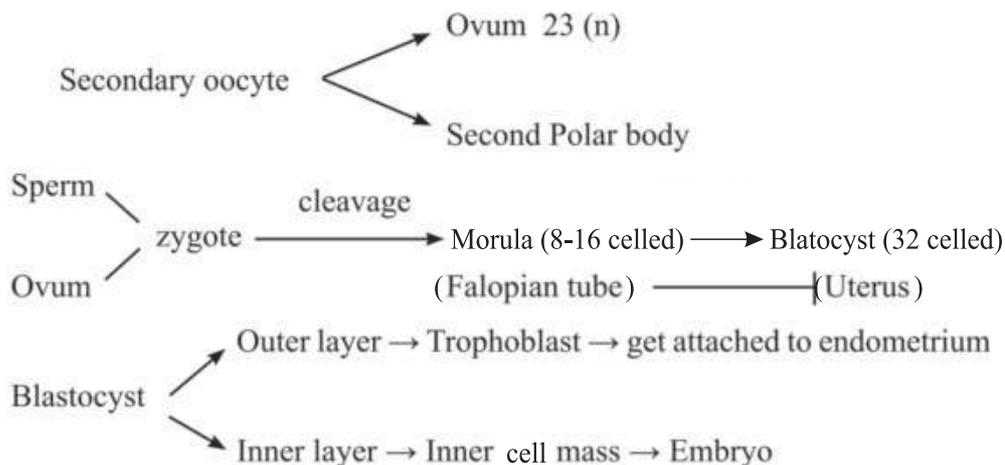
diag.- Menstrual Cycle



Fertilisation : Process of fusion of sperm with ovum

Site of fertilisation in human female : Ampullary region.

Secretion of acrosome helps the sperm entry into cytoplasm of ovum through zona pellucida and plasma membrane. Sperm entry induce the completion of the 2nd meiotic division of secondary oocyte.



Placenta : An intimate connection between foetus and uterine wall of the mother to exchange materials.

Function : Nutrition, Respiration, Excretion, as barrier, Endocrine function, shock absorber.

Placenta as Endocrine tissue : Placenta Produces several hormones such as Estrogen, hCG, hPL, Progesterone.

In late phase of pregnancy—relaxin hormone is released by ovary.

Progesterone is called 'Pregnancy hormone'.

Embryonic Development : (at various month of pregnancy) After 1 month = Heart, 2 months = Limbs and digits, 3 months = External genital organ, 5 months = First movement, 6 months = body covered with fine hairs, eye lid, eye lashes, 9 months = Fully developed and ready for delivery.

Questions

VSA

(1 Mark)

1. Failure of testes to descend into Scrotal sacs leads to sterility. Why ?
2. How many sperms will be produced from 10 primary spermatocytes and how many eggs will be produced from 10 primary oocytes ?

3. In ovary which structure transforms as corpus luteum and name the hormone secreted by corpus luteum?

Chapter-3: Human Reproduction

Multiple-Choice Questions

4. Name the hormone that has no role in menstruation.
- a) LH
 - b) FSH
 - c) GH
 - d) TSH
5. $2n=16$ in a primary spermatocyte which is in metaphase of first meiotic division. What shall be the total number of chromatids in each of the secondary spermatocyte?
- a) 8
 - b) 16
 - c) 24
 - d) 32
6. Some important events in the human female reproductive cycle are given below. Arrange the events in a proper sequence.
A - Secretion of FSH , B - Growth of corpus luteum, C - Growth of the follicle and oogenesis, D - Ovulation, E - Sudden increase in the levels of LH
- a) A, C, E, D, B
 - b) A, D, C, E, B
 - c) B, A, C, D, E
 - d) C, A, D, B, E
7. In the absence of acrosome, the sperm
- a) cannot get energy
 - b) cannot penetrate the egg
 - c) cannot swim
 - d) cannot get food

8. In oocyte, secondary maturation division occurs in
- (a) Ovary
 - (b) Abdominal cavity
 - (c) Fallopian tube
 - (d) Uterus

Assertion-Reason Questions

9. **Assertion:** Colostrum provides nutrition and helps the new born baby to develop resistance for healthy growth.

Reason: Colostrum contains proteins, lactose and antibodies such as IgA.

- a) Both assertion and reason are true, and reason is the correct explanation of assertion.
 - b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 - c) Assertion is true but reason is false.
 - d) Both assertion and reason are false.
10. **Assertion:** Sertoli cells provide nutrition and help in differentiation of cells undergoing spermatogenesis.

Reason: Leydig cells are present in connective tissue outside the seminiferous tubule.

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

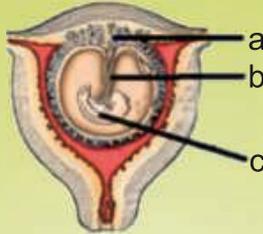
Case-based Questions

11. Read the following and answer any four questions from (i) to (v) given below:
The reproductive cycle in female primates is called the menstrual cycle. One ovum is released during the middle of each menstrual cycle. The cycle starts with the menstrual phase when menstrual flow occurs and it lasts for 3-5 days. The menstrual flow results due to the breakdown of the endometrial lining of the uterus and its blood vessels which form a liquid that comes out through the

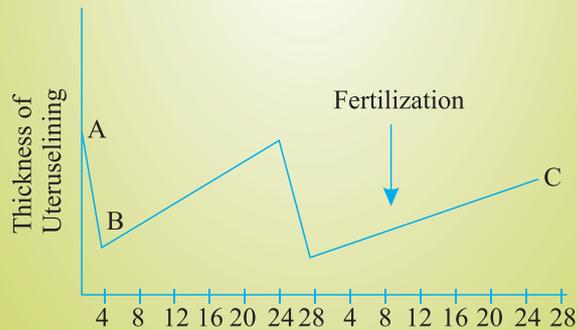
vagina. The menstrual phase is followed by the follicular phase, the primary follicles in the ovary grow to become a fully mature Graafian follicle. Both LH and FSH attain a peak level in the middle of the cycle. The ovulatory phase is followed by the luteal phase during which the remaining parts of the Graafian follicle transform. During pregnancy, all events of the menstrual cycle stop and there is no menstruation.

- (i) At what stage of life is oogenesis initiated in a human female?
- a) At puberty
 - b) During menarche
 - c) During menopause
 - d) During embryonic development
- (ii) Ovulation in the human female normally takes place during the menstrual cycle
- a) at the middle of secretory phase
 - b) just before the end of the secretory phase
 - c) at the beginning of the proliferative phase
 - d) at the end of the proliferative phase
- (iii) Immediately after ovulation, the mammalian egg is covered with a membrane known as
- a) chorion
 - b) zona pellucida
 - c) corona radiata
 - d) vitelline membrane
- (iv) Which one of the following events are correctly matched with the time period in a normal menstrual cycle?
- a) Release of egg: 5th day
 - b) Endometrium regenerates: 5-10 days
 - c) Endometrium secretes nutrients for implantation: 11-18 days
 - d) Rise in progesterone level: 1-15 days
- (v) Identify the correct sequence
- a) Primary follicle, ovum, corpus luteum, Graafian follicle
 - b) Corpus luteum, Graafian follicle, Primary follicle, ovum

- c) Primary follicle, Graafian follicle, ovum, corpus luteum
 d) Corpus luteum, Primary follicle, Graafian follicle, ovum
12. The following figure shows a foetus within the uterus. On the basis of the given figure, answer the questions that follow:

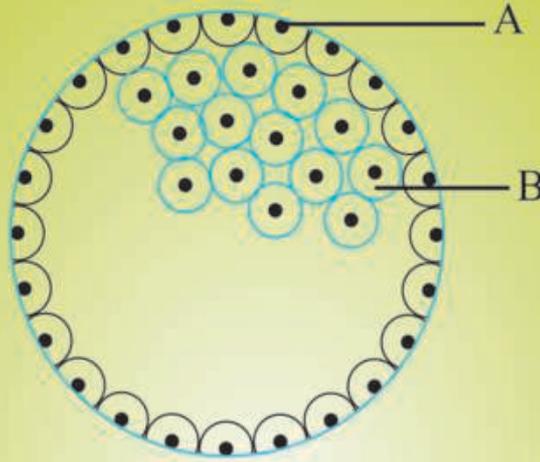


- (a) In the above figure, label the parts a, b and c.
 (b) In the above figure, choose and name the correct part (a, b or c) that act as a temporary endocrine gland and substantiate your answer.
 (c) Mention the role of the 'b' in the development of the embryo.
 (d) Name the fluid surrounding the developing embryo. How is it misused for sex determination?
13. The graph given below shows how the lining of the uterus in a female who has achieved puberty varies with time. Examine the graph and answer the following questions.

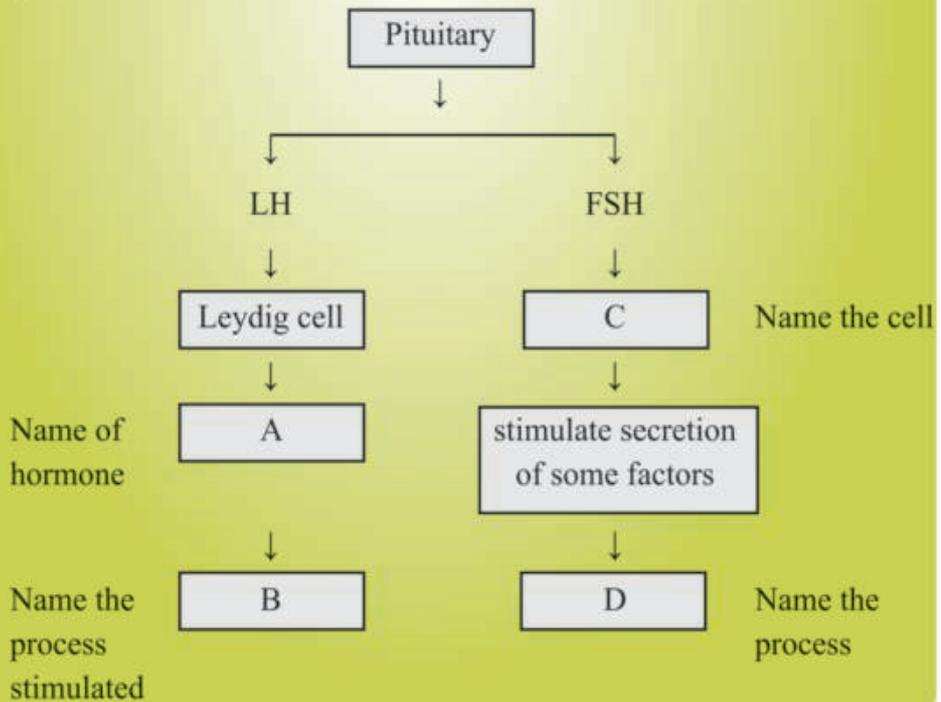


- (a) What is happening between A and B?
 (b) When the ovulation will take place? Surge of which pituitary hormone is required for ovulation?
 (c) Fertilisation occurs on the 16th day of the second menstrual cycle. How do you expect the graph to behave after points C? Will the pattern of the first and second months be followed?
 (d) Write the role of yolk sac.

14. In the given figure, give the name and functions of parts labelled A and B.



15. Given below is an incomplete flow chart showing influence of hormone on gametogenesis in male, observe the flow chart carefully and fill in the blank A, B, C and D.



16. Give reason for the following :

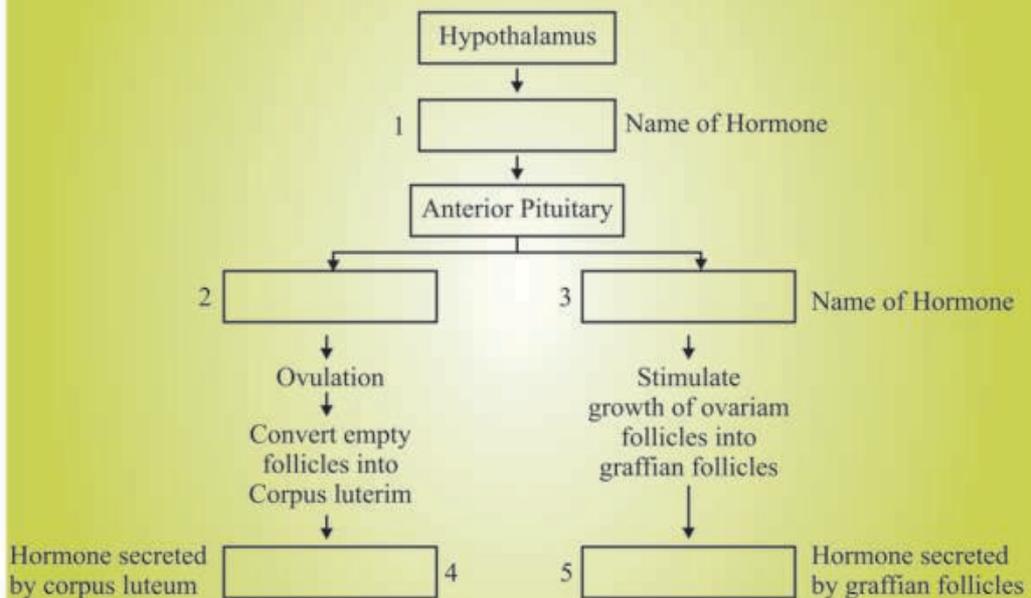
- (a) The first half of the menstrual cycle is called follicular phase as well as proliferative phase.
- (b) The second half of the menstrual cycle is called luteal phase as well as secretory phase.

17. What is meant by L.H. Surge ? Write the role of L.H.

SA-II

(3 Marks)

18. Study the flow chart given below. Name the hormones involved at each stage and in human female.

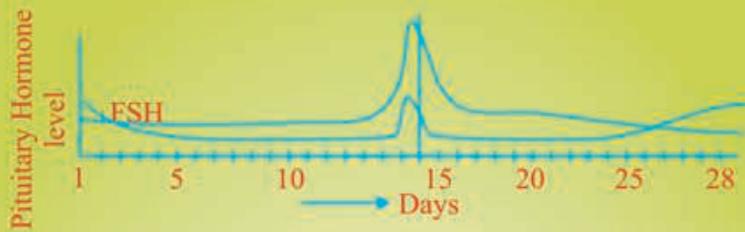


19. Three of the steps of neuro-endocrine mechanism in respect of parturition are mentioned below.

Write the missing steps in proper sequence.

- (a) Signals originate from fully developed foetus and placenta.
- (b)
- (c)
- (d) Oxytocin causes strong uterine contraction
- (e) Uterine contraction stimulates further secretion of oxytocin.
- (f)

20.(a) Read the graph given below. Correlate the ovarian events that take place in the human female according to the level of the pituitary hormone during the following day.



- (i) 10th – 14th days (ii) 14th – 15th days
 (iii) 16th – 23th days (iv) 25th – 29th days

(If the ovum is not fertilised)

(b) What are the uterine events that follow beyond 29th day if the ovum is not fertilised.

21. T.S. of mammalian testis revealing seminiferous tubules show different types of cell.

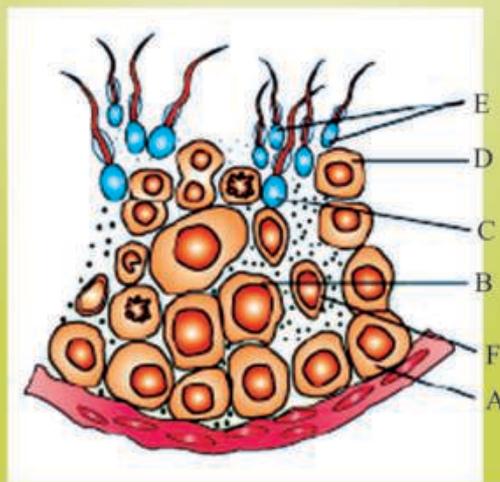
- (i) Name the two types of cells of germinal epithelium.
 (ii) Name of cells scattered in connective tissue and lying between seminiferous tubules.

Differentiate between them on the basis of their functions.

LA

(5 Marks)

22.



Study the figure given :

- (i) Pick out the name of cells that undergo spermiogenesis.
- (ii) Name A, B, C and F.
- (iii) Give ploidy of B and E.
- (iv) Mention the function of 'F' cell.

Answers

VSA

(1 Mark)

1. High temperature of abdomen kills the spermatogenic tissue of the testes, so no sperm are formed.
2. 40 sperms, 10 eggs.
3.
 - Follicular cells of empty Graafian follicle.
 - Progesterone.

Answer of Multiple-Choice Question :

4. (c) 5. (b) 6. (a) 7. (b) 8. (c)

Answer of Assertion-Reason Question :

9. (a) 10. (b) 11. (I) (d), (ii) (d), (iii) (d), (iv) b, (v) (c)

SA-I

(2 Marks)

12. (a) a-Placental villi, b-umbilical cord, c-embryo
(b) Part 'a' is placenta which act as temporary endocrine tissue and producers several hormones like human chorionic gonadotropin (hCG), human placental lactogen (hPL), estrogens and progestogens.
(c) 'b' is the umbilical cord. It connects placenta to embryo and help in transportation of substances to and from the embryo.
(d) Amniotic fluid. Used to determine sex based on chromosomal pattern of cells of amniotic fluid and misused for female foeticide.
13. (a) It represents menstrual flow. During this phase the uterus lining is said along with the blood and moves out of the body in the form of bleeding.
(b) 14th day or in the mid of the cycle. LH surge (Luteinising Hormone increases)

4. Progesterone 5. Estrogen

19. (b) Foetal ejection reflex

(c) The reflex triggers release of oxytocin

(f) Expulsion of the baby out through birth canal.

20. (a) (i) Gonadotropins and FSH increase

(ii) LH attains peak level but FSH decrease

(iii) LH and FSH level decrease

(iv) LH remains low and FSH increases.

(b) After 29th day there is a menstrual flow involving discharge of blood and cast off endometrium lining.

21. (i) Germinal epithelium have two types of cells. 1. Spermatogonium.
2. Sertoli cells

(ii) Leydig's cell or Interstitial cells.

Functions

Spermatogonium undergoes meiotic division leading to sperm formation.

Sertoli cell : Nourishes germ cells

Leydig cell : Synthesise and Secrete hormone androgen.

LA

(5 Marks)

22. (i) D—Spermatids

(ii) A—Spermatogonium;

B—Primary spermatocyte

C—Secondary spermatocyte

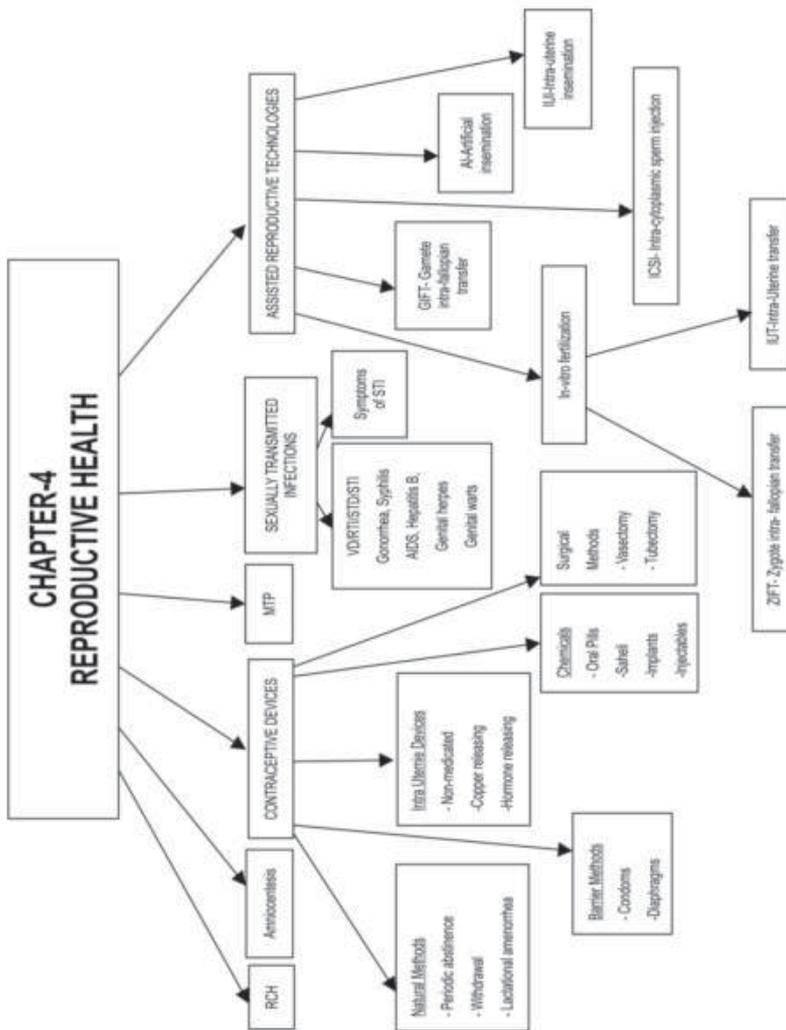
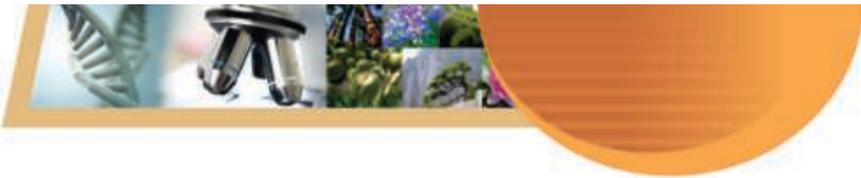
F—Sertoli cells

(iii) B—Diploid

E—Haploid

(iv) Provide nourishment to germ cells.





Amniocentesis : Diagnostic technique to detect chromosomal pattern in the foetus used to detect the genetic disorder and often misused to determine the sex of the foetus.

Sterilisation : A permanent method of birth control through surgery in male or female.

IUCD : Intra Uterine Contraceptive Device

RCH : Reproductive and Child Health care

STD : Sexually Transmitted Disease

CDRI : Central Drug Research Institute

MMR : Maternal Mortality Rate

MTP : Medical Termination of Pregnancy

VD : Venereal Disease

RTI : Reproductive Tract Infection

PID : Pelvic Inflammatory Disease

ART : Assisted Reproductive Technologies

IVF : In Vitro Fertilisation

ZIFT : Zygote Intra Fallopian Transfer

GIFT : Gamete Intra Fallopian Transfer

Methods of Birth Control

- (i) Natural Methods : Periodic abstinence
Coitus interruptus or withdrawal
Lactational amenorrhea.
- (ii) Barrier Methods : Condom, Diaphragms, Cervical cap.
and vault
- (iii) Intra Uterine Devices : Non—medicated (e.g. Lippes loop)
Copper releasing (e.g., Cu-T, multiload 375)
Hormone releasing (e.g. LNG-20,
progestasert)

- (iv) Oral contraceptives : Pills / Saheli, Mala-D
Small doses of either progestogens or Progestogen—estrogen combination
- (v) Injections : Progesterone derivatives given every three months.
- (vi) Implants : Synthetic progesterone patches are implanted under the skin.
Prevents pregnancy upto 4 years.
- (vii) Emergency pills : Must be taken within 72 hours of coitus. They have high concentration of progesterone and oestrogen which prevent ovulation eg. I pill, unwanted-72 etc.
- (viii) Surgical (Sterilisation) : (1) Tubectomy in females;
(2) Vasectomy in male.

MTP (Medical Termination of Pregnancy)

Voluntary or intentional abortion performed to end pregnancy before the completion of full term.

MTP is legalised :

- To abort unwanted pregnancies.
- If pregnancy is likely to produce a congenitally malformed child.
- Pregnancy leads due to failure of contraceptive or result of rape.

STD (Sexually Transmitted Diseases)

| Name of Disease | Causative agent | Symptoms |
|------------------------|---------------------------|--|
| Gonorrhoea | Bacterium | Painful urination, Pain around urethra |
| Syphilis | Bacterium | itching, fluid discharge, pain in urinogenital tract. |
| Genital Herpes | Virus (Herpes simplex) | Reddish ulcers over external genitalia, vaginal discharge. |

Genital warts

Virus

Warts over external genitalia, vagina & cervix etc.

Infertility : Inability to produce children, inspite of unprotected sexual cohabitation of a couple is termed as infertility.

Reasons for Infertility

- (i) Physical
- (ii) Congenital diseases
- (iii) Drugs
- (iv) Immunological reaction

The couple can be assisted to have children through certain special techniques commonly known as assisted reproductive technologies (ART).

- (i) **In Vitro Fertilisation (IVF)** : Fertilisation outside the body in almost similar conditions as that in the body, followed by embryo transfer (E.T.).

Test Tube baby Programme : Ova from the wife/donor female and sperm from husband/donor male are allowed to fuse under simulated condition in the laboratory.

ZIFT : Zygote intra fallopian transfer—Zygote or early embryo upto eight blastomeres is transferred into the fallopian tube.

IUT : Intra Uterine Transfer—Embryo with more than eight blasomeres are transferred.

- (ii) **Gamete intra fallopian transfer (GIFT)** : Transfer of an ovum collected from a donor to fallopian tube of another female who can not produce ova, but can provide suitable conditions for fertilisation and further development of the foetus upto parturition.
- (iii) **Intra Cytoplasmic sperm injection (ICSI)** : The sperm is directly injected into the ovum to form an embryo in the laboratory and then embryo transfer is carried out.
- (iv) **Artificial Insemination** : This method is used in cases where infertility is due to the inability of the male partner to inseminate the female or due to very low sperm counts in the ejaculates. In this method, the semen collected from the husband or a healthy donor is artificially introduced into the vagina or into the uterus (IUI-Intra uterine insemination).

Questions

VSA

(1 Mark)

1. Give the term for prenatal diagnostic technique aimed to know the sex of developing foetus and to detect congenital disorders.
2. After a successful in-vitro fertilisation, the fertilised egg begins to divide. Where is this egg transferred before it reaches the 8-celled stage and what is this technique called ?
3. Give the term for rapid population growth.
4. Name the fluid from which foetal cells are extracted for chromosomal analysis.

Multiple Choice Question

5. Oral contraceptives prevent pregnancy by
 - a) Killing the ovum
 - b) Blocking fertilisation
 - c) Preventing ovulation
 - d) Preventing implantation
6. Tubectomy is method of sterilisation in which
 - a) Small part of the fallopian tube is removed or tied up
 - b) Ovaries are removed surgically
 - c) Small part of vas deferens is removed or tied up
 - d) Uterus is removed surgically
7. Which of the following is a hormone releasing Intra-Uterine Device (IUD)?
 - a) Multiload - 375
 - b) LNG-20
 - c) Cervical cap
 - d) Vault
8. Which of the following is not a sexually transmitted disease?
 - a) Syphilis
 - b) AIDS
 - c) Trichomoniasis
 - d) Encephalitis

9. Embryo with more than 16 blastomeres formed due to in vitro fertilisation is transferred into
- a) Cervix
 - b) Uterus
 - c) Fallopian tube
 - d) Fimbriae

Assertion-Reason Question

10. **Assertion :** In IUT, zygote or early embryo with up to eight blastomeres is transferred into the fallopian tube.

Reason : In ZIFT, embryo with more than eight blastomeres is transferred into the fallopian tube.

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

11. **Assertion :** In Vitro Fertilisation involves fertilisation outside the body.

Reason : Ova from female and sperm from male are allowed to fuse under simulated condition in the laboratory.

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

SA-I**(2 Marks)**

12. Lactational Amenorrhea is a method of contraception. Justify. What is the maximum effectiveness of this method in terms of period/duration?
13. Why is CuT (copper T) considered as good contraceptive device to space children ?
14. Briefly explain two natural barriers for birth control.
15. Write any four characteristics of an ideal contraceptive.

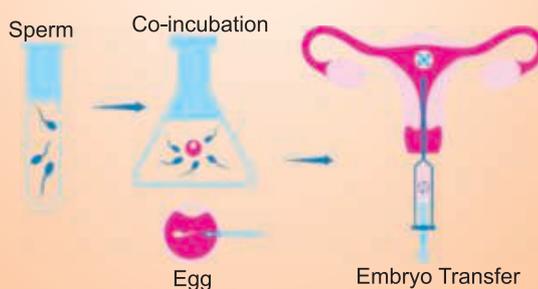
SA-II**(3 Marks)**

16. Give another name for sexually transmitted diseases. Name two sexually transmitted diseases which are curable and two diseases which are not curable.
17. Differentiate between Vasectomy and Tubectomy.
18. Mention the various precautions one has to take in order to protect himself/herself from STDs.

LA**(5 Marks)**

Briefly explain the various reproductive technologies to assist an infertile couple to have children.

19. A couple visited a fertility clinic with their reports. Doctor observed the report and explained the possibility of getting child by the method mentioned in the given picture. Answer the following questions regarding the mentioned technique.



- (a) How the fertilisation took place in this technique?
- (b) What is the probable test report of the female partner?
- (c) At which stage, the embryo is transferred in uterus? Write the term used for the same.
- (d) Expand ZIFT.

Answers

VSA

(1 Marks)

1. Amniocentesis.
2. Fallopian tube : Zygote intra fallopian transfer (ZIFT)
3. Population explosion.
4. Amniotic fluid.

Answer of Multiple-Choice Question :

5. (c) 6. (a) 7. (B) 8. (d) 9. (b)

Answer of Assertion-Reason Question :

- 10.(d) 11. (a)

SA-I

(2 Marks)

12. (a) Ovulation and menstrual cycle do not occur during the period of intense lactation following parturition. Therefore, as the mother breast feeds, chances of conception are nil.
(b) It is effective only upto a maximum period of six months following parturition.
13. (a) Copper releasing IUDs (CuT, Multiload 325) → These increase phagocytosis of sperms within uterus and release copper ions which suppress sperm motility and fertilising capacity of sperm.
(b) Hormone releasing IUDs—Progestasert, LNG—20—These makes uterus unsuitable for implantation and the cervix hostile to sperms.
14. Periodic abstinence—couple should avoid coitus from 10th to 17th day of menstrual cycle.
Coitus interruptus—male partner withdraws his penis from the vagina just before ejaculation of semen.
15. User friendly, easily available, effective, reversible with no side effects.

SA-II

(3 Marks)

16. Venereal disease (VD)/Reproductive tract infection (RTI)
Curable-Syphilis, Gonorrhoea
Non Curable—Hepatitis B, AIDS

| 17. | Vasectomy | Tubectomy |
|-----|---|--|
| | 1. Method of sterilisation in males 2. Vas deferential of both sides cut and tied 3. Prevent movement of sperms at cut end. | Method of sterilisation in females. Fallopian tube of both sides cut and tied. Prevent movement of egg at cut end. |

18.(i) Avoid blood transfusion from an infected person.

(ii) Avoid sex with an unknown partner and multiple partners.

(iii) Always use condom.

(iv) Avoid sharing of injections, needles, syringes and surgical instruments.

19. (a) By IVF (in vitro fertilisation) — fertilization outside the body in almost similar conditions as that in the body.

(b) Blockage in fallopian tube.

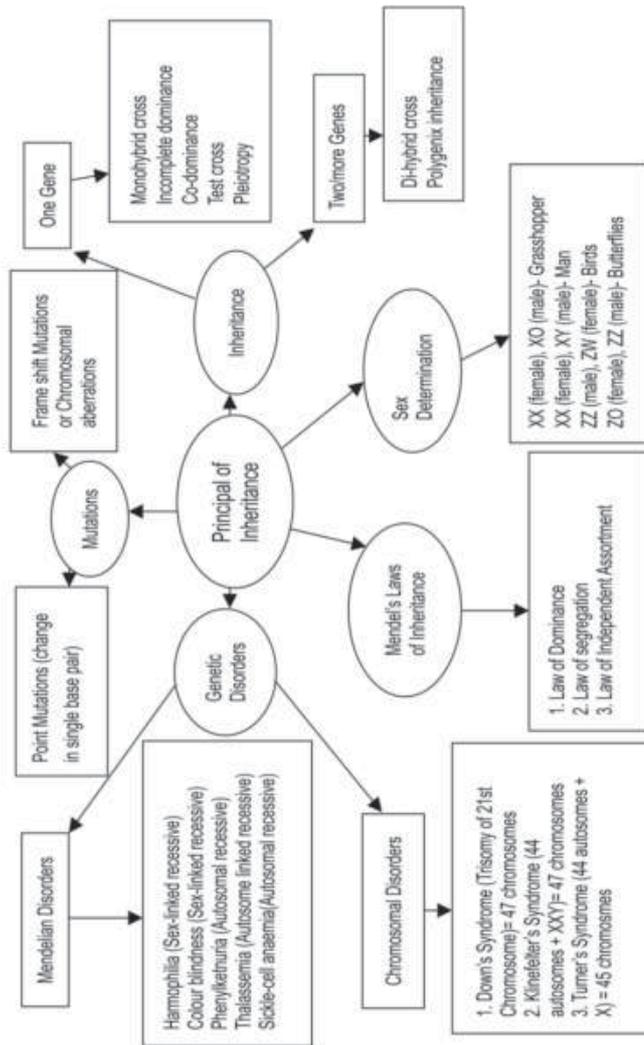
(c) More than 8 blastomeres. IUT – Intra uterine transfer.

(d) Zygote Intra Fallopian Transfer.



Chapter - 4

Principles of Inheritance and Variation



Allele : Various or slightly different forms of a gene, having same position on the two homologous chromosomes.

Phenotype : The observable or external characteristics of an organism.

Genotype : The genetic constitution of an organism.

Monohybrid cross : A cross between two individuals of species, considering the inheritance of single pair of contrasting character, e.g. a cross between pure tall (TT) and Dwarf (tt)

Dihybrid cross : A cross between two individuals of a species, considering the inheritance of two pairs of contrasting traits/characters e.g., a cross between Round and Yellow (RRYY) seed and wrinkled and green (rryy) seed.

Aneuploidy : The phenomenon of gain or loss of one or more chromosome(s) that results due to failure of separation of homologous pair of chromosomes during meiosis.

Trisomy : The condition in which a particular chromosome is present in three copies in a diploid cell/nucleus.

Male heterogamety : When male produces two different types of gametes/ sperms e.g. In human beings X and Y. Sperm with X chromosome or sperm with Y chromosome

Female Heterogamety : When female produces two different types of gametes/ova, e.g., female bird produces Z and W gametes.

Gene- It is a segment of DNA called cistron and the unit of inheritance which is carried from parent by a gamete.

Genome- The entire genetic set of a prokaryote or virus or the haploid genetic set of a eukaryote.

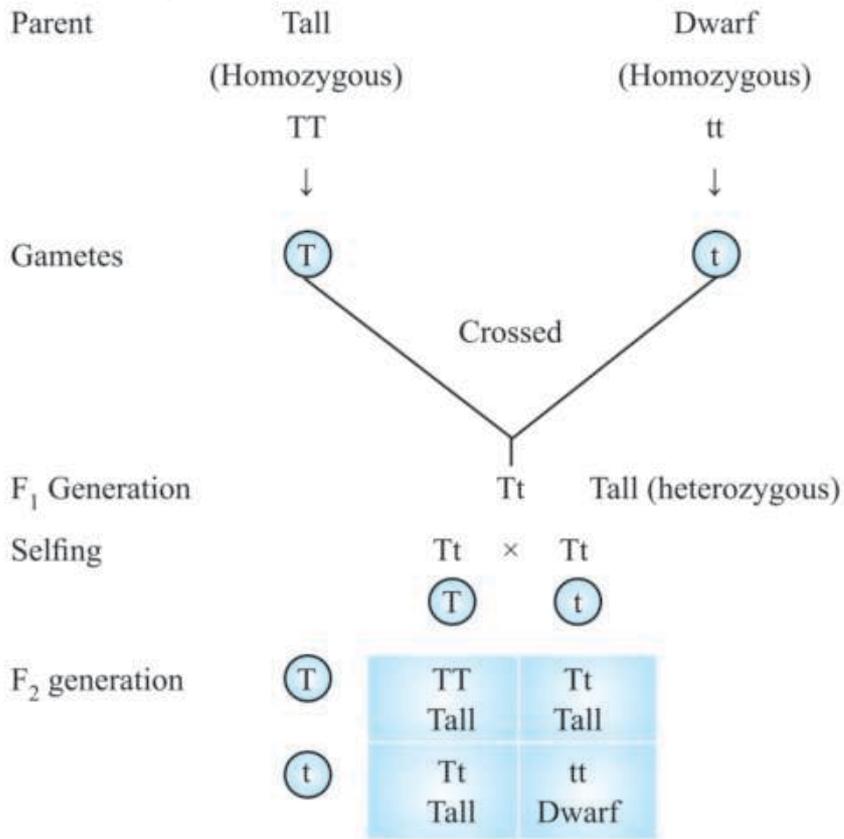
Gene Pool- An aggregate of all genes and their alleles, present in an interbreeding population.

Test Cross- A cross between an individual of unknown genotype and recessive parent. It is used to test whether an individual is homozygous (pure) or heterozygous (hybrid). It is also used as test for linkage.

Heredity- Also called inheritance is the process of transmission of genetic characters (traits) from parents to their offsprings.

Gregor Johann Mendel Conducted controlled breeding experiment on garden pea

(*Pisum sativum*) with a single trait. It is called monohybrid cross.



Tall homozygous (TT) – 25% Pure
 Tall heterozygous (Tt) – 50% Hybrid.
 Dwarf homozygous (tt) – 25% Pure.

Law of Dominance : When two individuals of a species differing in a pair of contrasting characters/traits are crossed, the trait that appears in the F₁ generation is dominant and the alternate form that remain hidden, is called recessive.

Law of Segregation (law of purity of gametes) : The members of allelic pair that remained together in the parent, segregate/separate during gamete formation and only one of the factors enters a gamete.

Incomplete Dominance : In this, both alleles of a gene at a locus, are partially expressed.

Example : In *Mirabilis jalapa*. (4'O Clock plant)

| | | | |
|----|--|------------|--|
| | Red RR | x | White rr |
| | | | <div style="display: flex; justify-content: space-around; width: 100px;"> (R) (R) </div> |
| F1 | <div style="display: flex; justify-content: center; width: 30px;"> (r) </div> | Rr Pink | Rr Pink |
| | <div style="display: flex; justify-content: center; width: 30px;"> (r) </div> | Rr Pink | Rr Pink |

| | | | |
|---------------|--|------------|--|
| Parents | Pink Rr | × | Pink Rr |
| Gametes | | | <div style="display: flex; justify-content: space-around; width: 100px;"> (R) (r) </div> |
| F2 generation | <div style="display: flex; justify-content: center; width: 30px;"> (R) </div> | RR Red | Rr Pink |
| | <div style="display: flex; justify-content: center; width: 30px;"> (r) </div> | Rr Pink | rr White |

| | | | | | |
|------------------|-----|---|------|---|-------|
| Phonotypic ratio | Red | : | Pink | : | White |
| | 1 | : | 2 | : | 1 |
| Genotypic ratio | RR | : | Rr | : | rr |
| | 1 | : | 2 | : | 1 |

In incomplete dominance, phenotypic ratio is equal to the genotypic ratio.

Multiple Allelism : It is a phenomenon in which a single character is governed by more than two alleles.

Example :

- ABO blood groups are controlled by gene I
- 'I' has three alleles— I^A , I^B , and i

I^A and I^B alleles produce slightly different form of sugar present on plasma membrane of red blood cells.

- In allele ' i ' do not produce any sugar.
- In any diploid individual only two alleles can be found. So multiple alleles can be detected only in a population.

Co-dominance : The alleles which do not show dominance recessive relationship and are able to express themselves independently when present together are called co-dominant alleles and this phenomenon is known as codominance. Example : Human blood groups.

There are 3 different alleles, 6 different genotypes control 4 different type of Phenotypes :

| Blood Group | Genotype | Blood Type |
|-------------|------------------|------------|
| A | $I^A I^A, I^A i$ | A |
| B | $I^B I^B, I^B i$ | B |
| AB | $I^A I^B$ | both A & B |
| O | ii | O |

In humans, blood group AB shows co-dominance as both the alleles I^A and I^B express themselves fully in presence of each other.

Chromosomal Theory of Inheritance : Proposed by Sutton and Boveri. The pairing and separation of a pair of chromosomes would lead to the segregation of a pair of factors they carried. They united the knowledge of segregation with Mendelian principles.

- **Linkage**- is the tendency of genes on a chromosome to remain together.
- Linked genes occur on the same chromosome.
- They lie in linear sequence on the chromosome - There is a tendency to maintain the parental combination of genes except for accessional choosers.
- Strength of linkage between genes is inversely proportional to the distance between the two.

Recombination : is the generation of non-parental gene combinations to the offsprings. Tightly linked genes show very low recombination frequency. Loosely linked genes show higher recombination frequency.

The frequency of recombination between gene pairs on the same chromosome is a measure of distance between genes and is used to map the position of genes on the chromosome.

Linkage and Recombination.

T. H. Morgan carried out several dihybrid crosses in *Drosophila melanogaster*. Two of them are given below :

Cross-I : Yellow-bodied and white eyed females crossed with brown-bodied, red eyed males (wild type)

- F_1 Progeny intercrossed and F_2 generation ratio deviated from 9 : 3 : 3 : 1 (two genes didn't segregate independently)
- The Parental combinations were 98.7% and recombinants were 1.3%

Conclusion : The two genes (body colour and eye-colour) are tightly linked ; results in less crossing over and less no. of non-parental progeny.

Cross-II : White bodied female with miniature wings and yellow-bodied male with normal wings (wild type) were crossed.

- The parental combination were 62.8% while the recombinants were 37.2%.

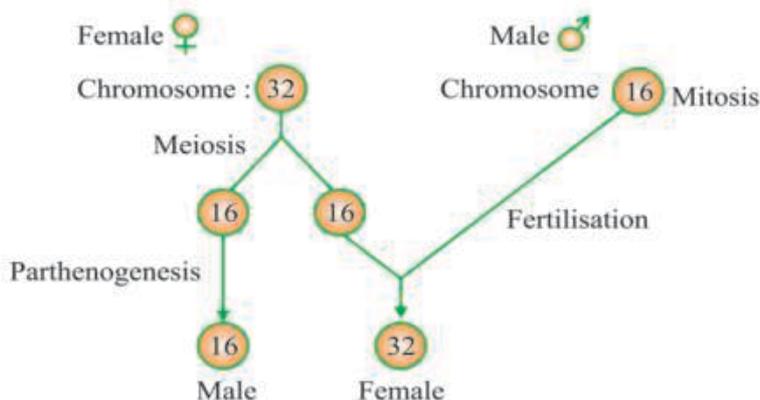
Conclusion : The two genes (body colour & wing's size) are loosely-linked ; results in more crossing over and more no. of non-parental progeny.

The seven character : Mendel Studied in garden pea, had their genes located on different (non-homologous) chromosomes or far apart on the same chromosome that they got separated by crossing over. So he was lucky that he could not note linkage and proposed law of independent assortment.

Chromosomal basis of sex Determination :

- XX-XY type - Female homogametic i.e. XX and male heterogametic i.e. XY in *Drosophila*, humans.
- XX-XO type—All eggs bear additional X chromosome, Males have only one X chromosome besides autosomes whereas females have a pair of X chromosomes e.g., grasshoppers.
- ZW-ZZ type—The females are heterogametic and have one Z and one W chromosome. The males are homogametic with a pair of Z chromosomes besides autosomes e.g., birds.
- ZO-ZZ type—Females are heterogametic and produce 2 types of eggs - (A + Z) and (A + O). The males are homogametic with all the sperms having (A + Z) e.g. moths and butterflies.
here A = autosome

Sex determination in honey Bee : In Honey bee fertilized eggs develop into female (Queen or Worker) While unfertilized egg develops into male (drone) by parthenogenesis, the males have half no. of chromosomes than a female. The males are haploid (16-chromosomes), females are diploid (32-chromosomes).



There are three types of individuals :

1. Queen — diploid
 - developed from fertilized egg
 - functional female
2. Worker — diploid
 - developed from fertilized egg
 - non-functional female
3. Drone — haploid (male)
 - developed from unfertilized egg parthenogenetically
 - functional Male.

Pedigree Analysis

A record of inheritance of certain genetic traits for two or more generation presented in the form of diagram or family tree is called pedigree.

Usefulness of Pedigree Analysis

1. It is useful for genetic counsellors to advice intending couples about the possibility of having children with genetic defects like haemophilia, thalassemia etc.
2. It is helpful to study certain genetic trait and find out the possibility or absence or presence of that trait in homozygous or heterozygous condition in a particular individual.
3. It can indicate the harms a marriage between close relatives, may cause.

Mendelian disorders

These are mainly determined by a alternation or mutation in single genes.

1. **Haemophilia** : Sex linked recessive disease which is transmitted from unaffected carriers female to male progeny. A single protein is affected which is a part of the cascade of proteins involved in the clotting of blood.

$X^h Y$ = affected male

$X^h X$ = carrier female

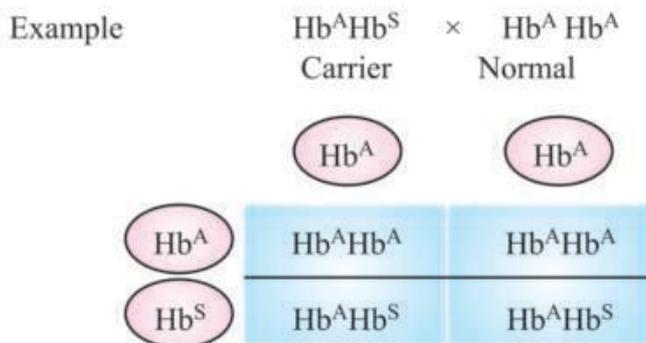
The heterozygous female for haemophilia may transmits the disease to her sons. The possibility of a female suffering from the disease is extremely rare (only when the mother of the female is a carrier is $X^h X$ and father is haemophilic i.e. $X^h Y$).

2. **Sickle-cell anaemia** : This is an autosome linked recessive trait. This defect is caused by substitution of glutamic acid by valine at the 6th position of the beta globin chain of the haemoglobin molecule. The mutant Hb molecule undergoes polymerisation under low oxygen tension which results change in shape of RBC from biconcave disc to elongated sickle like structure. The disease is controlled by a pair of allele, Hb^A and Hb^S

Hb^A Hb^A. Normal

Hb^S Hb^S sufferer

Hb^A Hb^S. Apparently unaffected/carriers



Phenylketonuria : Inborn error of metabolism, autosomal recessive trait. Affected individual lacks an enzyme that converts amino acid phenylalanine into tyrosine. Phenylalanine is accumulated and converted into phenylpyruvic acid which accumulates in brain resulting in mental retardation.

Thalassemia : Thalassemia is autosome linked recessive disease. This disorder caused by defect in the synthesis of globin chain. Thalassemia is of three types—Alpha (α) Thalassemia, Beta (β) Thalassemia and delta(s).

- In alpha Thalassemia production of alpha globin chain is affected. This Thalassemia is controlled by genes HBA1 and HBA2 located on chromosome 16th of each parent. Thalassemia occurs due to mutation or deletion of one or more of the four genes.
- In Beta Thalassemia production of (β-globin chain is affected, this thalassemia is controlled by gene HBB located on 11th chromosome of each parent. It occurs due to one or both HBB genes
- In Thalassemia very few globin is synthesized and is quantitative problem whereas in sickle cell anaemia there is a synthesis of incorrectly functioning globin and is a qualitative disorder.

Delta Thalassemia- It is caused due to defective allele of HBD gene present on chromosome 11 that form delta chain of haemoglobin. The effect of this thalassemia is minor.

These are caused due to absence or excess of one or more chromosomes.

Colour blindness : Colour blindness is sex-linked recessive trait in which a person fails to distinguish red and green colour. The gene for normal vision is dominant. The normal genes and its recessive alleles are carried by X-chromosome.

$X^c X^c$ — Colour blind female

$X X^c$ — Carrier female

$X^c Y$ — Colour blind male

Y Chromosome of male do not carry any gene for certain vision.

Inheritance Pattern in Colour Blindness

| Father | | Mother | | Son | | Daughter | |
|--------------|-----------|--------------|-----------|--------------|-----------|--------------|-----------|
| Pheno-type | Geno-type | Pheno-type | Geno-type | Pheno-type | Geno-type | Pheno-type | Geno-type |
| Normal | XY | Carrier | $X^C X$ | Normal | XY | Normal | XX |
| Normal | XY | Colour-blind | $X^C X^C$ | Colour-blind | $X^C Y$ | Carrier | $X^C X$ |
| Colour-blind | $X^C Y$ | Normal | XX | Normal | XY | Carrier | $X^C X$ |
| Colour-blind | $X^C Y$ | Carrier | $X^C X$ | Colour-blind | $X^C Y$ | Colour-blind | $X^C X^C$ |
| | | | | Normal | XY | Carrier | $X^C X$ |

Inheritance Pattern in Haemophilia

| Father | | Mother | | Son | | Daughter | |
|-------------|-----------|-------------|-----------|-------------|-----------|-------------|-----------|
| Pheno-type | Geno-type | Pheno-type | Geno-type | Pheno-type | Geno-type | Phen-type | Geno-type |
| Normal | XY | Haemophilic | X^hX^h | Haemophilic | X^hY | Carrier | X^hX |
| Normal | XY | Carrier | X^hX | Normal | XY | Normal | XX |
| | | | | Haemophilic | X^hY | Carrier | X^hX |
| Haemophilic | X^hY | Carrier | X^hX | Normal | XY | Carrier | X^hX |
| | | | | Haemophilic | X^hY | Haemophilic | X^hX^h |
| Haemophilic | X^hY | Normal | XX | Normal | XY | Carrier | X^hX |

Chromosomal Disorder :

- Down's syndrome :** Trisomy of chromosomes number 21 ($2n + 1$)
 Affected individual is short statured with small round head, furrowed tongue, partially open month, broad palm. Physical, psychomotor and mentally development is retarded.
- Klinefelter's syndrome :** extra copy of X chromosome ; karyotype XXY.
 Affected individual has overall masculine development with feminine characters like gynaecomastia (development of breast) and is sterile
 $44 \text{ autosomes} + xxy = 47 \text{ chromosomes}$
- Turner's syndrome :** has absence of one X chromosome i.e. 45 with XO.
 Affected females are sterile with rudimentary ovaries and lack secondary sexual characters.
 $44 \text{ autosomes} + xo = 45 \text{ chromosomes}$

Pleiotropy

The ability of a gene to have multiple phenotypic effects because it influences a number of characters simultaneously is known as pleiotropy. The gene having a multiple phenotypic effect because of its ability to control expression of a number of characters is called pleiotropic gene. E.g. in Garden Pea, the gene which controls the flower colour also controls the colour of seedcoat and presence of red spot in the leaf axis.

The disorder phenylketonuria shows pleiotropy.

Polygenic Inheritance

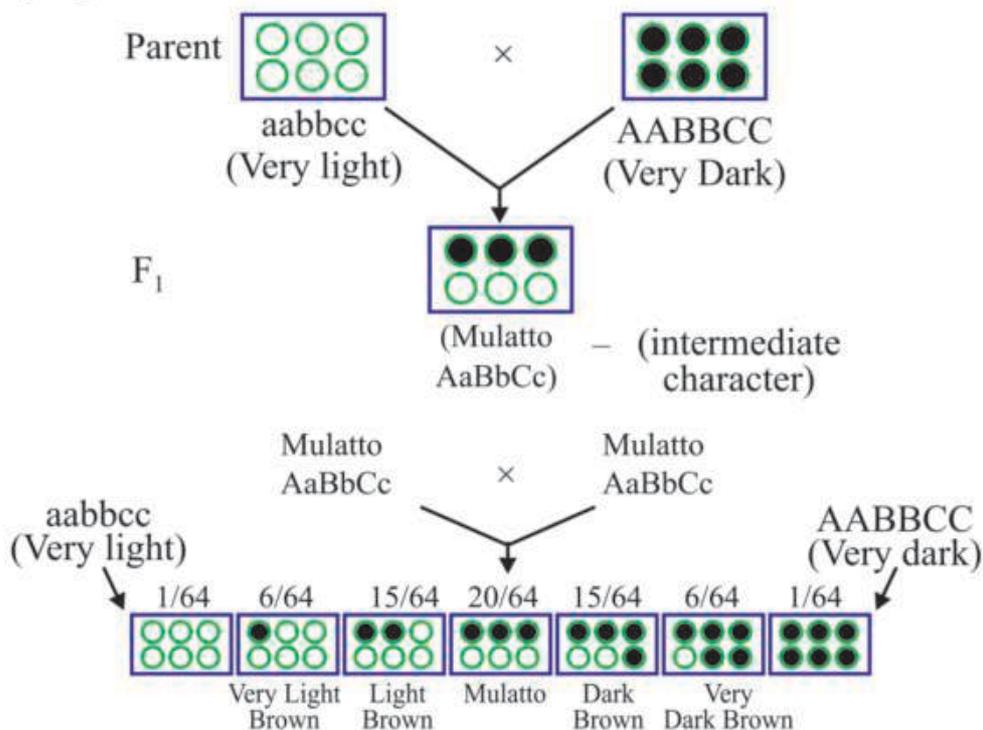
It is a type of inheritance controlled by three or more genes in which the dominant alleles have cumulative effect with each dominant allele expressing a part of the trait, the full being shown only when all the dominant alleles are present.

E.g., Kernel colour in wheat, skin colour in human beings, height in humans, cob length in maize etc.

In polygenic inheritance, a cross between two pure breeding parents produces an intermediate trait in F_1 . In F_2 generation, apart from the two parental types, there are several intermediates (gradations, show a bell shaped curve). F_1 hybrid form 8 kinds of gametes in each sex giving 64 combination in F_2 having 7 phenotypes.

Polygenic inheritance skin tone

3 loci : each has two possible alleles : Aa, Bb, Cc, each capital allele adds one unit of darkness, each lower case allele adds nothing. Parents produce F_1 offsprings with intermediate tone.



Offspring can have tone darker or lighter than either parent

Questions

VSA

(1 Mark)

1. Name the base change and the amino acid change, responsible for sickle cell anaemia.
2. Name the disorder with the following chromosome complement.
 - (i) 22 pairs of autosomes + X X Y
 - (ii) 22 pairs of autosomes + 21st chromosome + XY.
3. A test is performed to know whether the given plant is homozygous dominant or heterozygous. Name the test and phenotypic ratio of this test for a monohybrid cross.
4. Write the number of chromosomes body cells of honey bee workers and drone have.

Multiple Choice Question

5. When red blood corpuscles containing both A and B antigens are mixed in a person's blood serum, they agglutinate. The blood group of the person is
 - a) O
 - b) AB
 - c) B
 - d) A
6. The offspring produced from a marriage have only O or A blood groups. Of the genotypes given below, the possible genotypes of the parents would be
 - a) ii and ii
 - b) $I^A I^A$ and ii
 - c) $I^A i$ and ii or $I^A i$ and $I^A i$
 - d) $I^A I^A$ and $I^A i$
7. The gene of sickle cell anaemia is inherited by
 - a) Haemoglobin
 - b) Autosomes and sex chromosomes
 - c) Sex chromosomes
 - d) Autosomes

8. More men suffer from colour blindness than women because
- women are more resistant to disease than men
 - the male sex hormone testosterone causes the disease
 - the colour-blind gene is carried on the 'Y' chromosome
 - men are hemizygous and one defective gene is enough to make them Colour blind
9. if a cross between two individuals produces offsprings with 50% dominant character P and 50% recessive character p the genotypes of parents are
- Pp x Pp
 - Pp x pp
 - PP x pp
 - PP x Pp

Assertion-Reason Questions

10. **Assertion:** Aneuploidy is the phenomenon of gain or loss of one or more chromosome(s).
- Reason:** Sometimes homologous chromosomes are unable to separate
- Both assertion and reason are true, and reason is the correct explanation of assertion.
 - Both assertion and reason are true, but reason is not the correct explanation of assertion
 - Assertion is true but reason is false.
 - Both assertion and reason are false.
11. **Assertion:** Genes of body-colour and eye-colour of *Drosophila melanogaster* are tightly linked. **Reason:** Genes of body-colour and wing-size of *Drosophila melanogaster* are loosely linked.
- Both assertion and reason are true, and reason is the correct explanation of assertion.

- b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- c) Assertion is true but reason is false.
- d) Both assertion and reason are false.

SA-I

(2 Marks)

- 12. Identify the sex of organism as male or female in which the sex chromosome are found as (i) ZW in bird (ii) XY in Drosophila (iii) ZZ in birds, (iv) XO in grasshopper.
- 13. The human male never passes on the gene for haemophilia to his son. Why is it so ?
- 14. Mention four reasons why Drosophila was chosen by Morgan for his experiments in genetics.
- 15. Differentiate between point mutation and frameshift mutations.

SA-II

(3 Marks)

- 16. A woman with O blood group marries a man with AB blood group
 - (i) Work out all the possible phenotypes and genotypes of the progeny.
 - (ii) Discuss the kind of dominance in the parents and the progeny in this case.
- 17. Give reasons for success of Mendel.
- 18. In Mendel's breeding experiment on garden pea, the offspring of F₂ generation are obtained in the ratio of 25% pure yellow pod, 50% hybrid green pods and 25% green pods State (i) which pod colour is dominant (ii) The Phenotypes of the individuals of F₁ generation, (iii) Workout the cross.

LA

(5 Marks)

- 19. A dihybrid heterozygous round, yellow seeded garden pea (*Pisum sativum*) was crossed with a double recessive plant.
 - (i) What type of cross is this?
 - (ii) Work out the genotype and phenotype of the progeny.
 - (iii) What principle of Mendel is illustrated through the result of this cross?

Case Based Questions

20. Read the following and answer the questions given below:

TURNER'S SYNDROME

Turner's syndrome is an example of monosomy. It is formed by the union of an allosome free egg and a normal 'X' containing sperm or a normal egg and an allosome free sperm. The individual has $2n = 45$ chromosomes ($44 + XO$) instead of 46. Such individuals are sterile females who have rudimentary ovaries, underdeveloped breasts, small uterus, short stature, webbed neck and abnormal intelligence. They may not menstruate or ovulate. Individuals with Turner's syndrome have deficiency of FSH and oestrogen secretion. This disorder can be treated by giving female sex hormone to the women from the age of puberty to make them develop breasts and have menstruation. This makes them feel more normal.

- (a) What organ does turner syndrome affect?
- (b) What is the cause of turner syndrome?
- (c) What are clinical features of turner syndrome?

OR

Who suffer from turner syndrome? It is an example of which plaid?

21. Read the following and answer the questions given below:

In case of honey bee, the male is haploid while the female is diploid. Similar conditions are found in some other insects like ants and wasps. Male insects are haploid because they develop parthenogenetically from unfertilised eggs. The phenomenon is called arrhenotoky. Meiosis does not occur in the formation of sperms. Females grow from fertilized egg and are hence diploid.

Queen bee picks up all the sperms from drone during nuptial flight and stores them in seminal receptacle. When the queen visits drone cells it lays eggs but seminal receptacles fails to emit the sperms. The male honey bee develops parthenogenetically from these unfertilised eggs. However in all other cells, i.e., cells of workers, the female lays eggs and sperms are emitted properly from its seminal receptacle, upon these eggs leading to their fertilization. Hence except drones other honey bees (worker and queen) are diploid.

- (i) **The $2n$ number of chromosomes for honey bee is 32. How many chromosomes will be present in the cells of drone?**

- (a) 64 (b) 32
(c) 16 (d) 8

(ii) **The purpose of queen and drone for performing nuptial flight is**

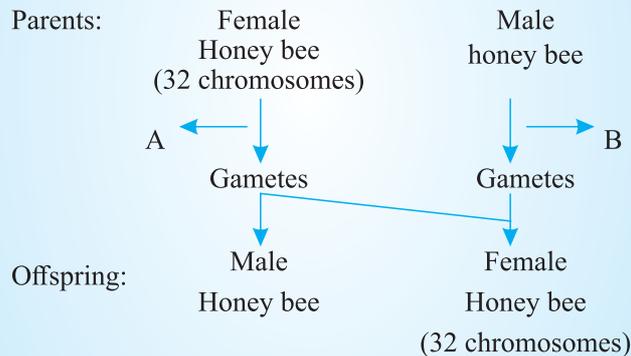
- (a) to establish a new life (b) to perform copulation
(c) to collect pollen and nectar (d) all of these

(iii) **What type of cell division is involved in spermatogenesis in honey bee?**

- (a) Meiosis (b) Endomitosis
(c) Mitosis (d) None of these

(iv) **Which of the following factors is responsible for the fertilized eggs to develop into queen or worker?**

- (a) Amount of temperature for incubation of eggs
(b) Type of nutrition given to the larvae
(c) Type of sperm performing fertilization of eggs
(d) All of these



- (a) What forms the basis of sex determination in honey bees? What term is given to this method of sex
(b) Identify the type of cell division at 'A' and 'B' occurring during gamete formation in the female and male honey bees respectively.
(c) Name the scientist who conducted the cytological studies during gametogenesis in insects. What did he observe?

OR

- (c) How many chromosomes does a male honey bee possess? Give reason for the difference in the number of chromosomes between males and females of honey bees.

Answers

VSA

(1 Mark)

1. GAG changes GUG, Glutamic acid is substituted by valine.
2. (i) Klinefelter's Syndrome (ii) Down's syndrome
3. Test cross 1 : 1.
4. Honey bee workers : 32 and Drones : 16 chromosomes

Answer of Multiple-Choice Question :

5. (a) 6. (c) 7. (d) 8. (d) 9. (b)

Answer of Assertion-Reason Question :

- 10.(a) 11. (b)

SA-I

(2 Marks)

- 12.(i) Female (ii) Male (iii) Female (iv) Male
13. The gene for haemophilia is present on X chromosome. A male has only one X chromosome which he receives from his mother and Y chromosome from father. The human male passes the X chromosome to his daughters but not to the male progeny (sons).
- 14.(i) Very short life cycle (2-weeks)
(ii) Can be grown easily in laboratory
(iii) In single mating produce a large no. of flies.
(iv) Male and female show many hereditary variations
(v) It has only 4 pairs of chromosomes which are distinct in size and shape.
15. **Point Mutations** : Arises due to change in a single base pair of DNA e.g., sickle cell anaemia.

Frame shift mutations : Deletion or insertion/duplication/addition of one or two bases in DNA.

SA-II

(3 Marks)

9. (i) Blood group AB has alleles as I^A , I^B and O group has i which on cross gives the both blood groups A and B while the genotype of progeny will be $I^A i$ and $I^B i$.
- (ii) I^A and I^B are equally dominant (co-dominant). In multiple allelism, the gene I exists in 3 allelic forms, I^A , I^B and i .
10. (i) He used large samples for his experiments.
- (ii) He selected only pure breeding varieties.
- (iii) He choose the character which had distinctive contrasts.
- (iv) He selected pea plant which can be cross-bred as well as self bred.
- (v) Use of statistical methods and law of probability.
- (i) Green pod colour is dominant

11. (ii) Green pod colour

| | | | | |
|------------------|-------------------|-----|-------------|------------|
| (iii) Parents | GG (green) | X | gg (yellow) | |
| Gametes | (G) | | (g) | |
| F1 generation | Gg (Hybrid green) | | | |
| Gametes | (G) | (g) | X | (G) (g) |
| F2 generation | GG | Gg | | Gg gg |
| Phenotypic ratio | 3 : 1 | | | |
| Genotypic ratio | 1 : 2 : 1 | | | |

LA

(5 Marks)

12. (i) It is a dihybrid test cross

(ii) Parent RrYy (Round Yellow) × rryy (Wrinkled green)

Gametes (RY), (Ry), (rY), (ry) × (ry)

| | | | | | |
|------------|---------------|-----------------|------------------|------------------|----|
| | Gametes | RY | Ry | rY | ry |
| F1 progeny | RrYy | Rryy | rrYy | rryy | |
| | Round, Yellow | Round and green | wrinkled, yellow | wrinkled, green. | |

| | |
|------------------|---------------|
| Phenotypic ratio | 1 : 1 : 1 : 1 |
| Genotypic ratio | 1 : 1 : 1 : 1 |

F₂ Progeny

| | | | | | | | |
|------------------|--------------|---|-------------|---|-----------------|---|----------------|
| Phenotypic ratio | Round yellow | : | Round green | : | Wrinkled yellow | : | Wrinkled green |
| Genotypic ratio | 9 | : | 3 | : | 3 | : | 1 |

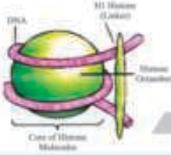
(iii) Principle of Independent Assortment.

20. (a) Turner syndrome affect veins, heart, eyes bones and kidneys.
 (b) Loss of 'x' chromosome $44 + \times O$
 (c) Short neck, underdeveloped breast, no menstrual cycle, rudimentary ovaries.
 (d) It is an example of monosomy in females.
21. No. of sets of chromosome and received by an individual called as haplodiploid system of sex determination.
 (a) A – Meiosis
 (b) B – Mitosis
 (c) Henking. He observe a specific nuclear structure all through Spermatogenesis in few Insects.

OR

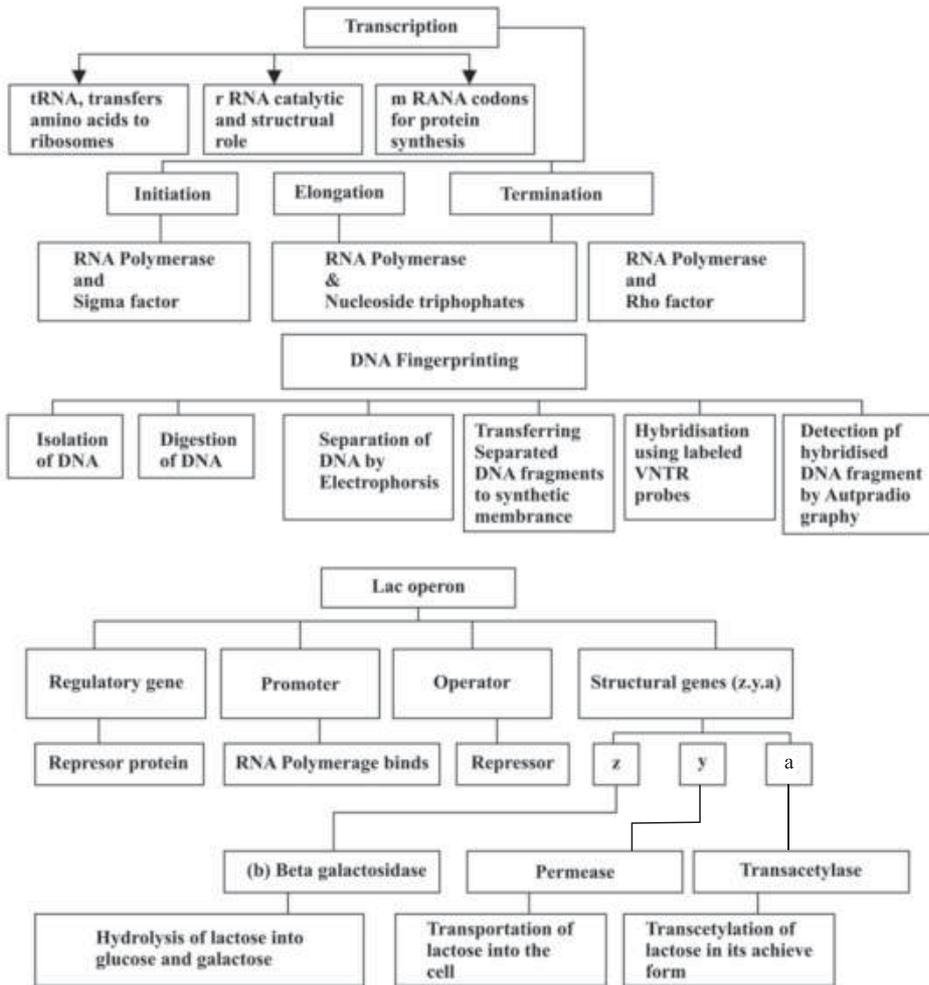
A male honey bee develops parthenogenetically C without fertilisation /from an ovum. Hence haploid. A female honey bee develops from fertilized eg. so diploid (32 chromosome.)

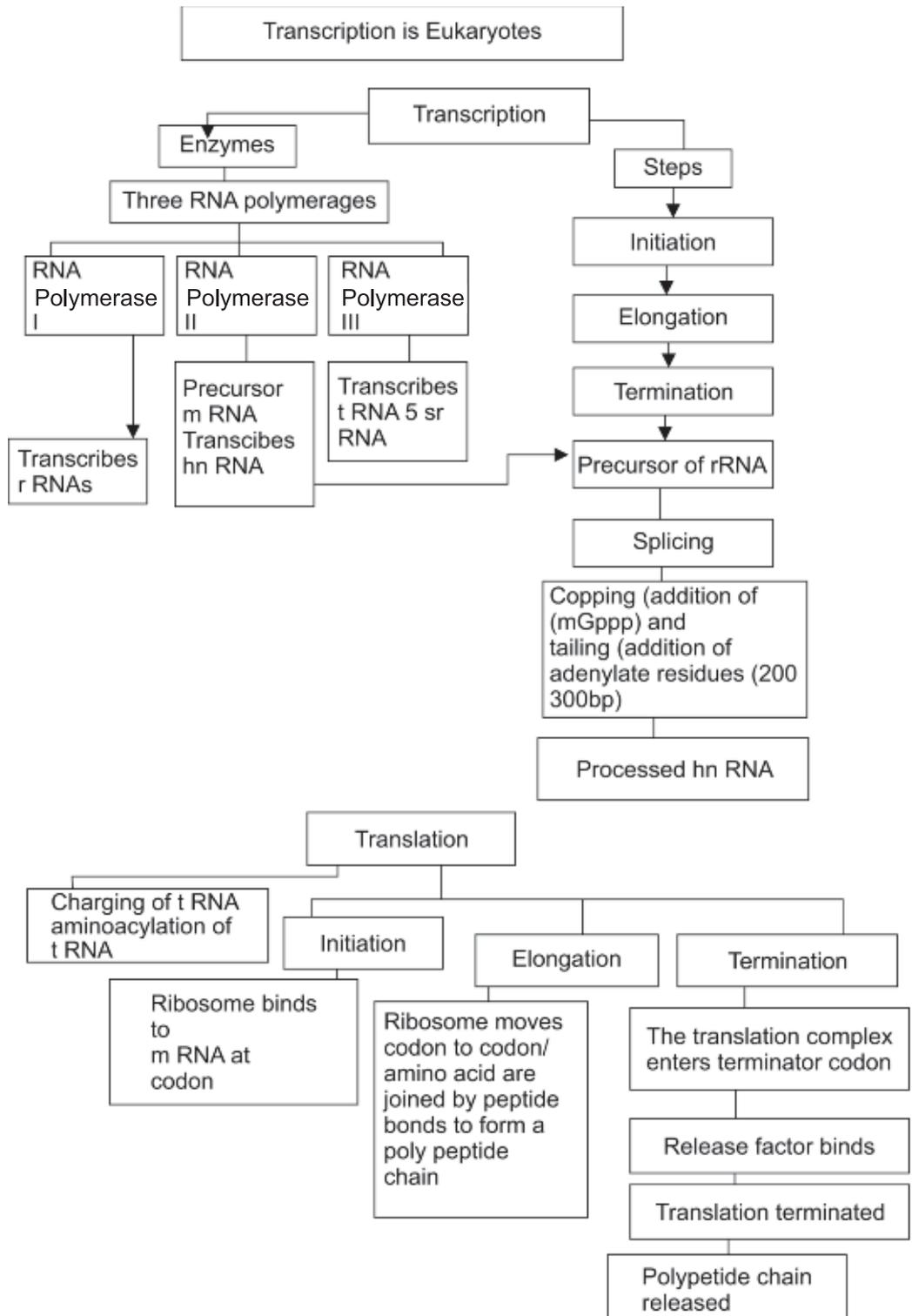
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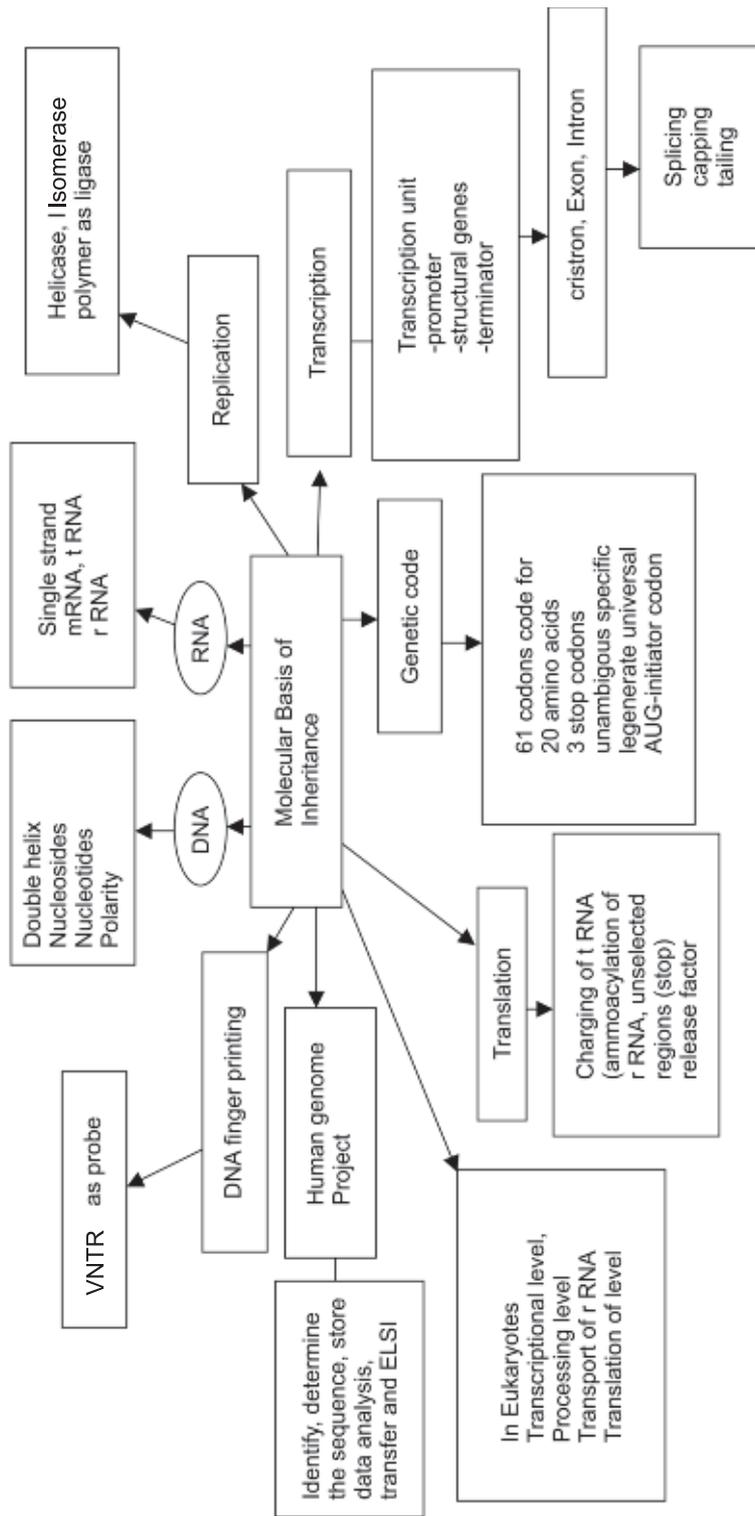


Chapter - 5

Molecular basis of Inheritance







Anticodon : A sequence of three nitrogenous bases on tRNA which is complementary to the codon on mRNA.

Genome : Sum total of genes in haploid set of chromosomes.

DNA Polymorphism : The variations at genetic level, where an inheritable mutation is observed, in a population at high frequency.

Satellite DNA : The repetitive DNA sequences which form a large portion of genome and have high degree of polymorphism but do not code for any proteins.

Operon : A group of genes which control a metabolic pathway.

Exons : The regions of a gene which become part of mRNA and code for different regions of proteins.

Introns : The regions of a gene which are removed during the processing of mRNA.

Euchromatin : The region of chromatin which is loosely packed and transcriptionally active, it stains lighter.

Heterochromatin : The chromatin that is more densely packed, stains dark and is transcriptionally inactive.

Splicing : The process in eukaryotic genes in which introns are removed and the exons are joined together to form mRNA.

Bioinformatics : Science of use of techniques including statistics, storing as data bases, analysing, modelling and providing access to various aspects of biological information usually on the molecular level.

Central Dogma :

replication DNA $\xrightarrow{\text{Transcription}}$ mRNA $\xrightarrow{\text{Translation}}$ Protein

Replication fork : The Y shaped structure formed when double stranded DNA is unwound upto a point during its replication.

VNTR : Variable Number of Tandem Repeats

Glycosidic bond (N-glycosidic linkage)-A linkage between a nitrogenous base and a pentose sugar to form a nucleoside.

Phosphodiester bond - The bond between two adjacent nucleotides to two adjacent sugar molecules at 3' and 5' positions with phosphate group.

Tandem Repeat-(One behind the other)-A DNA segment in which a nucleotide sequence is repeated one after another two or more times eg ATTCCGATTCCG ATTCCG is a tandem repeat in which the sequence ATTCCG is repeated threetimes.

KB-Kilobase-A unit for length for nucleic acids consisting of 1000 nucleotides abbreviated kb or kbp (kilobase pairs) DNA.

Oncogene-A gene that induces uncontrolled cell proliferation.

YAC : Yeast Artificial Chromosome

BAC : Bacterial Artificial Chromosome

SNPs : Single Nucleotide polymorphism

HGP : Human Genome Project

hnRNA : Heterogenous nuclear RNA. It is precursor of mRNA.

| | | |
|----------------------------|------|--|
| Friedrich Meischer | 1869 | First identified and isolated a acidic substance from pus cell and named it 'Nuclein'. |
| Altman | 1889 | Separated protein from nuclear substance and named it nucleic acid |
| Kossel | 1893 | Discover nitrogen bases (Adenine, Guanine, Cytosine, Thymine, Uracil) |
| T.H. Morgan | 1910 | Father of experimental genetics (experimental verification of chromosomal theory of inheritance) |
| Frederick Griffith | 1928 | Provide first clear-cut evidence that DNA is the hereditary material while working on <i>Streptococcus pneumoniae</i> . Biochemical nature of genetic material was not defined |
| Avery, Macleod and McCarty | 1944 | Discover that transforming principle is DNA, not a protein or RNA. First identification that DNA is the hereditary material |
| Erwin Chargaff | 1950 | Purine and pyrimidine components occur in equal amount in a DNA molecule. $A + G = T + C$ |
| Harshey and Chase | 1952 | Performed experiment with <i>Escherichia coli</i> and bacteriophage and showed that it is the viral DNA and not protein that passed from virus to bacteria and therefore DNA serves as the genetic material. |
| Wilkins and Franklin | 1952 | Produce X-ray diffraction data of DNA. |
| Watson and Crick | 1953 | Double helical structure of DNA. |
| Messelson and Stahl | 1958 | Experimentally proved the semiconservative nature of DNA replication. |
| Jacob and Monod | 1961 | Proposed operon model - genetic material has a number of functional unit is called operon. |
| Alec Jaffery | 1985 | Discovered the technique of DNA finger printing. |

Chemical Structure of Polynucleotide Chain (DNA/RNA) : A nucleotide has three components.

1. **Nitrogen base**

- (i) **Purines** : Adenine and Guanine
- (ii) **Pyrimidines** : Cytosine, Thymine and Uracil (Thymine in DNA and Uracil in RNA.)

2. **Pentose Sugar** : Ribose (in RNA) or Deoxyribose (in DNA).

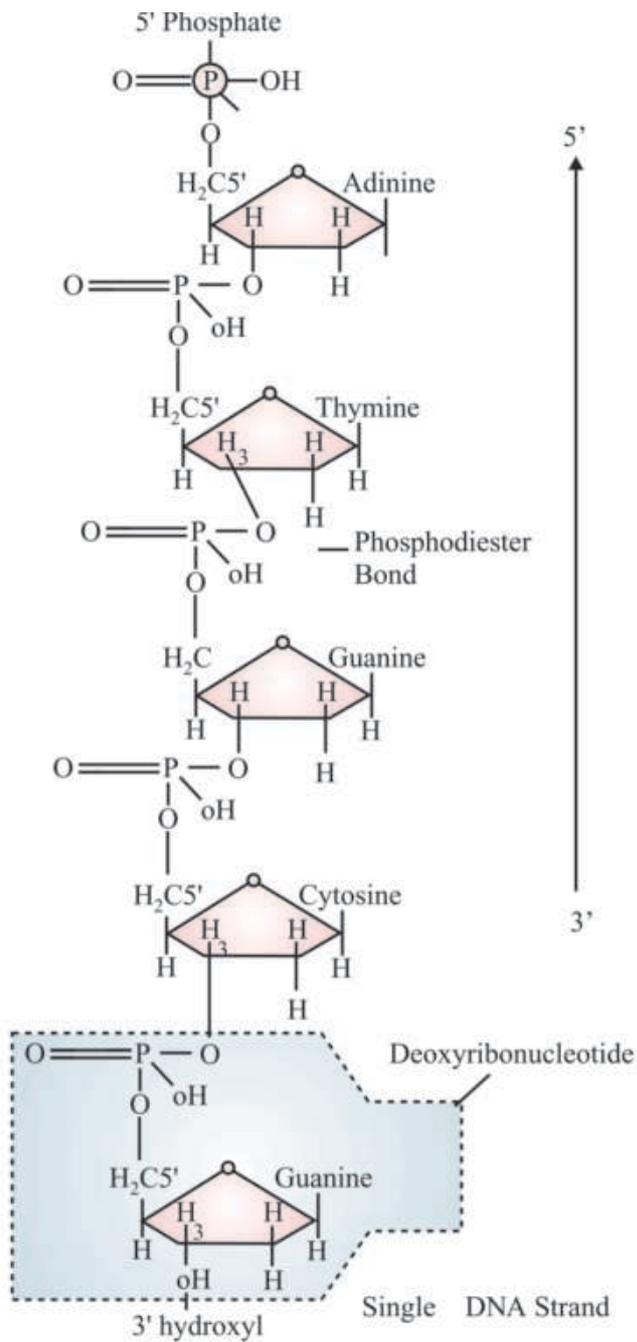
3. **Phosphate Group**

- Nitrogen base is linked to pentose sugar through N-Glycosidic linkage.
- Nitrogen base + Sugar = Nucleoside
- Phosphate group is linked to 5'-OH of a nucleoside through phosphoester linkage.
- Nucleoside + Phosphate group = Nucleotide
- Two nucleotides are linked through 3'-5 phosphodiester linkage to form a dinucleotide
- A polynucleotide chain has free phosphate group at 5' end of ribose sugar and a free 3'-OH group at other end.

RNA is highly reactive than DNA : In RNA nucleotide has an additional OH group at 2' positions in the ribose; RNA is also catalytic.

Double-helix Structure of DNA : Proposed by Watson and Crick in 1953.

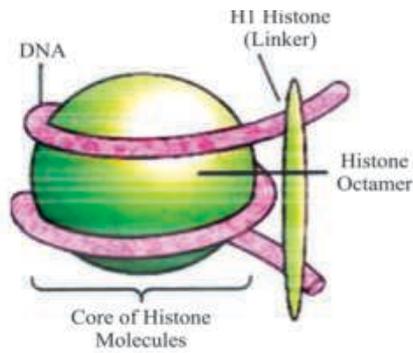
- (i) DNA is made up of two polynucleotide chains.
- (ii) The backbone is made up of sugar and phosphate and the bases project inside.
- (iii) Both polynucleotide chains are antiparallel i.e. one chain has polarity 5'-3' and other chain has 3'-5'.
- (iv) These two strands of chains are held together by hydrogen bonds i.e. A = T, C ≡ G.
- (v) Both chains are coiled in right handed fashion. The pitch of helix is 3.4 nm with 10 base pairs in each turn.



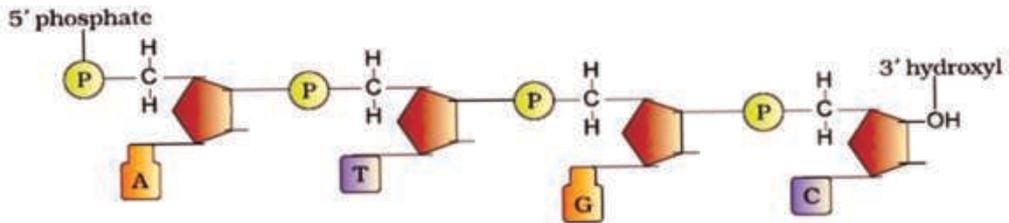
Packaging of DNA Helix

- The average distance between the two adjacent base pairs is 0.34 nm ($0.34 \times 10^{-9}\text{m}$ or 3.4 Å)

- The number of base pairs in *Escherichia coli* is 4.6×10^6 .
- **DNA Packaging in Prokaryotes :** DNA is not scattered throughout the cell. DNA (negatively Charged) is held by some proteins (has positive charges) in a region termed as nucleoid. The DNA in nucleoid is organised in large loops held by proteins.
- **DNA packaging in Eukaryotes :** There is a set of positively charged basic proteins called histones. Eight histone molecules combine together to form histone octamer.
- The negatively charged DNA is wrapped around positively charged histone octamer to form a structure called nucleosome.
- Histone H1 is situated outside of nucleosomal DNA in linker region.
- Nucleosomes constitute the repeating unit of a structure in nucleus called chromatin.
- The beads-on-string structure in chromatin is packaged to form chromatin fibres that are further coiled and condensed at metaphase stage of cell division to form chromosomes.
- The packaging of chromatin at higher level requires additional set of protein that collectively are referred to as Non-histone chromosomal (NHC) proteins. At some places chromatin is densely packed to form darkly staining heterochromatin. At other places chromatin is loosely packed to form euchromatin.
- Euchromatin is said to be transcriptionally active chromatin, whereas heterochromatin is inactive.



Structure of Nucleosome



A Polynucleotide Chain of DNA

Transforming Principle :

Frederick Griffith (1928) performed experiments with *Streptococcus pneumoniae* and mice. This bacterium has two strains.

1. S-strain (Virulent)-which possess a mucilage coat and has ability to cause pneumonia.
 2. R-strain (Nonvirulent) which do not possess mucilage coat and is unable to cause pneumonia.
- Griffith injected R-strain bacteria into mice.
→ No disease noticed and mice remain live.
 - On injecting S-strain bacteria into mice.
→ Mice died due to pneumonia.
 - When heat-killed S-strain bacteria were injected into mice → No pneumonia symptoms noticed and mice remain alive.
 - He than injected a mixture of R-strain bacteria (Non virulent) and heat killed S-strain bacteria (virulent) into mice → mice died due to pneumonia.
 - Moreover Griffith recovered living S-strain (virulent) bacteria from the dead mice.

Conclusion : He concluded that presence of heat-killed S-strain bacteria caused transformation of some R-strain bacteria into virulent by a chemical substance, called 'transforming principle'. But biochemical nature of the genetic material was not defined by him.

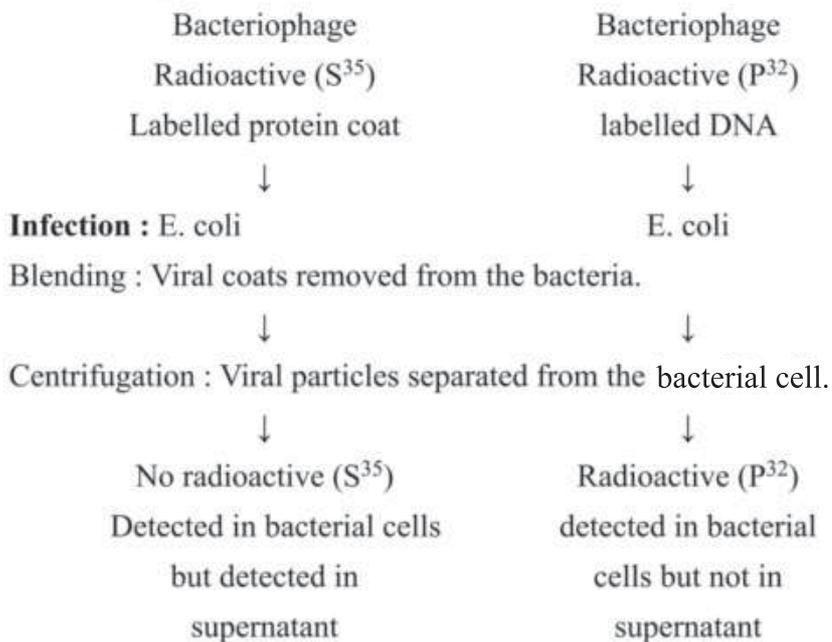
Chemical Nature of Transforming Principle

In 1944, Avery, MacLeod and McCarty worked to determine the chemical nature of 'transforming principle'.

They purified biochemicals from heat killed S-cells :

- Proteins $\xrightarrow{\text{Proteases}}$ Transformation takes place. So, protein is not a 'transforming principle'.
- RNA $\xrightarrow{\text{RNases}}$ Transformation takes place. So, RNA is not a 'transforming Principle'.
- DNA $\xrightarrow{\text{DNases}}$ Transformation inhibited. Therefore, DNA is the 'Transforming Principle'.

Hershey and Chase Experiment : In 1952, Hershey and Chase performed an experiment on bacteriophages (Viruses that infect bacteria) and proved that DNA is the genetic material.



Conclusion : DNA is the genetic material.

Messelson and Stahl's Experiment :

- Messelson and Stahl performed the experiment in 1958 on *E. coli* to prove that DNA replication is semiconservative.
- *E. coli* was grown in $^{15}\text{NH}_4\text{Cl}$ for many generations.
- N^{15} was incorporated into newly synthesised DNA.
- This heavy DNA could be differentiated from normal DNA by centrifugation in cesium chloride (CsCl) density gradient.
- Then they transferred these *E. coli* into medium with normal $^{14}\text{NH}_4\text{Cl}$.
- After 20 minutes, it was found that all the DNA molecules of daughter cells were hybrid-**First generation**.
- After 40 minutes, it was found that 50% DNA molecules were hybrid and 50% were normal-**second generation**.

DNA replication

DNA strands start separating from ori (origin of replication). This unwinding is catalysed by many enzymes. Y-shaped structure is formed at ori called replication fork



DNA polymerase attaches to the replication fork and add nucleotides complementary to the parental DNA strand. The direction of polymerisation is 5'-3'.



DNA polymerase cannot initiate the polymerisation itself, so a small segment of RNA called primer is attached at replication start point



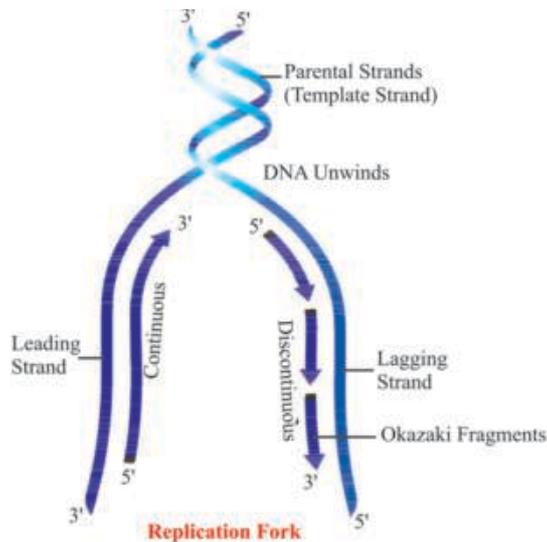
DNA polymerase adds nucleotides on one of the template strand, called as leading strand (the template with polarity 3'-5'). In this strand nucleotides are added continuously therefore called as continuous replication



On the other strand the replication is discontinuous, small fragment of DNA are formed called okazaki fragments which are later joined by DNA ligase. This strand is called as lagging strand.

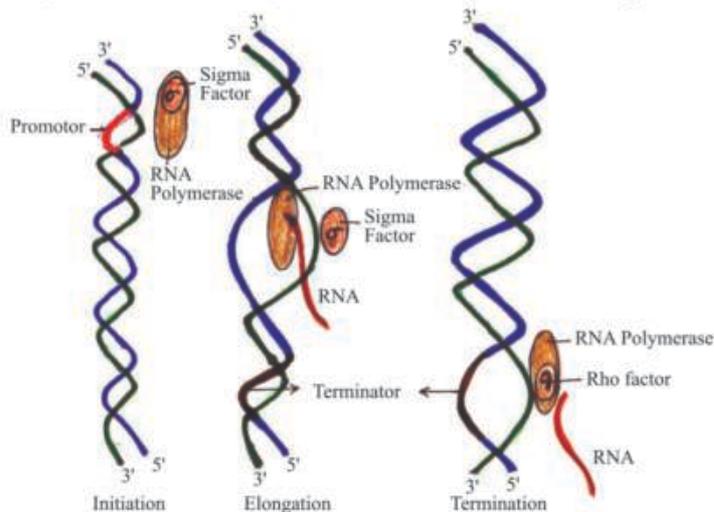


Accuracy of polymerisation is maintained by Proof reading and any wrong base added is removed



Transcription in Prokaryotes : In prokaryotes the process of transcription is completed in three steps :

1. **Initiation :** RNA polymerase binds with initiation factor (sigma factor) and then binds to promoter site.
2. **Elongation :** RNA polymerase separates from sigma factor and adds nucleoside triphosphate as substrate. RNA is formed during the process following the rule of complementary and remains bound to enzyme RNA polymerase.
3. **Termination :** On reaching terminator region, RNA polymerase binds with rho factor (terminator factor) as a result nascent RNA separates.



Transcription in Prokaryotes

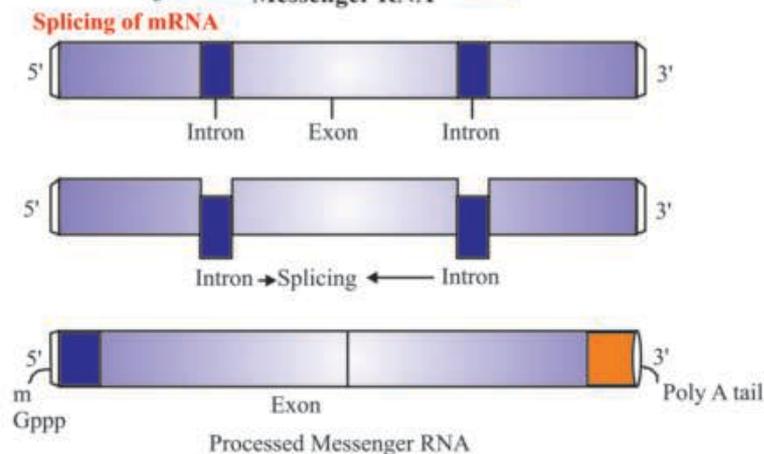
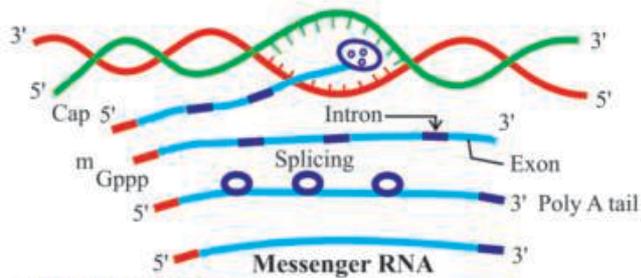
Transcription in Eukaryotes :

- In eukaryotes three types of RNA polymerases are found in the nucleus. (In addition to the RNA polymerase found in the organelles) are involved in transcription.

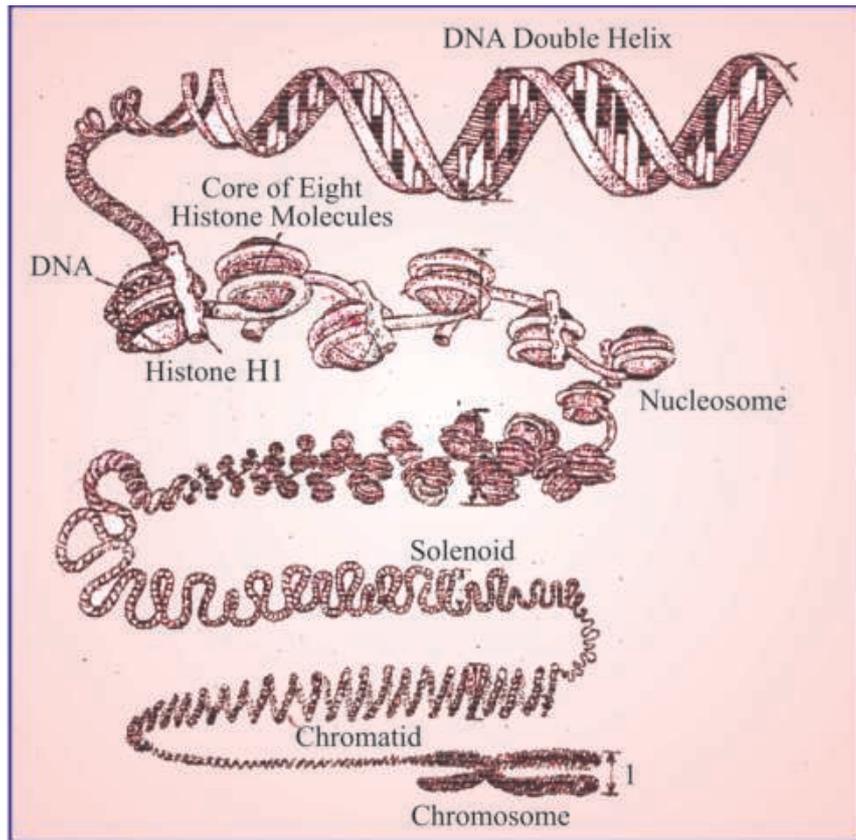
RNA Polymerase I : Transcribes rRNAs.

RNA Polymerase II : Transcribes hnRNA (which is precursor of mRNA).

- **RNA Polymerase III : Transcribes tRNA, 5 srRNA and sn RNA.**
- The primary transcription has both exon and intron regions.
- Introns which are non-coding regions removed by a process called splicing.
- hnRNA undergoes two additional process :
 - (a) **Capping** : An unusual nucleotide (methylguanosine triphosphate) is added to 5'-end of hnRNA.
 - (b) **Tailing** : Adenylate residues (200-300) are added at 3'-end. It is fully processed hnRNA. (now called mRNA) is transported out of the nucleus.



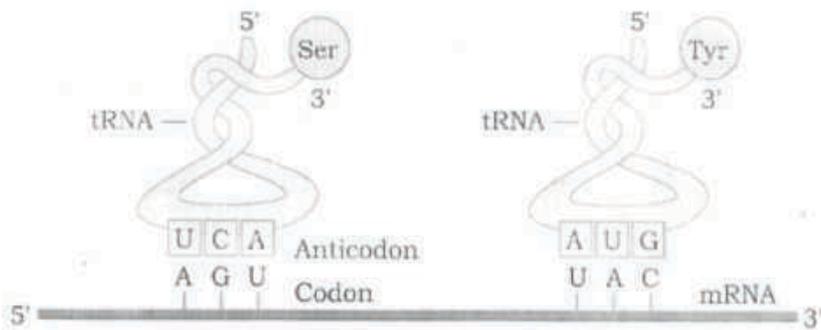
Transcription in Eukaryotes



Genetic Code

- (i) The codon is triplet 61 codons code for amino acids and 3 codons function as stop codons (UAG, UGA, UAA)
- (ii) One codon codes for only one amino acid, hence the codon is unambiguous
- (iii) Some amino acids are coded by more than one codon, hence called as degenerate.
- (iv) The codon is read in mRNA in a contiguous fashion. There are no punctuations.
- (v) The code is nearly universal.
- (vi) AUG has dual functions. It codes for Methionine (met) and it also acts as initiator codon.

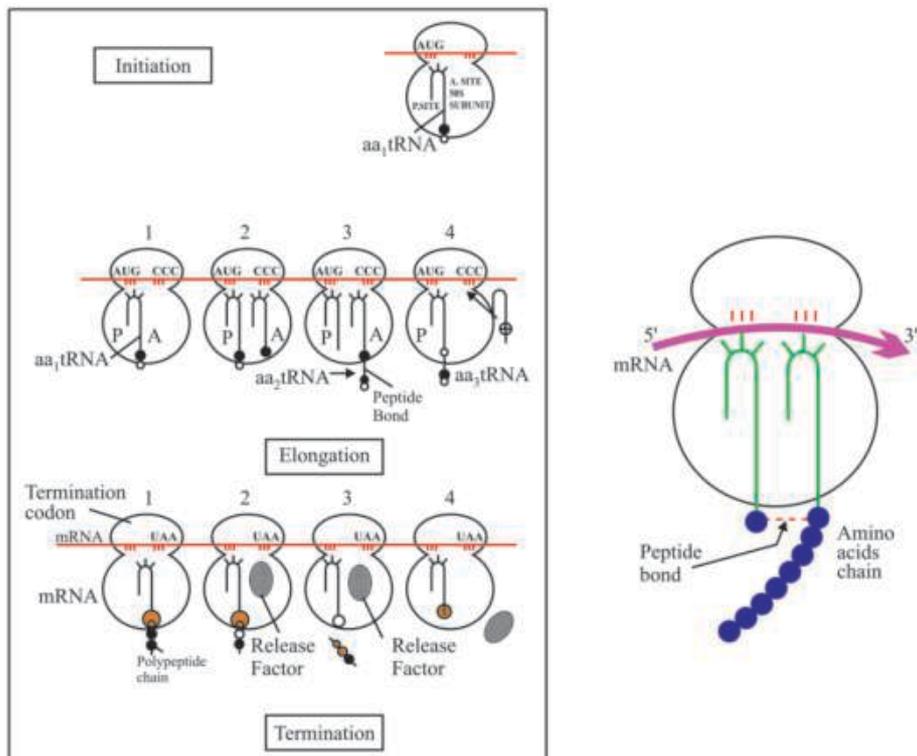
tRNA, the Adapter Molecule



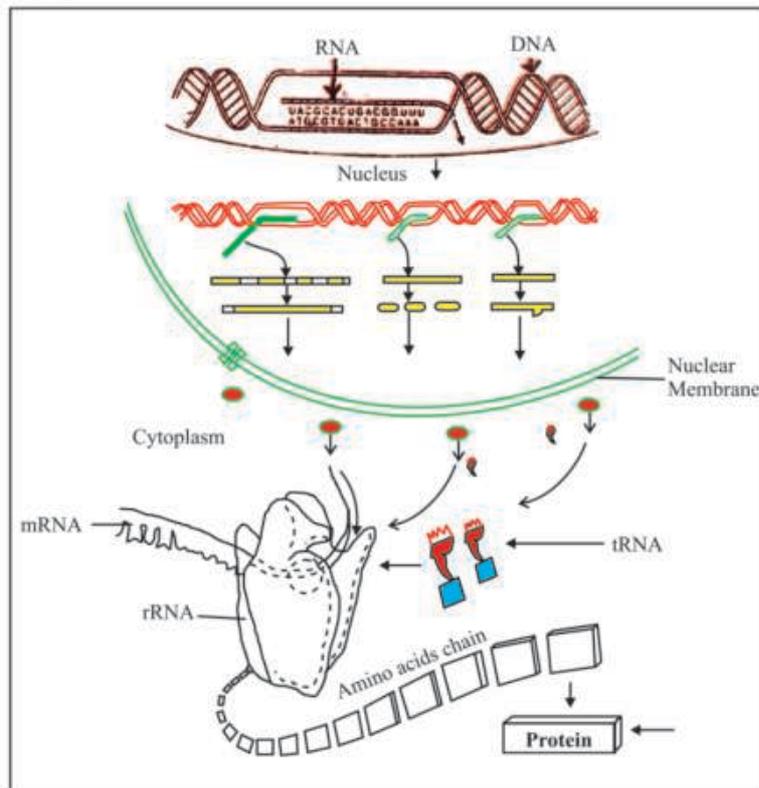
- tRNA has an anticodon loop that has bases complementary to the code, and also has an amino acid acceptor and through which it binds to amino acids.

Translation

- Translation refers to the process of polymerization of amino acids to form a polypeptide. The order and sequence of amino acids are defined by the sequence of bases in the mRNA. 20 amino acids participate in naturally occurring protein synthesis.



- First step is—charging of t-RNA or aminoacylation of t-RNA—here amino acids are activated in the presence of ATP and linked to specific t-RNA.
- **Initiation** : Ribosome binds to mRNA at the start codon (AUG) that is recognized by the initiator t-RNA.
- **Elongation phase** : Here complexes composed of an amino acid linked to tRNA. Sequentially bind to the appropriate codon in mRNA by forming complementary base pairs on t-RNA as anticodon. The ribosomes move from codon to codon along with mRNA. Amino acids are added one by one, translated into polypeptide sequences.
- **Termination** : Release factors binds to the stop codon (UAA, UAG, UGA) translation and releasing the complete polypeptide from the ribosome.

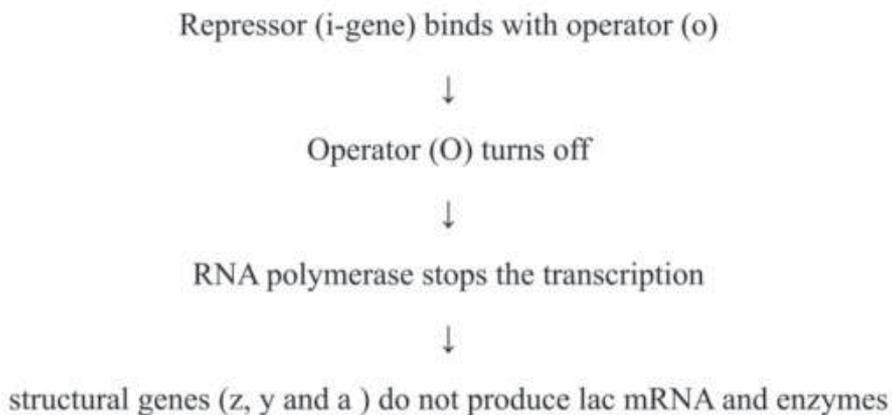


Lac Operon

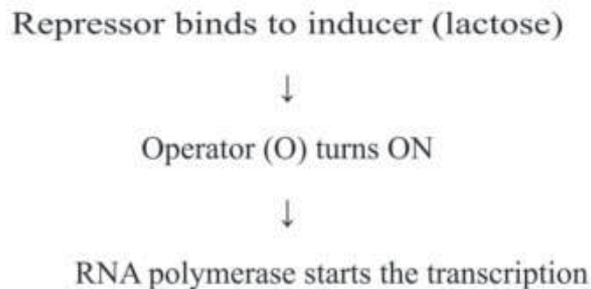
- The concept of operon was proposed by Jacob and Monod. Operon is a unit of prokaryotic gene expression.

- The lac operon consists of one regulatory gene (the i-gene) and three structural genes (z, y and a).
- The i-gene codes for repressor of lac operon.
- Promoter - It is the site where RNA-polymerase binds for transcription.
- Operator—acts as switch for operon.
- Lactose is an inducer.
- Operator : Act as switch for operon.
- Gene z—Codes for b-galactosidase
Gene y—Codes for permease
Gene a—Codes for transacetylase.

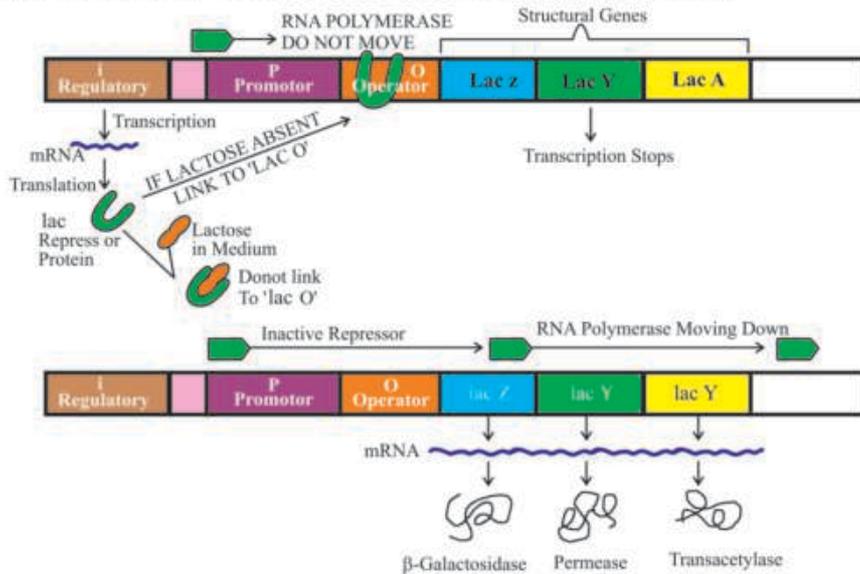
In the absence of Inducer (lactose)



In the presence of inducer (lactose)



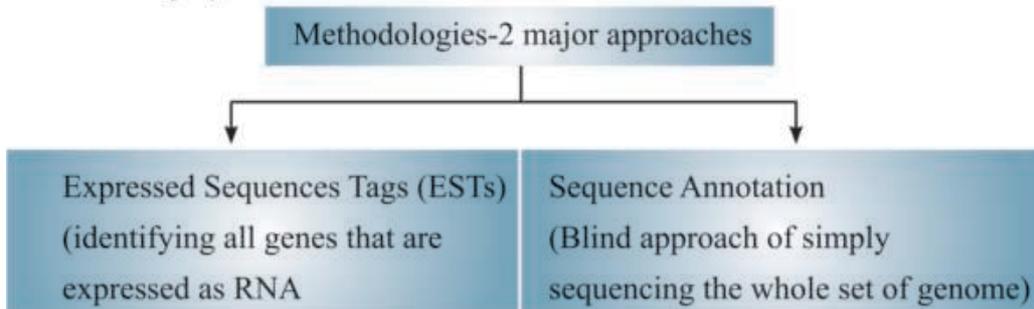
Structural genes (z, y and a) produce mRNA and enzymes
(β -galactosidase, permease and transacetylase respectively)



Human Genome Project was a 13 year project coordinated by the U.S. Department of Energy and National institute of Health, it was completed in 2003.

Important goals of HGP

- (i) Identify all the approximately 20,000-25,000 genes in human DNA.
- (ii) Determinate the sequence of the 3 million chemical base pairs that make up human DNA.
- (iii) Store this information in database.
- (iv) Transfer the related technologies to other sectors, such as industries.
- (v) Address the ethical, legal and social issues (ELSI) that may arise from the project.



Steps for Sequencing :

- DNA isolated from cell and converted into fragments.
- DNA is cloned for amplification in suitable host using specialised vectors.
- Commonly used hosts—Bacteria, Yeast
- Commonly used Vectors—BAC (Bacterial Artificial Chromosomes)
YAC (Yeast Artificial Chromosomes)

International Rice Genome Sequencing Project (IRGSP)

- Rice benefits from having the smallest genome of the major cereals, dense genetic maps.
- The IRGSP, formally established in 1998, pooled the resources of sequencing groups in 10 nations (Japan, Korea, UK, Taiwan, China, Thailand, India, United States, Canada and France)
- Estimated Cost— Rs. 200 million.
- India joined in June 2000 and chose to sequence a part of chromosome 11.
- Tools used in sequencing were :
 - BAC (Bacterial Artificial chromosomes)
 - PAC (P1-Phase derived artificial chromosomes)

- **How Sequenced**

Shotgun sequencing involved—generation of short DNA fragments that are then sequenced and linearly arranged.

It enables full coverage of the genome in a fraction of time required for the alternative BAC sequence approach.

- **Salient Features of Rice Genome**

Rice is monocarpic annual plant, wind pollinated. It is with only 389 base pairs.

The world's first genome of a crop plant that was completely sequenced. 2,859 genes seem to be unique to rice & other cereals.

Repetitive DNA is estimated to constitute at least 50% of rice genome. The transposon content of rice genome is at least 35%.

- **Applications**

- To improve efficiency of Rice breeding.
- To improve nutritional value of rice, enhance crop yield by improving seed quality, resistance to pests and diseases and plant hardiness.

DNA Fingerprinting :

It is a technique to determine nucleotide sequence of certain areas of DNA which are unique to each individual.

Principle of DNA Fingerprinting : Short nucleotide repeats in the DNA are very specific in each individual and vary in number from person to person but are inherited, these are Variable Number Tandem Repeats (VNTRs.). Each individual inherits these repeats from his/her parents which is used as genetic markers. One half of VNTR alleles of the child resembles that of mother and other half of the father.

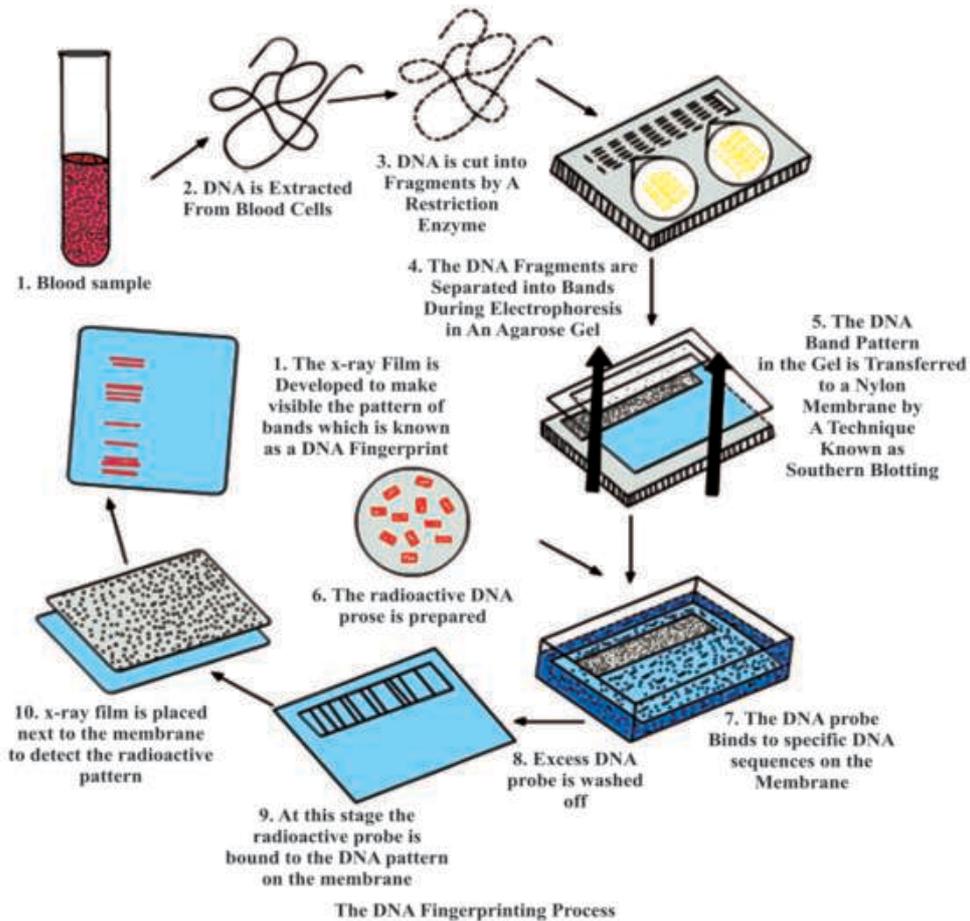
Steps/Procedure in DNA Fingerprinting

- Extraction of DNA—using high speed refrigerated centrifuge.
- Amplification—many copies are made using PCR
- Restriction Digestion—using restriction enzymes DNA is cut into fragments.
- Separation of DNA fragments—using electrophoresis agarose polymer gel
- **Southern Blotting :** Separated DNA sequences are transferred on to nitrocellulose or nylon membranes.

- **Hybridization** : The nylon membranes exposed to radio active probes.
- **Autoradiography** : The dark bands develop at the probe site.

Applications of DNA Fingerprinting

- identify criminals if their DNA from blood, hair follicle, skin, bone, saliva, sperm etc is available in forensic labs.
- determine paternity
- verify whether a hopeful immigrant is really close relative of an already established resident.
- identify racial groups to rewrite biological evolution.

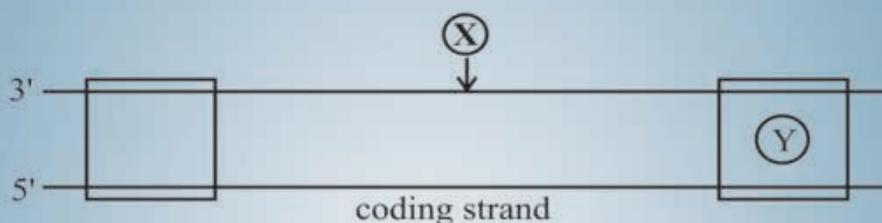


Questions

VSA

(1 Mark)

1. Name the factors for RNA polymerase enzymes which recognises the start and termination signals on DNA for transcription process in Bacteria.
2. RNA viruses mutate and evolve faster than other viruses. Why ?
3. Name the parts 'X' and 'Y' of the transcription unit given below.



4. Name the two initiating codons
5. Write the name of one stop codon

Multiple - Choice Question :

6. Purines of DNA are represented by:
 - a) Uracil and Thymine.
 - b) Guanine & Adenine.
 - c) Uracil & Cytosine.
 - d) Thymine & Cytosine.
7. Which is the DNA unwinding protein?
 - a) DNA polymerase.
 - b) Ligase.
 - c) Endonuclease.
 - d) Helicase.
8. Sigma factor (σ) is a component of
 - a) RNA polymerase
 - b) DNA ligase
 - c) DNA polymerase
 - d) Endonuclease.

9. The diagram shows an important concept in the genetic implication of DNA. Fill the 'A', 'B' & 'C'.

- a) A Transcriptase, B — Replication, C — James Watson
- b) A Translation, B — Transcription, C — Erevin Chargaff.
- c) A — Transcription, B — Translation, C — Francis Crick.
- d) A — Translation, B — Extension, C — Rosalind Franklin.

In Questions 10 to 13 a statement of Assertion is followed by a statement of Reason. Mark the correct choices as:

- a) Both Assertion and Reason are true, and the Reason is the correct explanation of the Assertion.
- b) Both Assertion and Reason are true, and the Reason is not the correct explanation of the Assertion.
- c) Assertion is true statement but Reason is false.
- d) If both Assertion & Reason are false statements.

10. **Assertion** : In prokaryotes, they do not have a defined nucleus, the DNA is scattered throughout the cell. Reason : DNA is held with some protein in a region termed as 'nucleolus'.

11. **Assertion** : The chromatin that is more densely packed and stains dark are called as heterochromatin.

Reason : Heterochromatin is said to be transcriptionally active chromatin.

12. **Assertion** : Eukaryotic mRNA requires post-transcription processing for formation of functional mRNA.

Reason : Eukaryotic transcripts possess extra non- functional segments called introns.

13. **Assertion** : Cistron is defined as a segment of DNA coding for a polypeptide.

Reason : Mostly in eukaryotes transcription unit could be said as monocistronic.

14. Read the following and answer the questions (1) to 1 (V) given below:

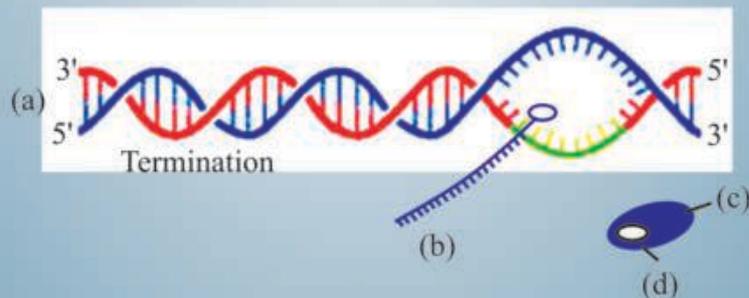
During the 1950s and 1960s, it became apparent that DNA IS essential in the synthesis of proteins. The key to a protein molecule is how the amino acids are linked. The sequence of amino acid in a protein is a type of code that specifies the protein A genetic code in DNA determines this amino acid code. The genetic code consists of the sequence of nitrogenous bases in DNA. Now the nitrogenous base code is translated to an amino acid sequence in a protein is the basis for protein synthesis.

- I. The process by which protein synthesis from genetic code occurs is best described by
- Transcription
 - Replication
 - Translation
 - Reproduction
- ii. In protein synthesis, translation is initiated with the movement of
- t-RNA from P - site to the A - site.
 - Dipeptidyl t RNA from A - site to P - site.
 - t-RNA from A - site to P - site.
 - t-RNA from P - site to E - site.
- iii. This is incorrect about the nature of genetic code.
- Comma less
 - Triplets
 - Universal
 - Overlapping
- iv. In translation, this is not an essential component.
- Amino acid
 - Ligase
 - mRNA
 - Anticodon
- V. The initiation t-RNA has an anticodon 'A' and carries amino acid 'B'. Identify 'A' & 'B'
- AUG, methionine.
 - GUG, Valine
 - UAC, methionine
 - CAC, Valine

SA-I

(2 Marks)

15. The process of termination during transcription in a prokaryotic cell is being represented here. Name the label a, b, c and d.



16. Give two reasons why both the strand of DNA are not copied during transcription.
17. State the 4 criteria which a molecule must fulfill to act as a genetic material.

18. Give six points of difference between DNA and RNA in their structure chemistry and function.
19. Explain how does the hnRNA becomes the mRNA.

OR

Explain the process of splicing, capping and tailing which occur during transcription in Eukaryotes.

20. Name the three major types of RNAs, specifying the function of each in the synthesis of Polypeptide.
21. A tRNA is charged with the aminoacids methionine.
- Give the anti-codon of this tRNA.
 - Write the codon for methionine.
 - Name the enzyme responsible for binding of aminoacid to tRNA.

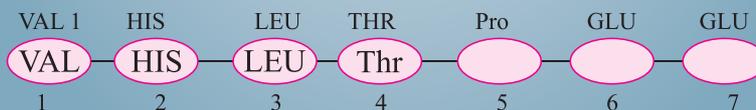
LA

(5 Marks)

22. State salient features of genetic code.
23. Describe the process of transcription of mRNA in an eukaryotic cell.
24. Describe the various steps involved in the technique of DNA fingerprinting Molecular both
25. Conchiporns of a key type $2n + 1$, $2n - 1$, and $2n + 2$, $2n - 2$ are called:
 (a) Aneuploidy (b) polyploid (c) allopolyploicty (d) Monosomy
26. Occasionally, a single gene may express more than one effect. The phenomenon is called.
 (a) Multiple allelism (b) Monogamy
 (c) Pleiotropy (d) polygon

Case Based Questions

27. A relevant portion of b-chain of haemoglobin's of a normal human is given below:



The codon for the six the amino acid as GAG. The sixth codon GAG mutates to GAA as a result of mutation 'A' and into GUG as a result of mutation 'B'. Haemoglobin's structure did not charge as a result of mutation

mutation 'B'. Haemoglobin's structure did not change as a result of mutation 'A' whereas haemoglobin's structure changed because of mutation of leading to sickle shaped RBC's.

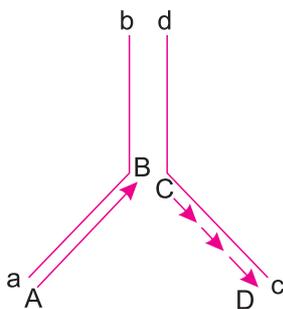
- What will be the genotype of an individual who is a carrier of sickle cell anemia gene but apparently unaffected?
- What is the cause of this disease.

28. What are the symptoms of the disease sickle cell anemia?

No. 29 and 30 are case based questions. Each question has subparts with internal choice in one subpart.

Just as they proposed the double helical structure of DNA, Watson and Crick had immediately proposed a scheme for replication of DNA. The scheme suggested that the two strands would separate and each of them acts as a template for the synthesis of a complementary strand. After completion of replication, each of the new DNA molecules would possess one parental strand and one newly synthesized strand. This scheme has been termed as semiconservative replication.

A DNA replication fork is shown. Observe the sketch and answer the question that follow:



- When and where does replication of DNA occur in eukaryotic cells?
- Identify the polarity of the strands a-b and c-d.
- Why does DNA replication occur in such small forks? Name the major enzyme that catalyzes this process.

or

Why is DNA synthesis continuous and discontinuous on the two strands? What name is given to (i) the continuously synthesised strand (A – B) (ii) the small segments of strand (C – D)?

Answers

VSA

(1 Marks)

1. Sigma (σ) factor and Rho(ρ) factor
2. OH group is present on RNA, which is a reactive group so it is unstable and mutate faster.
3. X Template strand, Y – Terminator.
4. AUG and GUG
5. UAG
6. (b) 7. (d) 8. (a) 9. (c) 10. (d)
- 11.(c) 11. (a) 13. (b) 14. (i)-c (ii)-b (iii)-d (iv)-b (v)-c
15. (a) DNA molecule
(b) mRNA transcript
(c) RNA polymers
(d) Rho factor
16. (a) If both the strands of DNA are copied, two different RNAs (complementary to each other) and hence two different polypeptides; if a segment of DNA produces two polypeptides, the genetic information machinery becomes complicated.
(b) The two complementary RNA molecules (produced simultaneously) would form a double-stranded RNA rather than getting translated into polypeptides.
(c) RNA polymerase carries out polymerisation in 5' – 3' direction and hence the DNA strand with 3' – 5' polarity acts as the template strand. (Any two)
17. (i) It should be able to generate its replica.
(ii) It Should be chemically and structurally stable.
(iii) It Should be able to express itself in the form of Mendelian characters.
(iv) It Should provide the scope for slow changes (mutations) that are necessary for evolution.

| 18. | DNA | RNA |
|-------|--|--|
| (i) | Double stranded molecules | Single stranded molecules |
| (ii) | Thymine as pyrimidine base | Uracil as pyrimidine base |
| (iii) | Pentose sugar is deoxyribose Quite stable and not very reactive | Sugar is ribose (iv) 2'-OH makes it very reactive and unstable. |
| (v) | Dictates the synthesis of Polypeptides | Perform other function in protein synthesis. |
| (vi) | Found in the nucleus. | They are transported into the cytoplasm. |

19. hnRNA is precursor of mRNA. It undergoes

- (i) **Splicing** : Introns are removed and exons are joined together.
- (ii) **Capping** : an unusual nucleotide (methyl guanosine triphosphate is added to the 5' end of hnRNA.
- (iii) Adenylate residues (200-300) are added at 3' end of hnRNA.

Or

Refer fig. 6.11, page 110, NCERT book. Biology-XII

20. (i) mRNA-(Messenger RNA) : decides the sequence of amino acids.
(ii) tRNA-(Transfer RNA) : (a) Recognises the codon on mRNA (b) transport the amino acid to the site of protein synthesis.
(iii) rRNA (Ribosomal RNA) : Plays the structural and catalytic role during translation.
21. (a) UAC (b) AUG
(c) Amino-acyl-tRNA synthetase.

LA

(5 Marks)

22. Refer page 6.9.1., Page No. 120 NCERT Biology XII.
23. Refer notes 35 and figure 6.11, page 110, NCERT Biology XII.
24. Refer points to remember. Steps involved in DNA fingerprinting.
25. (i) (a)
(ii) (c)
26. (a) HbA HbS
(b) People who have sickle cell Anaemia inherit two faulty hemoglobin genes called HbS HbS are from each parent. It occurs due to mutation in Hb chain as glutamic acid is replaced by valine.
(c) Symptoms are Anaemia, i.e., oxygen carrying capacity of Hb decreases. So pain in joints, palpitation, swelling in hands and that feet. Sickle cell anemia is quantitative and Thalassemia is qualitative disorder.
27. (a) DNA replication in S-phase, of interphase in the cell cycle.
(b) Strand a – b – 3' 5'
(c) Replication of DNA occurs in small replication bubbles because DNA is such a long molecule that the separation of two strands along its entire length requires a very high amount of energy. DNA – Dependent DNA polymerase is the enzyme.

or

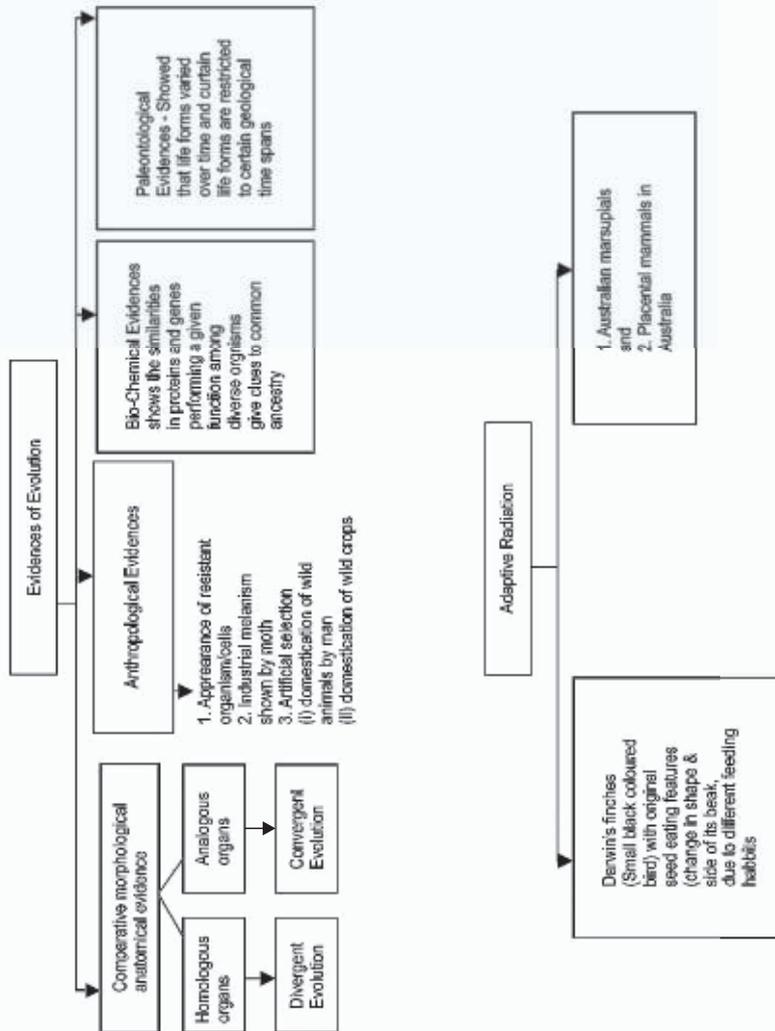
Since DNA dependent polymerase can catalyse the polymerisation in the 5'–3' direction only on the template strand with 3' — 5' polarity, synthesis is continuous and on the template strand with 5' — 3' polarity synthesis is discontinuous.

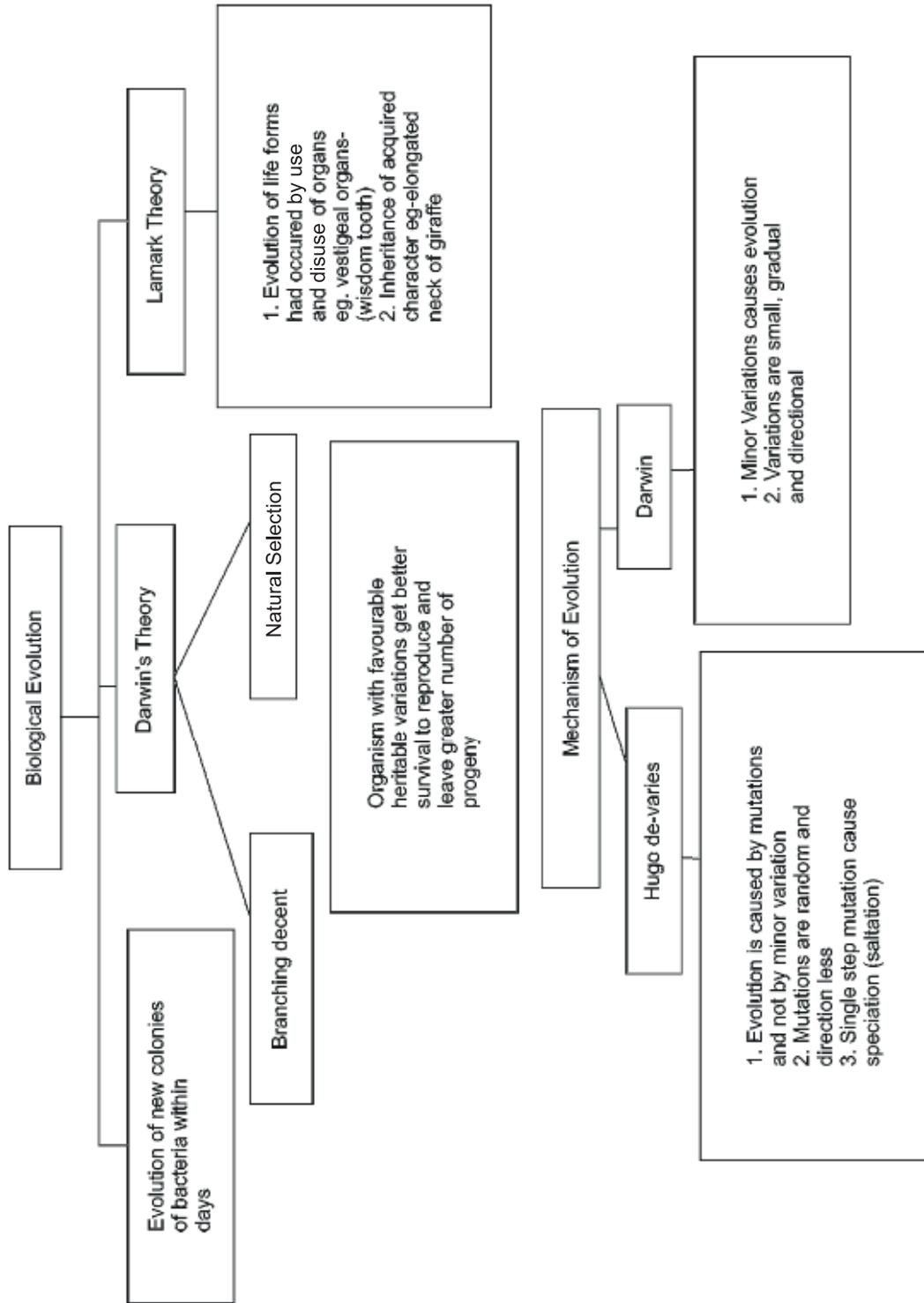
- (i) Strand A – B is called leading strand.
(ii) Okazaki Fragments.

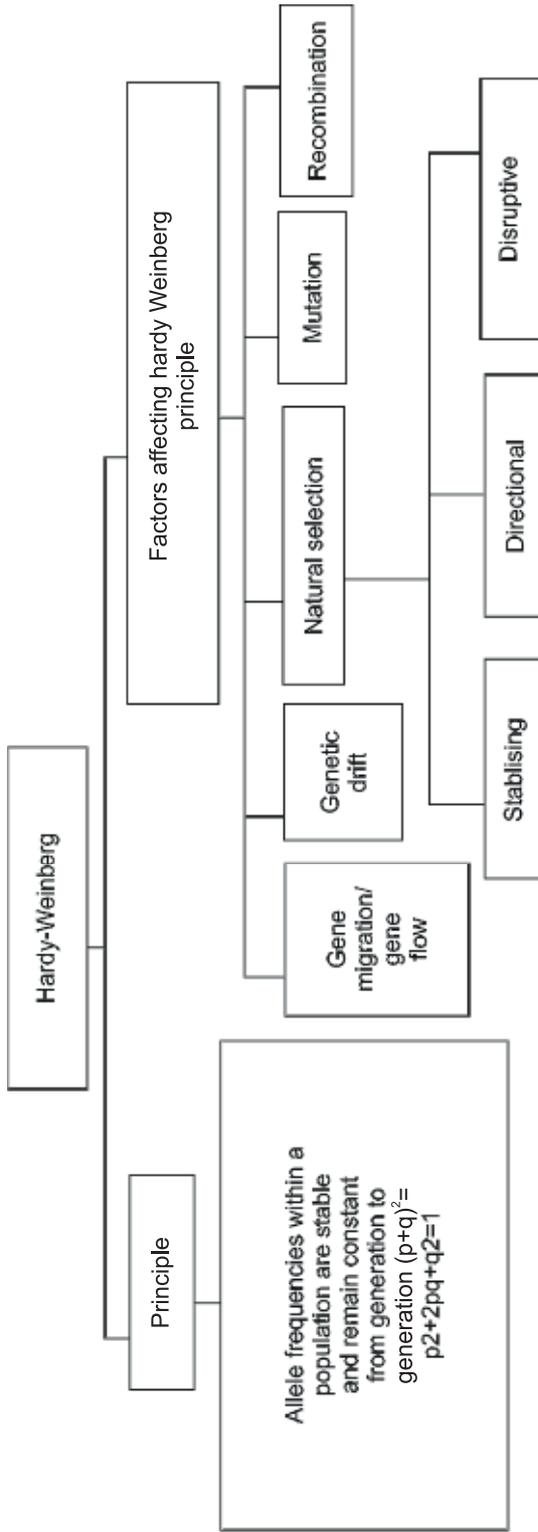


Chapter - 6

Evolution







Brief account of Evolution

| Time | Origin |
|-----------------------|--|
| 3 billion year ago | First non-cellular form of life |
| 2000 million year ago | First cellular form of life appeared |
| 500 million year ago | Invertebrate formed |
| 350 million year ago | Fishes with back to water-coelacanth called labefine evolved into the first amphibians |
| 320 million year ago | sea weeds and plant exist |

Big-bang Theory- proposed by Abbe Lemaitre in 1931. About 20 billion years ago an explosion took place which broke the condensed cosmic matter and scattered its fragments into space at an enormous velocity making a big bang sound.

Artificial Selection : It is the process carried out by man to select better breeds of plants and animals.

Founders Effect : A genetic drift in human population where a population in a new settlement have different gene frequency from that of the parent population. The original drifted population said to be founder.

Gene Pool : Sum total of all the genes in a population.

Genetic Drift : By chance elimination of genes or any other changes in gene, of certain traits from a population due to migration or death.

Panspermia : Units of life in the form of so called spores, which were transferred to earth from outer space, as believed by some scientists.

Saltation : Single step large mutations.

Speciation : It is the formation of new species from the pre-existing ones.

Organic (Biological) Evolution : Changes at the characteristics/features of organisms or groups of such population over a number of generations.

Homologous organs : (These are the result of divergent evolution) these have same basic structure and embryonic origin but perform different functions in different species.

Example :

Plants—Thorns of *Bougainvillea* and tendrils of *Cucurbita*

Animals—For limbs of whales, bat, cheetah and human

Analogous organs : (These are the result of convergent evolution) These organs are different in their basic structure and embryonic origin but perform similar functions.

Example :

Animals—Wings of insects and birds

Plants—potato and sweet potato.

Human Evolution : *Ramapithecus* → *Australopithecines* → *Homo habilis*
Homo erectus → *Homo sapiens* → *Homo sapiens sapiens*.

The Theories of Origin of Life

1. Theory of Special Creation : According to this theory God has created life within 6 days.

2. Theory of Spontaneous Generation : According to this theory life originated from decaying and rotting matter like straw and mud.

3. Panspermia Theory : According to this theory life came from space in the form of spores called Panspermia.

4. Modern Theory or Oparin-Haldane Theory : According to this theory life originated upon earth spontaneously from non-living matter. First inorganic compounds then organic compounds were formed in accordance with ever changing environment conditions, this is called chemical evolution. The conditions on earth were high temperature, volcanic storms, reducing atmosphere (without free oxygen) containing methane and ammonia.

Experimental Evidence for abiogenesis (Miller's Experiment) : Stanley Miller in 1953 demonstrated in a laboratory that electric discharges can produce complex organic compounds from a mixture of methane, ammonia, water vapours and hydrogen. In this experiment he found that simple organic compounds including some amino acids are formed. In similar experiments others observed the formation of sugar, nitrogen bases, fats and pigments.

He used Spark chamber with two electrodes(to provide Very high-voltage spark for simulation of lightening), a flask for boiling (Simulation for evaporation and circulation) to a temperature of 800°C and a condenser (simulation of raining and, Haldane's Soup). He used mixture of gases like CH₄, NH₃, H₂ and water vapours to simulate conditions of primeval atmosphere.

Molecular evidences : These evidences show common ancestry based on parallel nucleic acid and amino acid sequences as well as universal genetic codes, e.g. Human and Chimpanzee DNA is 98.2% same and protein cytochrome c is similar.

Evidences from embryology : These evidences based on comparative development studies of embryo of different vertebrates based upto the observation during embryonic stage of all vertebrates.

The embryo of vertebrates develop a row of gill slit, but these gill slits are functional only in fish.

Ernst Haeckel's biogenetic law : This law states that "ontogeny (development of the embryo) recapitulates phylogeny (development of race)."

e.g. Vertebrate head at embryonic stage has vestigial gill slits like fishes.

Hugo de vries mutation.

1. Mutation appear all of a sudden
2. Mutations are due to sudden change in genetic make-up
3. Mutations are raw material of evolution

Darwinian Variation

1. Darwinian variations are gradual
2. Genes were not known to Darwinian
3. The basis of evolution are continuous variations

Divergent evolution : Development of different functional structures from a common ancestral form is called divergent evolution, e.g. Development of homologous organs.

Convergent evolution : Development of similar adaptive functional structures in unrelated groups of organisms, e.g. Development of analogous organs.

Parallel evolution : When more than one adaptive radiation appeared to have occurred in an isolated geographical area then it is called parallel evolution.

e.g. Australian marsupials and placental mammals (corresponding)

Example of Natural Selection

1. Industrial Melanism
2. Resistance of insects to pesticides
3. Antibiotic resistance in Bacteria

Industrial Melanism : It is an adaptation where moth living in the industrial area developed melanin pigments to match their body colour to the tree-trunk. Before Industrialisation in England, it was observed that there were more white-winged moths on trees than dark-winged moths (melanised moths). After industrialisation (in 1920), there were more dark winged moths in some areas. After industrialisation, trees got covered by smoke. So whitewinged moth were picked up by the birds but dark-winged moths escaped and survived. Thus, industrial melanism supports the evolution by natural selection.

Adaptive radiation : The process of evolution of different species in a geographical area starting from a point and literally radiating to other habitats is called adaptive radiation. Examples : (i) Darwin's finches found in Galapagos Island (ii) Marsupials of Australia.

Evolution of Plants : Unicellular → Multicellular → Algae → Rhynia type plants → Cycads → Gnetales → Dicot → Monocot.

Hardy-Weinberg principle : The allele frequencies in a population are stable and is constant generation to generation. Sum total of all the allele frequencies is 1.

i.e. $p^2 + 2pq + q^2 = 1$ (Where p and q are frequency of Allele A and a)

Factors Affecting Hardy-Weinberg Equilibrium : Gene migration, Genetic drift, Mutations, Recombination, Natural Selection.

(I) Over population (ii) Limited food and space (iii) Struggle for Existence (iv) Variations (v) Natural Selection (Survival of the fittest) (vi) Inheritance of useful variation (vii) formation of new species.

Artificial Selection : (Selective breeding)-Crop plants developed from wild mustard eg. cabbage, kohlrabi, kali, broccoli, cauliflower etc.

Three types of Natural selection.

(i) stabilising selection (Balancing Selection)

(ii) Directional Selection (Progressive Selection)

(iii) Disruptive Selection (Diversifying Selection)

Brief Account of Evolution (mya - million years ago)

- 2000 mya : first cellular forms of life appeared on earth
- 500 mya : invertebrates formed
- 350 mya : jawless fish evolved probably, fish with stout and strong fins evolved which can move on lands as well as go back to water.
- 320 mya : Sea weeds and few plants existed probably.
- In 1938 : Fish caught in south Africa happened to be a coelacanth which was thought to be extinct. These animals are called lobefins (evolved into first amphibians)
- 200 mya : Some of land reptiles went back into water to evolve into fish like reptiles e.g. *Ichthyosaurs*. Land reptiles were Dinosaurs. Biggest Dinosaurs *Tyrannosaurus rex* (20 feet in height, have huge dagger like teeth.)
- First mammals were like shrews—They were small sized, viviparous intelligent.

Evolution of Man :

About 15 mya, primates called *Dryopithecus* and *Ramapithecus* were existing.

Dryopithecus : Were more ape-like, live in Asia, Africa and Europe. Walk semierect, Hands & Skull were monkey like.

Ramapithecus : First man-like, walk straight on legs, not taller than 4 feet.

Australopithecines : 2 mya, lived in east african grassland, hunted with stones, ate fruits, Teeth larger.

Homo habilis : 2 mya, brain capacity 650-800cc, did not eat meat, dentition like humans.

Homo erectus : 1.5 mya, brain capacity 900cc, ate meat, walk erect.

Homo sapiens : 75000-100000 years ago., in Africa, and spread to all parts of world.

Neanderthal man : 40,000-1,00,000 years ago, brain capacity 1400cc, broad forehead, lives in caves, use hides to protect their bodies.

Questions

VSA

(1 Mark)

1. If abiotic origin of life is in progress on a planet other than earth, what should be the conditions there?
2. Name the person who proposed that population tends to increase geometrically while food production supply arithmetically.
3. Name the scientist who had also come to similar conclusion as that of Darwin about natural selection as a mechanism of evolution. Which place did he visit to come to conclusions ?
4. State the two principle outcomes of the experiements conducted by Louis on origin of life.

SA-I

(2 Marks)

Multiple - Choice Question :

5. Abiogenesis means
 - a) Origin of life from non-living molecules.
 - b) Origin of life from living organisms.
 - c) Origin of viruses & microbes.
 - d) Spontaneous generation.
6. Hardy - Weinberg principle explains.
 - a) Chromosomal abberation
 - b) Genetic drift.
 - c) Genetic equilibrium.
 - d) All of these

7. Which is correct chronological sequence of human evolution?
- a) Ramapithecus - Australopithecus - Homo erectus - Neanderthalensis - Homo sapiens.
 - b) Ramapithecus - Homo habilis - Homo sapiens - Homo erectus.
 - c) Australopithecus - Ramapithecus - Homo habilis - Homo sapiens.
 - d) Homo habilis - Australopithecus - Homo erectus - Homo sapiens.

In Questions from 8 to 11, a statement of Assertion is to statement of Reason. Mark the correct choices as:

- a) Both Assertion and Reason are true and the Reason is the correct explanation of the Assertion.
 - b) Both Assertion and Reason are true and the Reason is not the correct explanation of the Assertion.
 - c) Assertion is true statement but Reason is false.
 - d) If both Assertion & Reason are false statements.
8. **Assertion :** Vertebrate hearts are an example of homology
Reason: Homologous organs indicates convergent evolution.
9. **Assertion :** Excess use of herbicides, pesticides etc., has only resulted in selection of resistant varieties in a much lesser time scale.
Reason: This is due to anthropogenic action.
10. **Assertion :** Hardy-Weinberg principle says that allele frequency in a population are stable and constant from generation to generation.
Reason: Change in frequency of alleles in a population would be interpreted as resulting in evolution.
11. **Assertion :** Homo erectus has a large brain around 1400°C.
Reason: Homo erectus used hides to protect their bodies and buried their dead.
12. Explain Oparin-Haldane theory of chemical evolution of life.
13. How do Darwin and Hugo de Vries differ regarding mechanism of evolution?
14. How did Louis Pasteur disprove spontaneous generation theory?
15. What are the two key concepts of Darwinian theory of evolution?

16. How would the gene flow or genetic drift affect the population in which either of them happen take place?

17. Write two difference between *Homo erectus* and *Homo habilis*?

SA-II

(3 Marks)

18. (i) State the Hardy-Weinberg principle.

(ii) When there is a disturbance in the Hardy-Weinberg equilibrium, what would it result in?

(iii) According to this principle, what is the sum total of all allelic frequencies ?

19. Classify the following as examples of homology and analogy-

(i) Hearts of fish and crocodile

(ii) Wings of butterfly and birds

(iii) Eyes of Octopus and Mammals

(iv) Tubers of Potato and sweet potato

(v) Thorns of *Bougainvillea* and spines of *Opuntia*

(vi) Thorn of *Bougainvillea* and tendrils of Cucurbits.

20. Stanley Miller and Harold Urey performed an experiment by recreating in the laboratory the probable conditions of the atmosphere of the primitive earth.

(i) What was the aim of the experiment ?

(ii) In what forms was the energy supplied for chemical reactions to occur ?

(iii) For how long was the experiment run continuously? Name two products formed.

21. 'Industrial Melanism' in peppered moth is an excellent example of 'Natural selection'. Justify the statement.

22. Fill up the blanks left in the table showing Era, period and organism.

| Era | Period | Organism |
|-----------|----------|---|
| Cenozoic | a | Modern man, Mammals, Birds, rise of monocot |
| b | Tertiary | Rise of first Primate, angiosperm |
| Mesozoic | c | Ginkgo, Gnetales |
| d | Jurassic | Conifers, cycads, Reptiles |
| Paleozoic | e | Early reptiles (extinct) |
| f | Silurian | Psilophyton |

23. (i) In which part of the world, Neanderthal man lived ?
 (ii) What was his brain's capacity ?
 (iii) Mention the advancement which Neanderthal man showed over *Homo erectus*.

24. Figures given below are of Darwin's finches ?



Variety of beaks of Darwin's finches

- (a) Mention the specific geographical area where these were found.
 (b) Name and explain the phenomenon that has resulted in the evolution of such diverse species in the region.
 (c) How did Darwin visit the particular geographical area?
25. Give examples to show evolution by anthropogenic action.

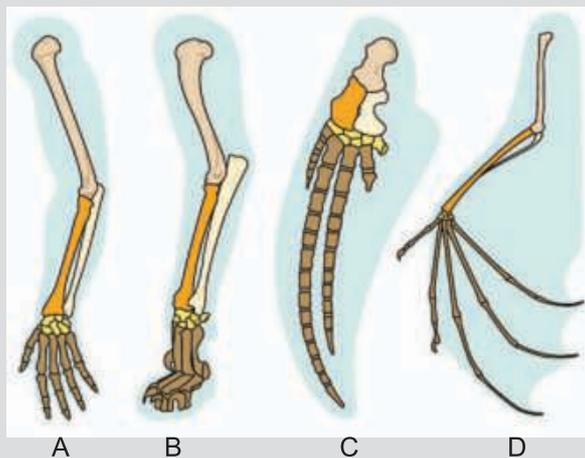
LA

(5 Marks)

26. Is evolution a process or the end result of a process, discuss. Describe various factors that effect Hardy-Weingberg equilibrium.

Read the following and answer the questions that follow:

Evidences that evolution of life form has indeed taken place on the Earth, have come from many quarters. There are evidences from comparative anatomy and morphology too. They show similarities and differences among organisms of today and those that existed in the past. Such similarities can be interpreted to understand whether common ancestry was shared or not. The forelimbs of whale, bat, cheetah and human share similarities in the pattern of bones of forelimbs, but perform different functions in these animals.



- Name and define the type of evolution, these organs of different animals exhibit.
- What are such organs called? What do they indicate about ancestry?
- Contrary of the above condition, organs that are not anatomically similar, but perform similar functions in different groups are also found.
 - What are such organs called and what type of evolution do they exhibit?
 - Give two example (one from plants and one from animals) of such organs.

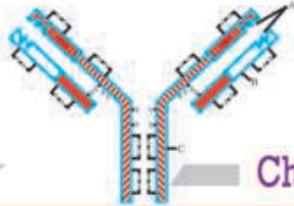
20. (i) To prove Oparin's theory of origin of life.
(ii) Electric discharge using electrodes.
(iii) One week; Amino acids and Sugar.
21. Refer Page 131, NCERT Text book of class XII.
22. (a) Quaternary (b) Coenozoic (c) Cretaceous
(d) Mesozoic (e) Carboniferous (f) Paleozoic
23. (i) Near Eastern and Central Asia
(ii) 1400 c.c.
(iii) More brain capacity, use of hides to cover body and burial of dead.
24. (a) Galapagos Island.
(b) Adaptive radiation—Refer page 133, NCERT book.
(c) Through sea voyage in a sail ship called H.M.S. Beagle.
25. Excess use of herbicides, pesticides etc. has resulted in selection of resistant varieties in a much lesser time scale. Same is true for antibiotic or drug resistant microbes.

LA

(5 Marks)

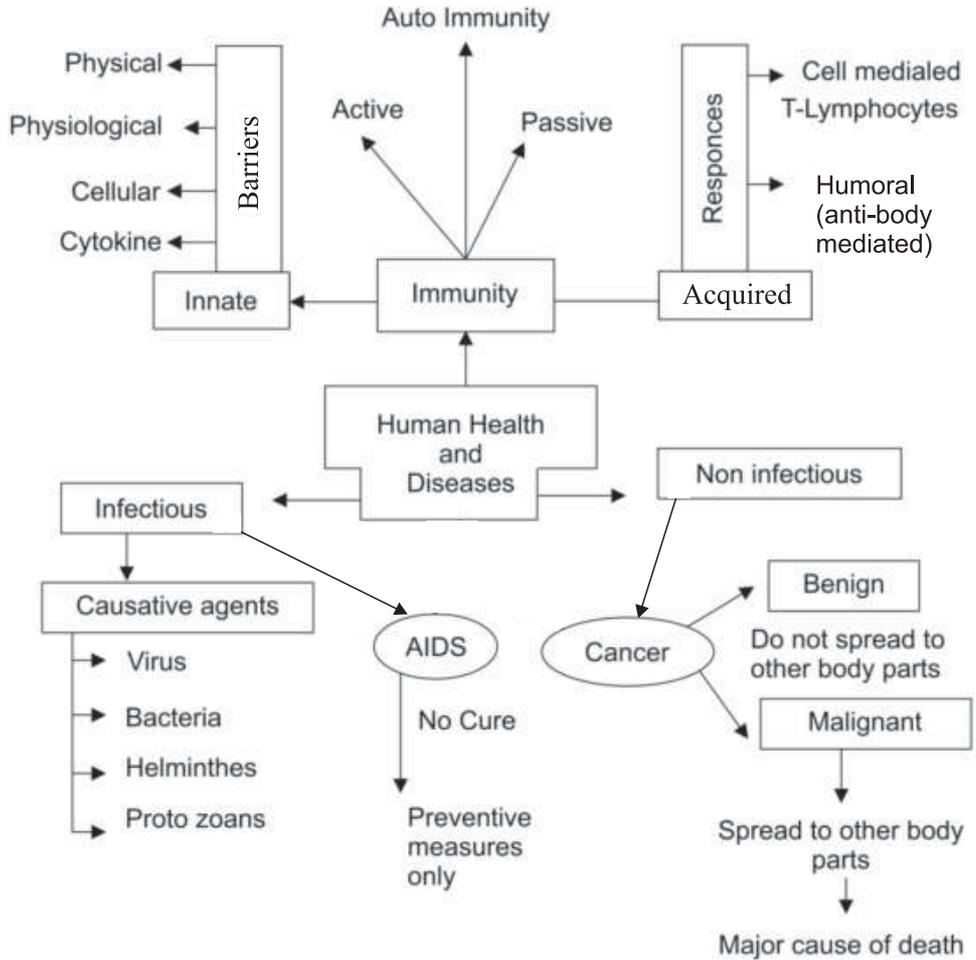
26. Refer page 135, NCERT Text book, Biology—XII.

27. They show divergent evolution.
- (a) The evolutionary process in which same structure developed along with different directions as adaptations to different needs.
- (b) They are called homologous organs. They indicate common ancestry.
- (c) (i) They are called of Analogous organs. They exhibit convergent evolution.
(ii) Tubers of potato and sweet potato from Animals.
Eyes of octopus and of mammals. Flippers of penguin and dolphin.



Chapter - 7

Human Health and Disease



Carcinogens : Cancer causing agents e.g., gamma rays, UV rays, dyes and lead.

Interferon : The glycoproteins produced by our body cells in response to a viral infection.

Incubation Period : The time period between infection and first appearance of symptoms.

Metastasis : The property in which the cancer cells spread to different sites through blood and develop secondary tumours.

Oncogenes : Viral genome which causes cancer/Cancer causing genes.

Retrovirus : A virus having RNA as genetic material and forms DNA by reverse transcription and then replicate e.g., Human Immunodeficiency Virus (HIV).

Sporozoites : The infective stage of protozoa Plasmodium which is injected into human blood through saliva of female Anopheles mosquito.

Withdrawal Syndrome : If a drug dependent person stop taking drugs then his body stop functioning normally and he feels severe physical and psychological disturbance called withdrawal syndrome.

Contact Inhibition : It is a property of normal cells in which the cells stop dividing when comes in contact with its surrounding cells.

Abbreviations

| | | |
|-------|---|------------------------------------|
| PMNL | : | Polymorpho-Nuclear Leukocytes |
| CMI | : | Cell Mediated Immunity |
| ELISA | : | Enzyme Linked Immunosorbent Assay |
| HLA | : | Human Leukocyte Antigen |
| MALT | : | Mucosal Associated Lymphoid Tissue |
| SCID | : | Severe Combined Immuno Deficiency |
| NACO | : | National AIDS Control Organisation |
| MRI | : | Magnetic Resonance Imaging |

- **Health** : The state of complete physical, mental and social well being
- Goods health can be achieved by
 - (i) Awareness about disease and their effects on different body functions.
 - (ii) Vaccination
 - (iii) Control of vectors
 - (iv) Proper disposal of wastes
 - (v) Maintenance of hygienic food and resources,
- **Infectious Diseases**
 - (i) Viral Diseases—e.g., polio, common cold, measles, rabies
 - (ii) Bacterial diseases—e.g., Typhoid, Pneumonia, Diphtheria, Tetanus.
 - (iii) Fungal diseases—e.g., Ring worm & Scabies
 - (iv) Helminthic diseases—e.g. Ascariasis, Filariasis, Taeniasis
 - (v) Protozoan diseases—e.g. Malaria, Amoebiasis.

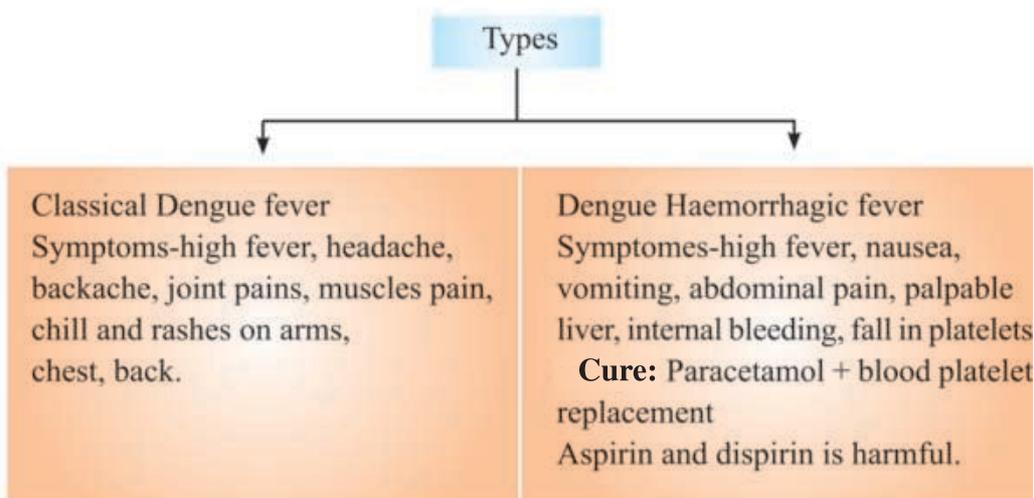
| Disease | Causative Agents | Symptoms |
|----------------|---|---|
| 1. Common cold | <i>Rhinoviruses</i> | Nasal congestion and discharge, sore throat cough, headache, tiredness and hoarseness. |
| 2. Typhoid | <i>Salmonella typhi</i> | sustained higher fever, stomach pain, loss of appetite, constipation, headache. |
| 3. Pneumonia | <i>Streptococcus pneumoniae</i> and <i>Haemophilus influenzae</i> | fever, headache, cough, chills in severe cases finger nails may turn grey to bluish in colour |

| | | |
|--------------------------------|--|---|
| 4. Malaria | <i>Plasmodium</i> viz <i>P. malaria</i> , <i>P. vivax</i> , <i>P. falciparum</i> | acute headache, muscular pain, flu-like symptoms and shivering, nausea and high temperatures. |
| 5. Amoebic dysentery | <i>Entamoeba histolytica</i> | Abdominal pain, cramps, stool with excess mucus and blood clots, constipation. |
| 6. Ringworm | <i>Microsporum</i> , <i>Epidermophyton</i> and <i>Trichophyton</i> | Dry scaly lesions on skin, nails and scalps itching |
| 7. Ascariasis | <i>Ascaris lumbricoides</i> | Anaemia, muscular pain, internal bleeding, insomnia, blockage of intestinal passage. |
| 8. Filariasis or Elephantiasis | <i>Wuchereria bancrofti</i> and <i>W. malayi</i> | Fever, blockage of lymphatic vessels, enormous swelling of affected part viz. arm, foot, leg. |

Dengue

Caused by—Viruses DEN-1, DEN-2, DEN-3, DEN-4

Vector—Female mosquito *Aedes aegypti*



Chikungunya

Caused by—*Alpha virus*

Vector—mosquitoes (*Aedes aegypti* and *A. albopictus*)

Symptoms—rashes on limbs and trunk, arthritis of multiple joints, fever (102–104°F), etc.

Drug—Chloroquine phosphate reduces impact of disease.

Treatment—Rest & increase in fluid intake.

Prevention of Dengue and Chikungunya : Protection against mosquitoes by wearing long sleeves and fullpants, window and doors should have wire gauze screens, use mosquito repellents and there should be no stagnant water nearby.

Life cycle of *Plasmodium*

(A) Asexual Phase

- When female anopheles mosquito bites human sporozoites (infective stage) are injected into blood stream.
- Parasite reaches the liver cells and multiply.
- Liver cell burst releasing parasite into the blood.
- Parasite then enters into RBCs and multiply.
- RBCs ruptured and release haemozoin that causes symptoms of malaria like chill and high fever.
- Finally gametocytes develop in RBCs and are released in blood.

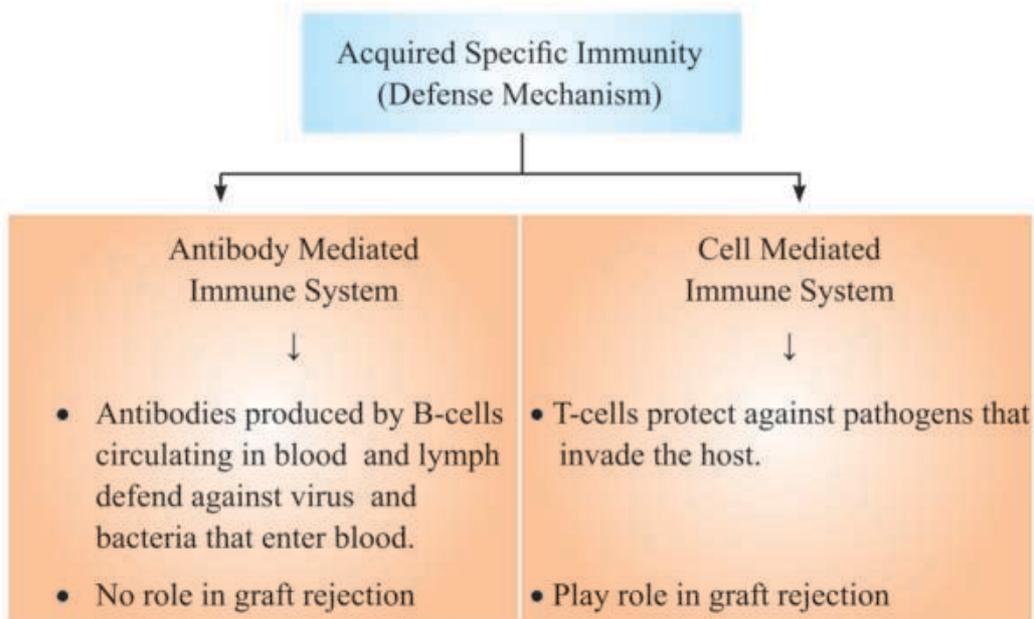
(B) Sexual Phase :

- Female *Anopheles* mosquito takes up gametocytes with blood meal from infected person.
- Fertilisation and development takes in mosquito's gut.
- Mature infective stage (sporozoites) escape from intestine.
- Sporozoites migrate to the salivary gland.

Immunity : Resistance to infections or antigens.

Two types of immunities.

- (i) **Innate immunity** : It is non-specific and present at the time of birth, It consists of four types of barriers:
- (a) Physical : e.g. skin, mucus coating of epithelium of respiratory, gastrointestinal and urinogenital tracts.
 - (b) Physiological : e.g. acid of stomach, lysozymes of saliva and tears
 - (c) Cellular e.g. PMNL, monocytes, neutrophils and macrophages
 - (d) Cytokine barriers : e.g. virus infected cells secrete proteins called interferons which protect non-infected cells from further infection
- (ii) **Acquired Immunity**. Acquired by a person after birth by vaccination or contacting the disease. It is pathogen specific



- It is based on the principle of memory and immunity
- The antigenic preparations of proteins of pathogens or a solution of inactivated or weakened pathogens are introduced in the body.
- The antigenic properties are recognised.
- Cascade of reactions forms antibodies.
- History of reactions is stored as memory.
- Subsequent exposures result in intensified response.

| Active Immunity | Passive Immunity |
|---|---|
| 1. Body prepares antibody itself due to exposure of antigen (Pathogen) Example : Typhoid vaccination 2. Immunity is not immediate 3. It has very few side effects. 4. It lasts for long period. | Preformed antibodies are injected in the body in case of deadly microbe attack. Example : Anti-snake venom, ATS. Very quick immune response. May show side effects like allergic reaction. It lasts for limited period. |

Vaccination : A preparation of weakened or attenuated pathogen is introduced in the human body. Antibodies are formed against the pathogen. B and T memory cells are generated that recognises the pathogen quickly on subsequent exposure kills it with quick and massive production of antibodies.

Allergy : Exaggerated response of immune system to certain antigens present in the environment.

Allergens : Substances to which immune system shows exaggerated response.

e.g. mites in dust, pollens, animal dander, perfume, wool, nail polish and drugs.

Symptoms of Allergy : Sneezing, watery eyes, rashes, running nose and difficulty in breathing.

Cause: release of chemicals like histamine and serotonin from mast cells

Treatment: using drugs like anti-adrenalin and steroids to reduce symptoms of allergy.

Auto Immunity : When the immune system of body starts destroying 'self' cells and molecules, called auto immune diseases e.g. Rheumatoid arthritis, multiple sclerosis and insulin-dependent diabetes.

Immune system in the body plays an important role in organ transplantation, allergic reactions and auto immune diseases.

Lymphoid Organs : Organs where lymphocytes are formed proliferate and mature are called lymphoid organs.

Bone Marrow : It is a primary lymphoid organ. Lymphocytes maturing here are called B-lymphocytes.

Thymus : Lymphocyte which matures in thymus are called T-lymphocyte.

Secondary Lymphoid Organs : Spleen, lymph nodes, tonsils, Peyer's patches of small intestine are secondary lymphoid organs.

MALT : (Mucosal associated lymphoid tissue) is a lymphoid organ present in the lining of respiratory tract, digestive tract and urinogenital tract.

AIDS-(Acquired Immuno Deficiency Syndrome)

- caused by HIV (Human Immuno deficiency Virus) which belongs to retrovirus category of viruses.

Modes of transmission

- By sexual contact with infected person
- By transfusion of contaminated blood and blood products
- By Sharing the infected needles
- From infected mother to child through placenta

Persons who are at high risk of getting infection include

- Individuals who have multiple sex partners.
- Drug addicts taking drugs intravenously, individuals who require repeated blood transfusions
- Children born to HIV infected mother.

Prevention of AIDS

- Using disposal syringes and needles, screening the blood of HIV, controlling drug abuse, free distribution of condoms and advocating safe sex.
- Main test for AIDS is ELISA (Enzyme Linked Immuno Sorbent Assay)

Cancer

- Cells loose the property of contact inhibition.
- Carcinogens induce the transformation of normal cells into cancerous cells e.g. UV rays, X-rays, gamma-rays, aniline dyes and tumour viruses, cadmium oxide, mustard gas, Ni & Cr compounds etc.
- **Two types of tumors**, (a) Benign—confined to the area of formation and do not spread to other parts, (b) Malignant—show metastasis i.e. cells of

these tumors can be carried by blood stream or lymph to other parts of body and form secondary tumors in neighbouring organs.

- **Treatment**—through surgery, radiotherapy, chemotherapy, immunotherapy, biological response modifiers such as α -interferon which activates immune system and helps in destroying tumor.
- **Detection and diagnosis**—By radiography (X-rays), CT Scan, MRI, Biopsy.

Drugs

| Criteria | Opioids | Cannabinoids | Coca alkaloids |
|-----------------------|---|--|---|
| Source | <i>Papaver somniferum</i> (Poppy Plant) | <i>Cannabis sativa</i> (Hemp Plant) | <i>Erythroxylum coca</i> (Coca plant) |
| Part of Plant | Fruits (Unripen Capsules) | Inflorescence, leaves resin | Leaves and Young twigs |
| Product | Opium, Morphine Heroin/Smack | Charas, Ganja Hashish, Marijuana | Cocaine (Coke/ Crack) |
| Mode of Intake | Snorting, Injection | Oral, Inhalation | Snorting |
| Effects (Property) | Neuro depressant, Slow down the functions of the body | Interact with cannabinoid receptors, Cardio- vascular system effects | Sense of euphoria interferes with neurotransmitters, Hallucination |
| Receptors | in CNS & GIT | in Brain | — |

Drug Abuse :

Adolescents are vulnerable for drug abuse

1. Need for adventure, experimentation
2. First use of drugs for curiosity but later uses to escape facing problems (like academic stress)

Sports person use drugs to enhance performance to fluid up muscles and for aggressiveness. e.g. dopamine.

Adverse Effects :

In males : Acne, mood swing, depression, premature baldness, reduced male hormones.

In females : Masculinisation, aggressiveness, hirsutism (excessive hair growth) disturbed ovulation, stunted growth.

Withdrawal Symptoms: Dependence or addiction is a state of compulsion to take drug in absence of which body shows withdrawal symptoms such as insomnia, craving, tremors, cramps, twitching and convulsions.

Harmful effects of Drugs and Alcohol Abuse

- Change in behaviour i.e. vandalism, violence
- Damage to liver and kidney
- Disturbed respiratory system
- Affects cardiovascular system
- Sexual dysfunctions

Preventing Alcohol/Drug Abuse

- Avoid peer pressure
- Education and counselling
- Help from parents and peers
- Seeking medical help.

Questions

VSA

(1 Mark)

1. Name the diagnostic test which confirms typhoid.
2. You have heard of many incidences of Chikungunya in our country. Name the vector of the disease.
3. Breast fed babies are more immune to diseases than the bottle fed babies. Why ?
4. Name the pathogen which causes malignant malaria.
5. Elephantiasis (Filariasis) in man is caused by
 - a) Ancylostoma
 - b) Ascaris lumbricoides
 - c) Entamoeba histolytica.
 - d) Wuchereria bancrofti
6. Humoral immunity is due to
 - a) B-Lymphocytes
 - b) T - Lymphocytes
 - c) L-Lymphocytes
 - d) P-Lymphocytes
7. A person is injected with globulins against hepatitis, it is
 - a) Naturally acquired active immunity.
 - b) Naturally acquired passive immunity.
 - c) Artificially acquired passive immunity.
 - d) Artificially acquired active immunity.

In Question from 8 to 11 a statement of Assertion is followed by a statement of Reason. Mark the correct choices as :

- a) Both Assertion and Reason are true, and Reason is the correct explanation of the Assertion.
- b) Both Assertion and Reason are true, and the Reason is not the correct of the Assertion.
- c) Assertion is true statement but Reason is false.
- d) If both Assertion & Reason are false statements.

8. **Assertion :** In Malaria, a person experience chills and high fever recurring every three to four days.

Reason : This is caused by the release of haemozoin with rupture of liver cells

9. **Assertion :** Ascaris, the common round worm causes amoebiasis.

Reason : The mode of transmission is through droplets.

10. **Assertion :** Virus infected cells secrete proteins called interferons.

Reason : Interferons are substances which protect non-infected cells from further viral infection.

11. **Assertion :** Active immunisation stimulates the immune system to produce antibodies against a particular infectious agents.

Reason : Colostrum secreted by mother during initial days of lactation has abundant antibodies to protect the infant.

SA-I

(2 Marks)

12. Where are B-cells and T-cells formed? How do they differ from each other ?

13. Lymph nodes are secondary lymphoid organs. Describe the role of lymph nodes in our immune response.

14. What is the role of histamine in inflammatory response ? Name few drugs which reduce the symptoms of allergy.

SA-II

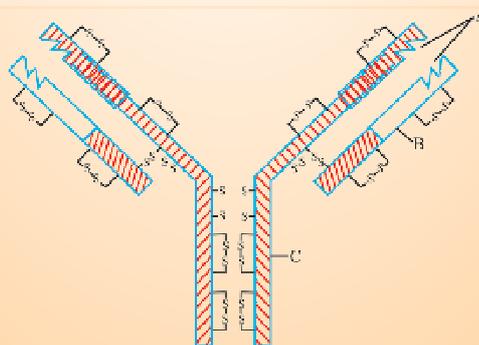
(3 Marks)

15. In the figure, structure of an antibody molecule is shown. Observe it and Give the answer of the following questions.

(i) Label the parts A, B and C.

(ii) Which cells produce these chemicals ?

(iii) State the function of these molecules.

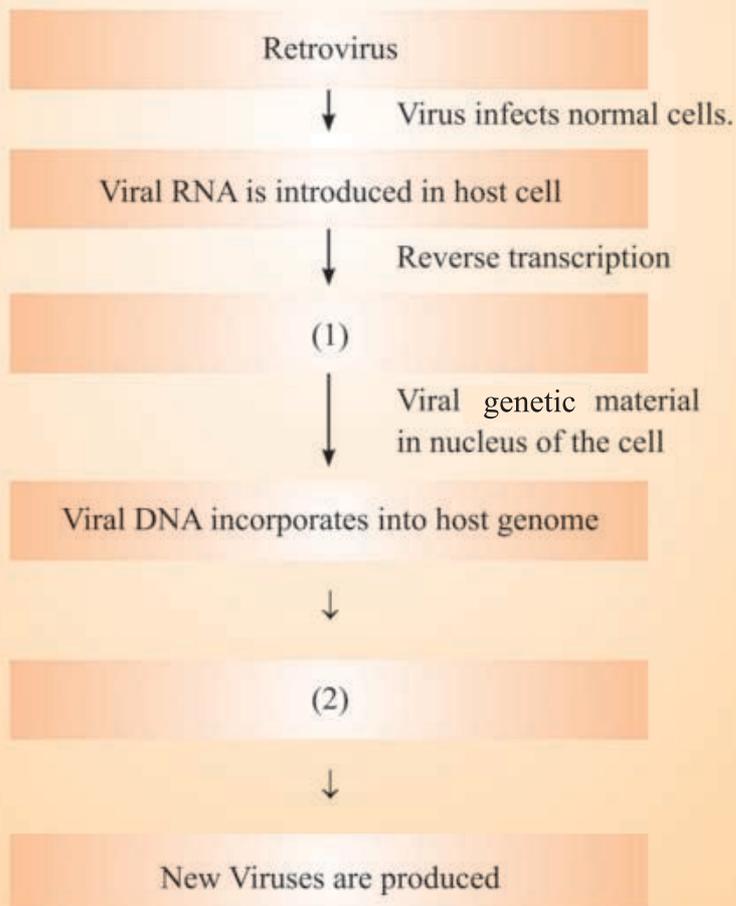


16. A person shows unwelcome immunogenic reactions while exposed to certain substances.

- (a) Name this condition.
- (b) What common term is given to the substances responsible for this condition?
- (c) Name the cells and the chemical substances released which cause such reactions.

17. In the given flow diagram, the replication of retrovirus in a host cell is shown. Examine it and answer the following questions.

- (a) Why is virus called retrovirus?
- (b) Fill in the blank (1) and (2)
- (c) Can infected cell survive while viruses are being replicated and released by host cell ?



18. Answer the following with respect to Cancer.
- How does a cancerous cell differ from a normal cell?
 - Benign tumor is less dangerous than malignant tumor. Why?
 - Describe causes of cancer.
 - Mention two methods of treatment of the disease.
19. The pathogen of a disease depends on RBCs of human for growth and reproduction. The person with this pathogen suffers with chill and high fever.
- Identify the disease.
 - Name the pathogen.
 - What is the cause of fever?
 - Represent the life cycle of the pathogen diagrammatically.
20. The immune system of a person is suppressed. He was found positive for a pathogen in the diagnostic test ELISA.
- Name the disease, the patient is suffering from.
 - Which pathogen is identified by ELISA test?
 - Which cells of the body are attacked by the pathogen?
 - Suggest preventive measures of the infection.
21. A mosquito bites a malaria infected person and is observed for a few days. It was however, found out that the mosquito had not developed the infection. What could be the reason for the same?
22. A woman suffering from arthritis visited a doctor who after diagnosis told her that her body cells are attacking self-cells. What is this phenomenon called? Which type of arthritis is the woman suffering from?
23. A person continues tobacco smoking for a long time. What would be the effect of this habit on.
- his blood
 - his heart rate
 - Oral cavity

Answers

VSA

(1 Marks)

1. Widal test
2. Aedes mosquitoes.
3. The mother's milk consists of antibodies (IgA) such antibodies are not available to bottle fed babies.
4. Plasmodium falciparum.
5. (d) 6. (a) 7. (c) 8. (c) 9. (d) 10. (a) 11. (b)
12. B-cells and T-cells are formed in bone marrow. B-cells produce antibodies but T-cells do not produce antibodies but help B-cells produce them.
13. Lymph nodes provide the sites for interaction of lymphocytes with the antigen. When the microorganisms enter the lymph nodes, lymphocytes present there are activated and cause the immune response.
14. Histamine acts as allergy-mediator which cause blood vessels to dilate. It is released by mast cells. Antihistamine steroids and adrenaline quickly reduce the symptoms of allergy.

SA-II

(3 Marks)

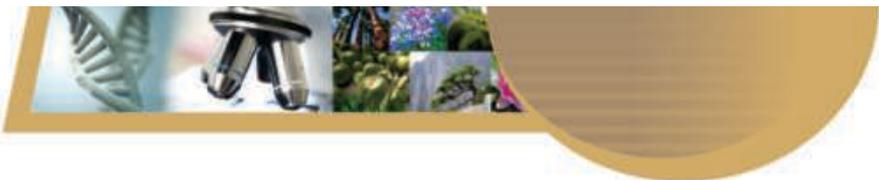
15. (a) A-Antrigen binding, B-Light chain, C-Heavy chain
(b) B-lymphocytes.
(c) Heavy Chain
(d) Antibodies provide acquired immune response.
16. (a) Allergy (b) Allergens
(c) Mast Cells—Histamine, Serotonin
17. (a) HIV has RNA genome. It produces DNA by reverse transcription.
(b) 1 : Viral DNA is produced by reverse transcriptase.
2 : New Viral RNA is produced by the infected cell.
(c) Infected cell can survive.

18. (a) In normal cells, growth and differentiation is highly controlled and regulated (contact inhibition). The cancerous cells have lost the property of contact inhibition, hence continue to divide giving rise to masses of cells (tumors).
- (b) The benign tumor remains confined in the organ affected as it is enclosed in a connective tissue sheath and does not enter the metastatic stage.
- (c) Cancer may be caused due to carcinogens which are physical (X-rays, gamma rays and UV rays), chemicals (Nicotine, Aflatoxin, Cadmium oxide, Asbestos) and biological (viral oncogens and proto oncogenes).
- (d) Surgery, radiotherapy, Chemotherapy, immunotherapy by using biological response modifiers like α -interferons.
19. (a) Malaria
- (b) Different species of *Plasmodium* viz *P. vivax*, *P. Malariae* and *P. falciparum*.
- (c) Malaria is caused by the toxins (haemozoin) produced in the human body by the malarial parasite. This toxin is released by the rupturing of RBCs.
- (d) Life cycle of Plasmodium : Fig. 8.1 Page 148, NCERT book, Biology- XII
20. (i) AIDS (Acquired Immuno Deficiency Syndrome)
- (ii) HIV (Human Immunodeficiency Virus)
- (iii) Helper T-cells, macrophages, B-lymphocytes.
- (iv) Preventive measures :
- (a) People should be educated about AIDS transmission.
- (b) Disposable needles and syringes should be used
- (c) Sexual habits should be changed immediately
- (d) High-risk groups should be discouraged from donating blood.
- (e) Routine screening may be done.



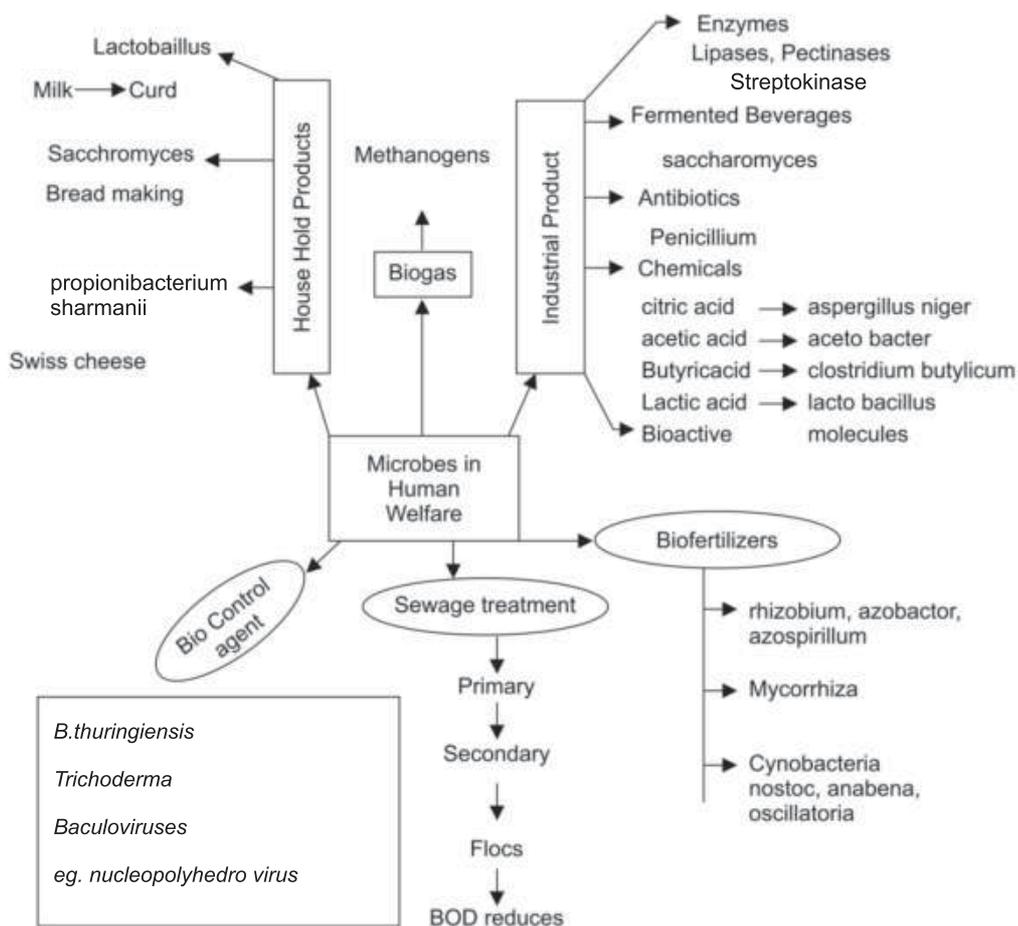
21. Both the gametes types (male and female) were not taken in by the mosquito.
Hence, no fertilisation and no further development of the parasite.
22. Auto immunity, Rheumatoid Arthritis.
23. (a) Increased levels of carbon monoxide in blood.
(b) Increased heart rate.
(c) Increased risk of cancer of oral cavity.





Chapter - 8

Microbes in Human Welfare



Biofertilisers : Microorganisms which produce fertilisers and enrich the soil e.g., bacteria, cyanobacteria and fungi.

Bioactive Molecules : Molecules produced for commercial use from microbes and used for various purposes e. g., *Trichoderma polysporum* (fungus) is used to obtain immunosuppressive agent cyclosporin–A.

Biochemical Oxygen Demand (BOD) : Total amount of oxygen consumed by bacteria for oxidation of organic matter present in one litre of water.

Baculovirus : Pathogens that attack insects and other arthropods. They are used to kill harmful pests and arthropods e.g., *Nucleopolyhedrovirus*.

Flocs : During secondary treatment of effluent, excessive growth of aerobic bacteria and fungi form a mass of mesh like structure called flocs.

Immunosuppressive Agent : Chemicals which suppress the immunity against organ transplant.

Organic Farming : Technique of farming, in which biofertilisers are used to enrich the soil, without using chemical fertilisers and pesticides to reduce their harmful effect on human health.

Biological Control : Reduction of pest population by natural enemies minimising the use of harmful chemical pesticide. e.g. ladybird beetle can eradicate aphids.

Thermal vents : The sites deep inside the geysers/hot springs and oceans where the average temperature is as high as 100°C.

Methanogens : Bacteria producing large quantity of methane during decomposition of organic matter.

| | | |
|-------------|---|---|
| GAP | : | Ganga Action Plan |
| KVIC | : | Khadi and Village Industries Commission |
| TMV | : | Tobacco Mosaic Virus |
| YAP | : | Yamuna Action Plan |
| IPM | : | Integrated Pest Management. |

- Microbes includes protozoa, bacteria, fungi, microscopic plants, viruses, viroids and prions (the infectious protein)

Microbes in Household Products

Milk $\xrightarrow[\text{LAB}]{\text{Lactobacillus}}$ Curd

Dough $\xrightarrow[\text{Fermentation}]{\text{Yeast}}$ Swollen, Little fermented dough

Palm sap $\xrightarrow[\text{Yeast}]{\text{Microbes}}$ Toddy (fermented drink)

Microbes in production of Biogas

- Some bacteria which grow anaerobically on cellulosic material produce large amount of Methane (CH_4), along with Carbondioxide and hydrogen. These bacteria are called methanogens.
- Methanogen are naturally found in rumen of cattle, Cowdung and sewage.

Microbes as Biocontrol Agents

| Microorganisms | Category | Action |
|---|----------|--|
| (i) <i>Trichoderma</i> Species | fungus | Kills pathogen in the root system |
| (ii) <i>Bacillus thuringiensis</i> | bacteria | Kills the insect pest (cotton bollworms) |
| (iii) <i>Nucleopolyhedrovirus</i> (Baculoviruses) | Virus | Kills insects and other arthropods. |

Microbes as biofertilisers.

Rhizobium : Have symbiotic association with roots of leguminous plants, help in atmospheric nitrogen fixation.

Azospirillum and Azotobacter : Free living in soil and help in nitrogen fixation enrich nitrogen content of soil.

Mycorrhiza : Symbiotic; association of fungi with roots of higher plants. Fungi help in absorption of phosphorous from soil. It belongs to genus *Glomus* It provides resistance to root borne pathogens, tolerance to salinity and drought.

Cyanobacteria : Found in aquatic or terrestrial environment, help in nitrogen fixation, add organic matter to the soil, increase fertility of soil, e.g., *Nostoc*, *Anabaena*, *Oscillatoria*.

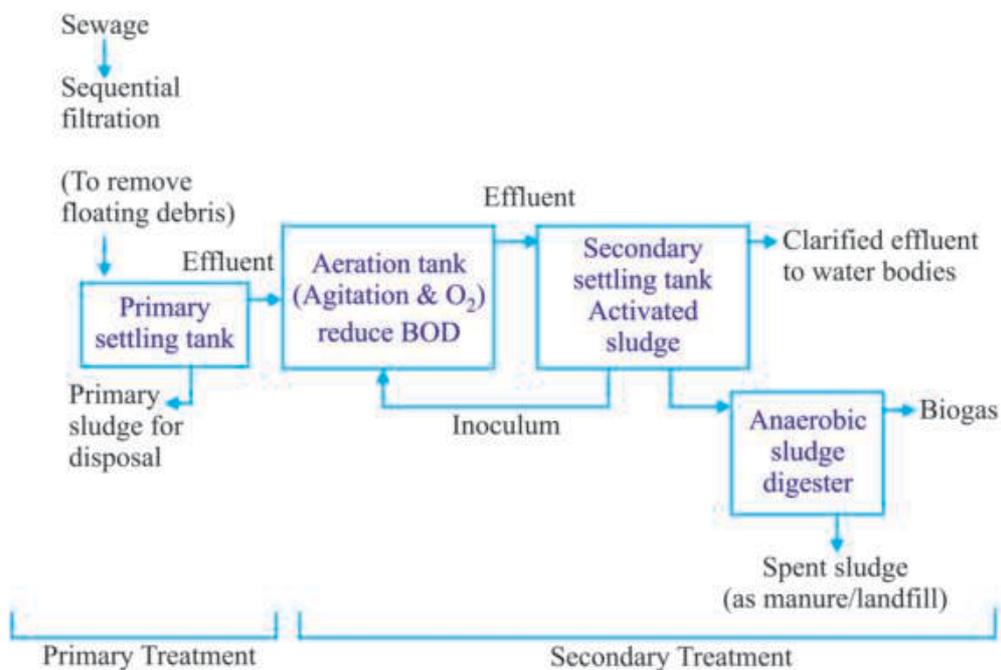
In paddy fields, these acts as biofertilisers.

Microbes in Industries

- (a) Fermented Beverages : Liquid food made by anaerobic digestion of carbohydrate rich food is called beverage. *Saccharomyces cerevisiae* (yeast) is also used to make bread, fermented fruit juice and alcohol.
- (b) Antibioitics : *Penicillium notatum*
- (c) Other chemicals/enzymes/Bioactive molecules Many organic acids, enzymes are also produced by microorganisms.

| S. No. | Microbe | Category | Product | Role (Used as) |
|--------|---------------------------------|-----------------|--------------------------|---|
| 1. | <i>Aspergillus niger</i> | Fungus (Yeast) | Citric Acid | Used in beverages |
| 2. | <i>Acetobacter</i> | Aceto bacterium | Acetic acid (Vinegar) | Preservative |
| 3. | <i>Saccharomyces cerevisiae</i> | Fungus | Ethanol | Disinfectant, fuel |
| 4. | <i>Lactobacillus</i> | Bacteria | Lactic acid | In making Curd |
| 5. | <i>Streptococcus</i> | Bacteria | Streptokinase | Clot buster |
| 6. | <i>Clostridium butylicum</i> | Bacteria | Butyric acid | Prolective agent against in flammatory bowel diseases |
| 7. | <i>Monascus purpureus</i> | Fungus (Yeast) | Statin | Blood cholestrol lowering agent |
| 8. | <i>Trichoderma polysporum</i> | Fungus | Cyclosporin A | immunosupressive agent |

Sewage treatment :



Antibiotics : Secondary metabolites produced by microbes and used to kill pathogenic microbes.

Penicillin, First antibiotic discovered by Alexander Flemming from fungus *Penicillium notatum*.

Mode of action of antibiotics

- (1) **Bacteriocidal :** To kill bacteria by stopping cell wall formation
- (2) **Bacterio-static :** To stop growth or multiplication of bacteria by stopping DNA replication or other cellular metabolism.

Production of Antibiotics : Mass production of antibiotics is done in fermentor tanks from lichens, fungi, actinomycetes, eubacteria etc. Maximum antibiotics are produced from bacillus (eubacteria)

Precautions in taking antibiotics :

- Keep intake continuous as prescribed by doctor till course gets completed.
- Avoid over use otherwise our body become resistant to antibiotics.

QUESTIONS

VSA

(1 Mark)

1. Why is secondary treatment of water in sewage treatment plant called biological treatment ?
2. An antibiotic called 'Wonder Drug' was used to treat the wounded soldiers of America during World War-II. Name the drug and the scientist who discovered it.
3. You have observed that fruit juice in bottles bought from the market are clearer as compared to those made at home. Give reason.
4. Name the plant whose sap is used in making 'Toddy'. Mention the process involved in it.

MULTIPLE CHOICE TYPE QUESTIONS

5. Spirulina is :
 - a) Bio fertilizer
 - b) Bio pesticide
 - c) Edible fungus
 - d) Single cell protein
6. Baker's yeast is
 - a) *S. Cerevisae*
 - b) *Ludwingi*
 - c) *S. octosporus*
 - d) *Schizo Saccharomyes*
7. Which one is wrongly matched?
 - a) *Streptomyces* - Antibiotics
 - b) *Coli forms* - Vinegar
 - c) *Methanogens* - Gobar gas
 - d) Yeast - ethanol

8. Bt. cotton is resistant to

- a) Insects
- b) Herbicides
- c) Salt
- d) Drought

9. Which is wrongly matched

- a) Alcohol - Nitrogen
- b) Detergents - Lipase
- c) Textiles - Amylase
- d) Fruit juice - Pectinase

10. Assertion : Curdling is required in the manufacture of cheese.

Reason : Lactic acid bacteria are used for the purpose.

- a) If both assertion and reason are true and reason is the correct explanation of assertion.
- b) If both assertion and reason are true but reason is not true correct explanation of assertion.
- c) If assertion is true but reason is false.
- d) If both assertion and reason are false.

11. Assertion : Yeasts such as *Saccharomyces cerevisiae* are used in baking industry.

Reason : Carbon dioxide produced during fermentation causes bread dough to rise by thermal expansion.

- a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
- b) If both assertion and reason are true but the reason is not the correct explanation of the explanation of the assertion.
- c) If assertion is true statements but reason is false.
- d) If both assertion and reason are false.

12. More than 25% of human population is suffering from hunger and malnutrition. Scientists have developed techniques where microbes are grown on industrial scale as a source of good protein which can be grown from waste water, animal and even sewage.

Answer the following questions:

i) Example of SCP is

- a) Azolla b) Anabaena c) Oscillatoria d) Spirulina

ii) SCP is

- a) Single cell protein
b) Single cytoplasmic protein
c) Soluble cell protein
d) Soluble cell protein

iii) The malnutrition due to protein and carbohydrate is

- a) Vitamin deficiency
b) Mineral deficiency
c) PEM
d) Carbohydrate disorders

iv) Hunger signs are due to

- a) Mineral deficiency
b) Protein deficiency
c) Vitamin deficiency
d) All of the above

SA-I**(2 Marks)**

13. Name two alcoholic drinks produced in each of the following ways.
- by distillation and
 - without distillation.
14. Lactic Acid Bacteria (LAB) is commonly used in the conversion of milk into curd. Mention any two other functions of LAB that are useful to humans.
15. Which Ministry of Govt, of India had initiated Ganga Action Plan and Yamuna Action Plan ? What are the objectives of these plans?

SA-II**(3 Marks)**

16. Fill in the blanks spaces a, b, c, d, e, and f, given in the following table :

| S. No. | Name of Organism | Commercial Product | Application |
|--------|---------------------------------|--------------------|--------------------------|
| 1. | <i>Penicillium notatum</i> | <i>Penicillium</i> | (a) |
| 2. | (b) | Lactic acid | Making Curd. |
| 3. | <i>Streptococcus</i> | Clot buster enzyme | (c) |
| 4. | <i>Trichoderma polysporum</i> | (d) | Immuno suppressive agent |
| 5. | <i>Saccharomyces cerevisiae</i> | ethanol | (e) |
| 6. | (f) | Swiss cheese | Food Product |

17. What is biochemical oxygen demand (BOD) test ? At what stage of Sewage treatment this test is performed?

BOD level of three samples of water labelled as A, B and C are 30 mg/L, 10mg/L and 500 mg/L respectively. Which sample of water is most polluted ?

18. Given below is the Flow chart of Sewage treatment. Fill in the blank spaces marked 'a' to 'f'.

Sewage treatment is done in step, subjected to filtration and sedimentation, called.....(a).....



Supernatant is shifted to separate tanks and air is pumped mechanically, called.....(b).....



Microbes grow into masses, called.....(c).....



There is reduction in.....(d).....



Bacterial flocs are allowed to settle, the sedimentation is called(e).....



After Secondary treatment, the water is released into(f).....

19. A girl visits a cotton field and observes that a liquid is being sprayed on the plants. On being enquired she comes to know that it is to protect the crop from the insects. As a biology students can you explain the process to her that how would this liquid help in getting rid of the insects.
20. Plants have symbiotic associations with fungi show many benefits. Mention 5 such advantages.
21. What are biofertilisers? How are they useful instead of chemical fertilises?

Answers

VSA

(1 Mark)

1. In this treatment Organic wastes of sewage water are decomposed by certain microorganisms in presence of water.
2. Penicillin, Alexander Fleming.
3. Bottle juices are clarified by the use of pectinase and proteases.
4. Palm tree, by fermentation.

Solution Lesson : 10

MCQ

5. d) 6. a) 7. b) 8. a) 9. a) 10. b) 11. d)

Solution

Ans. 12 i) d) ii) a) iii) c) iv) d)

SA-I

(2 Marks)

13. (i) Whisky, brandy, rum—by distillation

(ii) Wine, beer - without distillation

14. (i) LAB in human intestine synthesizes Vitamin B₁₂.

(ii) LAB in human stomach checks the growth of harmful microbes.

15. The Ministry of Environment and Forests.

The objective of Ganga Action Plan and Yamuna Action Plan is to save these rivers from pollution. It was proposed to build a large number of sewage treatment plants. So that only treated sewage may be discharged into these rivers.

SA-II

(3 Marks)

16. (a) to kill disease causing bacteria

(b) *Lactobacillus*

(c) remove clots from blood vessels

(d) Cyclosporin A

(e) Beverage/medicines

(d) *Propionibacterium sharmanii*.

17. The BOD test measures the rate of uptake of oxygen by microorganisms in a sample of water.

Biological treatment or Secondary treatment

Sample 'c' is most polluted because it has highest BOD level among the three samples of water.

18. (a) Primary treatment

(b) Aeration

(c) Floccs

(d) Biochemical oxygen Demand (BOD)

(e) Activated sludge

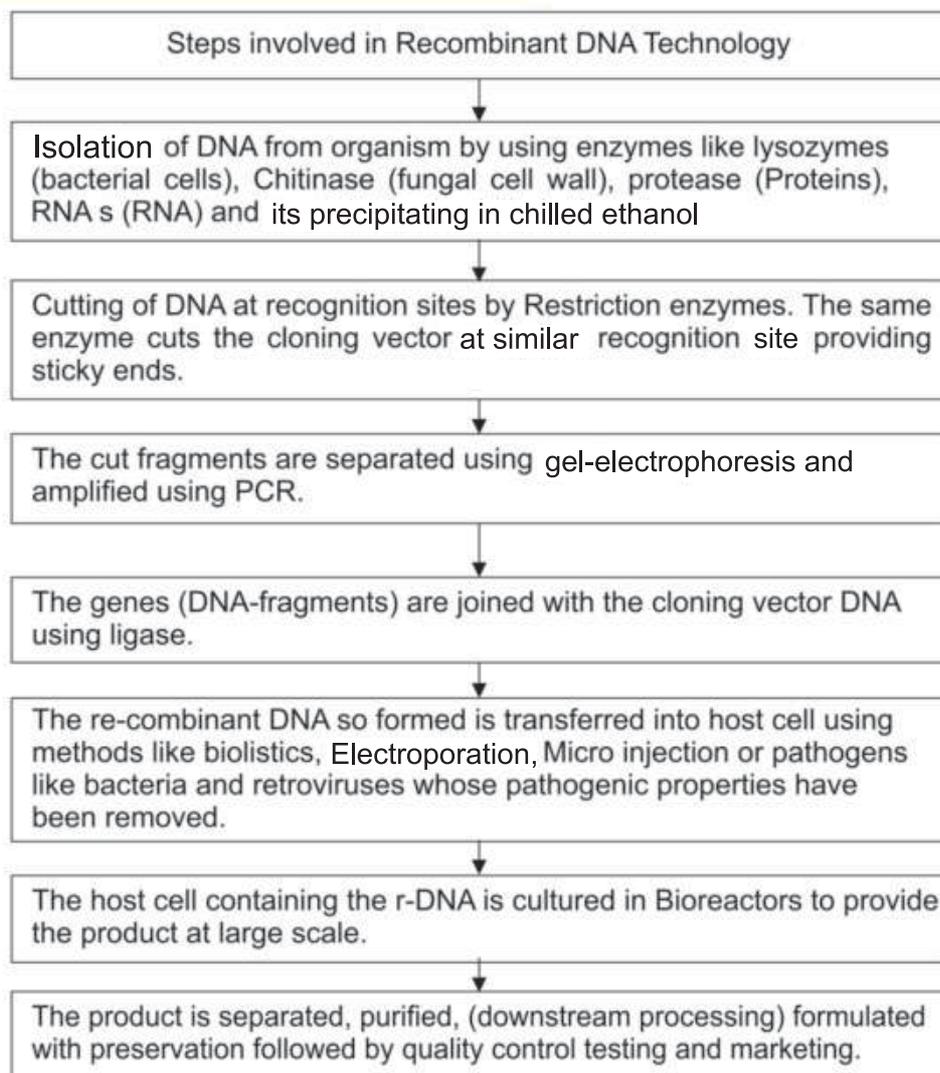
(f) Water bodies like river.

19. Liquid containing spores of *Bacillus thuringiensis*; eaten by insect larvae; toxin released inside gut; larvae killed.
20.
 - (i) Increased absorption of phosphorus
 - (ii) Resistance to root-borne pathogens;
 - (iii) tolerance to salinity and drought;
 - (iv) Overall increase in plant growth;
 - (v) Overall increase in plant development
21. Biofertilisers are organisms that enrich the nutrient quality of the soil.
Advantage no negative impact on soil. Doesn't cause water pollution



Chapter - 9

Biotechnology: Principles and Processes



GEL ELECTROPHORESIS

Negatively charged DNA fragments are - Separated by forcing them to move through Agarose gel get aligned towards anode under an electric field.

The smaller fragments move faster through the gel towards anode

The larger fragments remain near the walls at the cathode end (where poured initially) as they sieve slowly)

The separated fragments are stained with ethidium bromide and visualized under UV light

The DNA fragments are cut out from agarose gel by the process known as elution.

These DNA fragments are used in recombinant DNA by joining them with cloning vectors

Polymerase Chain Reaction (PCR)

Denaturation-Separation of DNA into single strand) by applying high temperature upto 95°C

Annealing-Two sets of primers (Short stretches of RNA) attach to the single stranded DNA at complementary sites.

Extension-The primers extend by addition of nucleotides in the presence of thermostable DNA polymerase complementary to the DNA strand. The primers are removed.

Repetition- This cycle get repeated so time and the DNA fragments get amplified about one billion times.

Biotechnology : The application of living organisms or of substances made by living organisms to make products for welfare of mankind.

The definition of Biotechnology given by the European Federation of Biotechnology (EFB) : ‘The integration of natural science and organisms, cells, parts there of, and molecular analogues for products and services.’

Molecular scissors- Restriction endonuclease

Molecular glues- DNA ligases

Natural genetic engineer- *Agrobacterium tumefaciens*

Three basic steps involved in creating genetically modified organism (GMO) or transgenic organisms-

(i) Identification of DNA with described genes

(ii) Introduction of the identified DNA into the host

(iii) Maintenance of Introduced DNA into the host and transfer of DNA to its progeny

Principles of Biotechnology :

1. Genetic Engineering : The techniques used to alter the chemistry of genetic material (DNA/RNA) and introduction of it into organisms to change its phenotype.

2. Chemical Engineering : Use of contamination free chemical engineering process of growth of desired microbe or cell in large quantity to obtain bio-technological product like enzyme, antibiotic, vaccine etc.

First Artificial recombinant DNA Molecule :

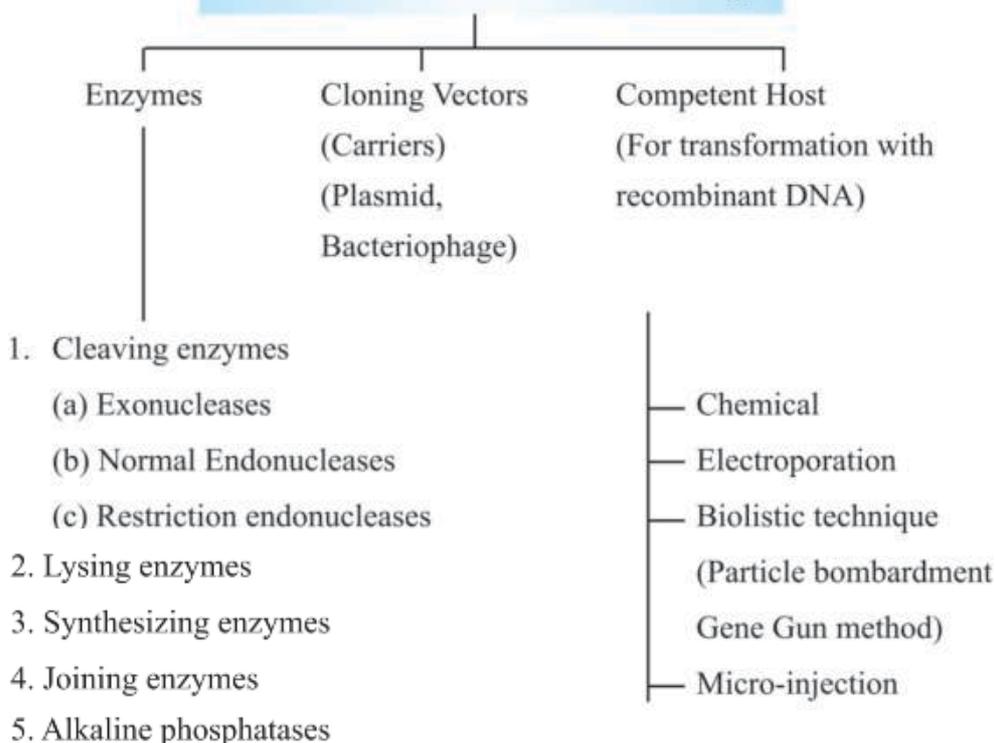
(i) The two scientists of USA, Stanley Cohen and Herbert Boyer (1972) isolated the antibiotic resistance gene by cutting the desired piece of DNA from the plasmid of the bacterium *Salmonella typhimurium* with the help of restriction enzymes (molecular scissors).

2. This piece of DNA was then linked with the plasmid DNA acting as vector by DNA ligase enzyme.

3. The newly formed recombinant DNA was transferred to bacterium *Escherichia coli* for replication by using the enzyme DNA polymerase. This process is called Cloning.

Recombinant DNA (rDNA) : The hybrid DNA formed by combining DNA segment of two different organisms.

Tools of Recombinant DNA Technology



(1) Cleaving Enzymes : These enzymes are used to break DNA molecules.

(a) Exonucleases : Cut off nucleotides from terminal ends of DNA

(b) Endonucleases : Make cut DNA at any point within a DNA.

(c) Restriction Endonucleases : Make cut only specific position within a DNA. Single stranded free ends of DNA which can form hydrogen bonds with their complementary cut DNA segments are called 'Sticky Ends'. These ends can be joined by enzyme ligase.

(2) Lysing Enzymes : These enzymes are used to open the cells to get DNA. For example : Lysozyme is used to dissolve the bacterial cell wall.

(3) Synthesizing :

(a) Reverse Transcriptases : Used in the synthesis of Complementary DNA strands on RNA templates.

(b) DNA Polymerases : Used in the synthesis of Complementary DNA strands on DNA templates.

(4) Joining Enzymes : Are used to join the cut ends of double stranded DNA (act as molecular glue). They join DNA fragments by forming phosphodiester bonds e.g., Ligase.

(5) Alkaline Phosphatases : These enzymes cut the phosphate group from the 5' end of linearised circular DNA to check its recircularization.

Some Restriction Enzymes

| S. No. | Restriction Enzymes | Source | Recognition Site |
|--------|---------------------|-----------------------------------|---|
| 1. | Alu I | <i>Arthrobacter luteus</i> | $\begin{array}{c} \downarrow \\ 5'-A-G-C-T-3' \\ 3'-T-C-G-A-5' \\ \uparrow \end{array}$ |
| 2. | EcoR I | <i>Escherichia coli</i> RY 13 | $\begin{array}{c} \downarrow \\ 5'-G-A-A-T-T-C-3' \\ 3'-C-T-T-A-A-G-5' \\ \uparrow \end{array}$ |
| 3. | Bam H I | <i>Bacillus amyloliquefaciens</i> | $\begin{array}{c} \downarrow \\ 5'-G-G-A-T-C-C-3' \\ 3'-C-C-T-A-G-G-5' \\ \uparrow \end{array}$ |
| 4. | Sal I | <i>Streptomyces albus</i> | $\begin{array}{c} \downarrow \\ 5'-G-T-C-G-A-C-3' \\ 3'-C-A-G-C-T-G-5' \\ \uparrow \end{array}$ |
| 5. | Hind II | <i>Haemophilus influenzae</i> RD | $\begin{array}{c} \downarrow \\ 5'-G-T-C-G-A-C-3' \\ 3'-C-A-G-C-T-G-5' \\ \uparrow \end{array}$ |

Palindromic Sequence : Complementary DNA sequences that are the same when each strand is read in the same direction (5' → 3'). These sequence act as recognition sites for restriction endonuclease.

5'—GAATTC—3'

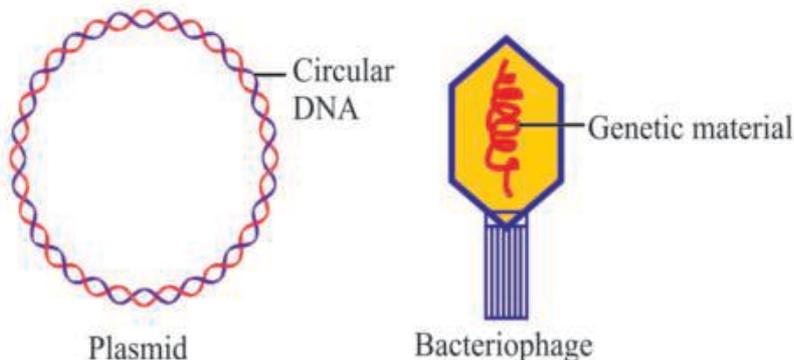
3'—CTTAAG—5'

Complementary DNA (cDNA) : A DNA strand formed from mRNA by using the enzyme reverse transcriptase.

Cloning Vectors : A small, self-replicating DNA molecule into which foreign DNA is inserted. It replicates inside the host cell. The vectors that may be used in genetic engineering are plasmids, bacteriophages, animal, plant, virus, YACs and BACs and some yeasts.

Plasmid : Extra chromosomal, self replicating circular DNA molecule found in certain bacteria and in some yeasts. It has a few genes. Plasmids are used as cloning vectors in genetic engineering. Plasmids were discovered by William Haes and Joshua Leduberg in 1952. The most widely used vector in cloning is pBR322. (an artificial plasmid)

Bacteriophage : A virus which infects bacteria is called bacteriophage.



Ti Plasmid : It is an extrachromosomal, double stranded and self replicating DNA molecule found in *Agrobacterium tumifaciens*. It causes tumor in plants. But now Ti Plasmid has been modified into a cloning vector by which desired genes can be delivered into many plants.

Features of cloning vector : Origin of replication (Ori), selectable marker and cloning sites are the features that are required to facilitate cloning into a vector.

(a) **Origin of Replication (Ori) :** This is a sequence from where replication starts and any piece of DNA when linked to this sequence can be made to

replicate within the host cells. This sequence is also responsible for controlling the copy number of the linked DNA.

- (b) **Selectable Marker** : It is a gene which helps in identifying and eliminating non-transformants from transformants (having recombinant DNA) by selectively permitting the growth of transformants. The process through which a piece of DNA is introduced in a host bacterium is called transformation. The genes encoding resistance to antibiotics are considered useful selectable marker for *E. coli*.
- (c) **Cloning Sites** : A location on a cloning vector into where a foreign gene can be introduced is called recognition site. The vector must have very few (preferably single) recognition sites. The presence of more than one recognition sites within the vector will produce several fragments which will make the process of gene cloning more complicated. Therefore, the foreign DNA is ligated at a restriction site present in one of the two antibiotic resistance gene.
- (d) **Small Size of Vector** : This facilitates the introduction of DNA into the host easily.

Insertional Inactivation : This method is used to differentiate recombinants from non-recombinants on the basis of ability to produce colour in the presence of a chromogenic substrate. When a rDNA is inserted in the coding sequence of an enzyme. It results in inactivation of the enzyme. This is called insertional inactivation.

Case I : The absence of insert in the plasmid of bacteria :

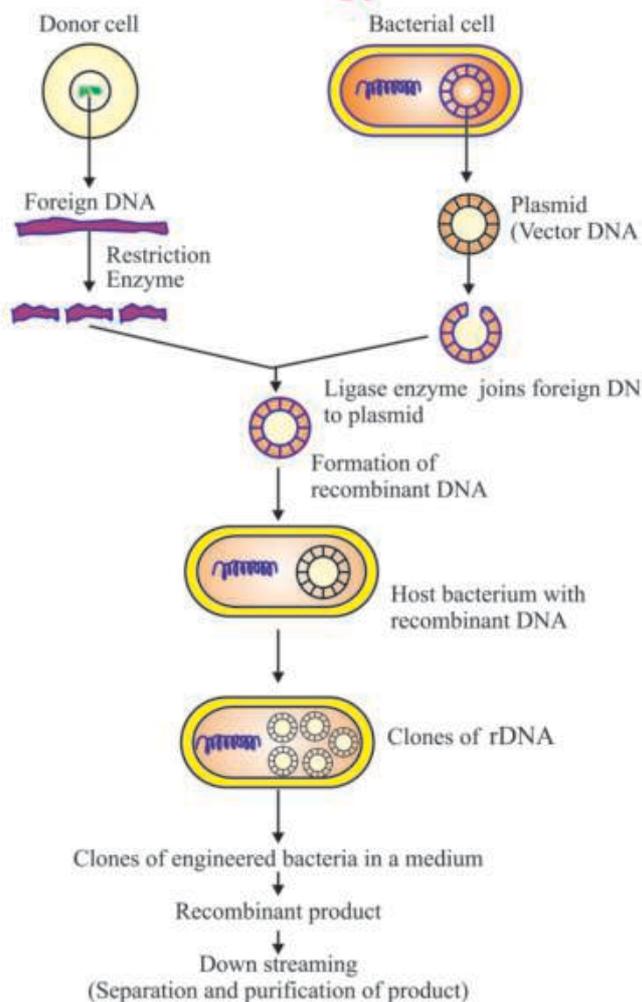
The presence of chromogenic substrate gives blue coloured colonies of bacteria, hence these bacterial colonies are non-recombinant.

Case II : The presence of insert in the plasmid of bacteria :

It results insertional inactivation of the β -galactosidase, therefore bacterial colonies do not give any colour. Hence the bacterial colonies are recombinant.

Steps in Formation of rDNA by action of EcoRI : EcoRI cuts the DNA between bases G and A only \rightarrow sticky ends of cut DNAs are formed \rightarrow DNA fragments join at sticky ends by DNA ligase \rightarrow Recombinant DNA is formed.

Recombinant DNA Technology :



Process of Recombinant DNA Technology : Isolation of DNA → Cutting of DNA using restriction endonuclease → Amplification of Gene using PCR → Making rDNA and insertion of it into host cell/organism → obtaining the foreign gene product → Downstream processing.

(i) Isolation of Genetic Material (DNA) :

- DNA can be obtained from the cell by treating with enzymes like, Lysozyme for bacteria, Cellulase for plant cell, Chitinase for fungus.
- Histone protein and RNA can be removed by treating with proteases and ribonuclease respectively.
- Purified DNA precipitated by the addition of chilled ethanol, fine threads of DNA are obtained in the suspension.

GEL Electrophoresis :

- (1) DNA fragments are separated by forcing them to move towards anode under an electric field through a medium. Agarose gel is used as medium.
- (2) Ethidium bromide is used as stain for DNA.
- (3) Then on exposure to UV-light appear as orange coloured bands.
- (4) Separated bands of DNA are cut out from agarose gel, this is called elution.
- (5) These DNA fragments are used in recombinant DNA by joining them with cloning vectors.

(ii) Cutting of DNA at specific location : The purified DNA is cut by use of restriction enzymes. Agarose gel electrophoresis is used to check the progression of restriction enzymes digestion.

(iii) Amplification of gene of interest using PCR : Amplification is the process of making multiple copies of desired DNA segment *invitro*. Polymerase chain reaction involves three steps :

(a) **Denaturation :** The target DNA is heated to high temperature (94°C), resulting the separation of two strands of DNA. Each strand acts as template.

(b) **Annealing :** Two oligonucleotide primers anneal to each of the single stranded DNA template.

(c) **Extension of Primers :** DNA polymerase (*Taq* polymerase) extends the primers using the nucleotides provided in the reactions.

Taq polymerase is a heat stable (Thermostable) DNA polymerase which is isolated from thermophilic bacterium named *Thermus aquaticus*.

(iv) Ligation : The cut out gene of interest from the source of DNA and cut vector with appropriate space, are mixed and ligase enzyme is added. This results recombinant DNA (r-DNA).

(v) Transfer of recombinant DNA into the host : the ligated DNA is introduced into the recipient cell makes itself competent to receive and take up DNA present in the surrounding.

(vi) Obtaining the foreign gene product : The cell containing the foreign gene is cultured on suitable medium and the product can be extracted from the medium.

Bioreactors are used for processing large volume of culture for obtaining products of interest in sufficient quantities. Bioreactor is a large vessel in which raw material is biologically converted into specific product under optimal condition.

(vii) Downstream Processing : The products so obtained undergo a series of processes before putting them in market as a final product. This process includes separation and purification. The products are formulated with suitable preservation and subjected to quality control testing and clinical trials, (in case of drugs).

Questions

VSA

(1Mark)

1. Write conventional nomenclature of EcoRI.
2. An extra chromosomal segment of circular DNA is used to carry gene of interest into the host cell. What is the name given to it ?
3. Mention the uses of cloning vectors in biotechnology.
4. Identify the recognition sites in the given sequences at which *E.coli* will cut and make sticky ends.

5'GAATTC-3'

3'CTTAAG-5'

MULTIPLE CHOICE TYPE QUESTIONS

5. Restriction endonuclease cut
 - a) Single stranded DNA
 - b) Single stranded RNA
 - c) Double stranded DNA
 - d) Double stranded RNA.
6. Ti phasmid is obtained from
 - a) Azotobacter
 - b) Agrobacterium
 - c) Yeast
 - d) Rhizobium

7. PCR is required for

- a) DNA synthesis
- b) DNA amplification
- c) Protein synthesis
- d) Amino acid synthesis

8. Restriction endo nucleases

- a) Break DNA at specific sites
- b) Create sticky ends
- c) Produce cross - overs
- d) Both 'A' and 'B'

9. (I) GAATTC is recognition site for restriction endonuclease.

- a) HIND III) b) ECORI c) Bam I d) Hae III

(ii)Assertion- DNA ligase plays important role in rDNA technology

Reason: Linking of antibiotic resistant gene with plasmid vector became possible by DNA ligase.

- a) If both Assertion and Reason are true and Reason is the correct explanation of assertion.
- b) If both assertion and reason are true but reason if not the correct explanation of Assertion.
- c) If assertion is true but reason is false.
- d) If both assertion and reason are false.

10.Assertion : DNA fragments move to words anode in get electrophoresis.

Reason : DNA fragments are negatively charged

- a) If both assertion and reason are true and reason is are correct explanation of assertion.
- b) If both assertion and reason are true but reason is not the correct explanation of assertion.
- c) If assertion is true but reason is false.
- d) If both assertion and reason are false.

12. Mr. Sunderam wants to start his business of making drugs at low cost developed by team researcher now, he needs to buy an instrument for his factory. He went to a company to purchase it. The salesman explain features of various types of reactors and Mr. Sunderam purchased the best.

Q.12

i) The optimum conditions in a bio reactor are :

- a) Ph, temp, nutrient supply
- b) Moisture, Humidity
- c) Soil, moisture, Humidity
- d) Heat, Cold, Moisture

ii) Downstream processing refers to

- a) Making of rDNA
- b) Recovery and purification of biosynthetic products
- c) Preparation of hybrid DNA
- d) Testing of DNA

iii) DNA can be separated in

- a) PVC
- b) Agar - agar
- c) Agarose gel
- d) Hydro gel

iv) The type of bio reactors is

- a) Sparged and ring type
- b) Sparged and stirred type
- c) only sparged type
- d) only stirred type

13. Name two main steps which are collectively referred to as down streaming process. Why is this process significant ?
14. How does plasmid differ from chromosomal DNA ?
15. (A) bacterial cell is shown in the figure given below. Label the part (A) and (B). Also mention the use of part 'A' in rDNA technology.



16. In the given process of separation and isolation of DNA fragments, some of the steps are missing, Complete the missing steps :

A : Restriction digestion of DNA fragments



B :



C : Staining with ethidium bromide



D : Visualisation in U.V. light



E :



F : Purification of DNA fragments.

SA-II**(3 Marks)**

17. Since DNA is a hydrophilic molecule, it cannot pass through cell membranes. Name and explain the technique with which the DNA is forced into (i) a bacterial cell (ii) a plant cell (iii) an animal cell.
18. In recombinant DNA technology, vectors are used to transfer a gene of interest in the host cells. Mention any three features of vectors that are most suitable for this purpose.
19. Why is “*Agrobacterium*-mediated genetic engineering transformation” in plants considered as natural genetic engineering ?
20. Observe the given sequence of nitrogenous bases on a DNA fragment and answer the following questions.

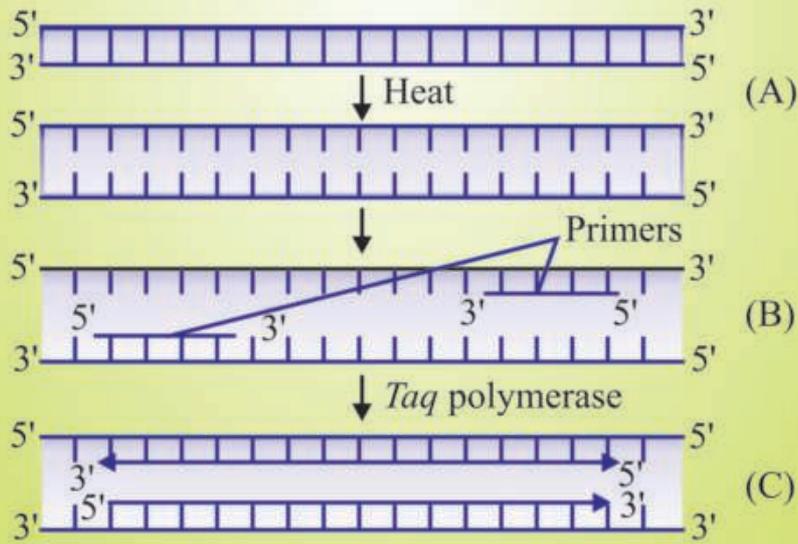
5'—CAGAATTCTTA—3'

3'—GTCTTAAGAAT—5'

- (a) Name of restriction enzyme which can recognise this DNA sequence.
- (b) Write the sequence after digestion.
- (c) Why are the ends generated after digestion called sticky ends ?
21. A selectable marker is used in the selection of recombinants on the basis of their ability to produce colour in presence of chromogenic substrate.
- (a) Mention the name of mechanism involved.
- (b) Which enzyme is involved in production of colour ?
- (c) How is it advantageous over using antibiotic resistant gene as a selectable marker ?

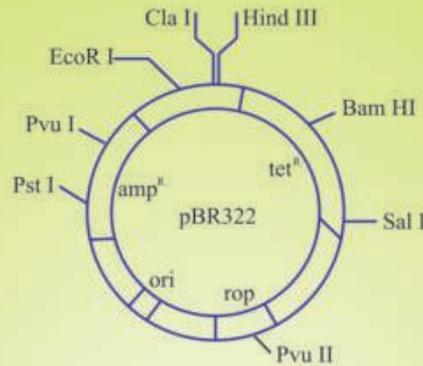
LA**(5 Marks)**

22. The development of bioreactors is required to produce large quantities of products.
- (a) Give optimum growth conditions used in bioreactors.
- (b) Draw a well labelled diagram of simple stirred-tank bioreactor.
- (c) How does a simple stirred tank bioreactor differ from sparged stirred tank bioreactor ?
23. In the given figure, one cycle of polymerase chain reaction (PCR) is shown :



- Name the steps A, B and C.
- Give the purpose of each of these steps.
- State the contribution of *Thermus aquaticus* in this process.

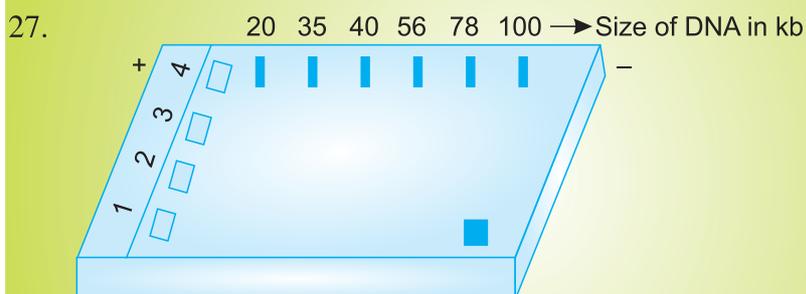
24. Study the figure of vector pBR322 given below in which foreign DNA is ligated at the Bam HI site of tetracycline resistance gene.



Answer the following questions :

- Mention the function of rop.
- What will be the selectable marker for this recombinant plasmid and why ?
- Explain transformation.

25. A recombinant protein was formed, using the cloning vector pBR322 at the doing side to BamHI. However, the labels test tubes containing, transformants having recombinant and non-recombinant cloning vector got detached accidentally. How would you differentiate between the two test tubes [Hints: You can use different antibiotics.]
26. While performing gel electrophoresis, a student mistakenly attached wrong electrodes i.e., he attached the positive electrode towards the loading the well. Would you expect same results in the process? Why or why not?



The above figure shows the result of agarose gel electrophoresis performed by a student of undigested DNA fragment (lane 1) and digested DNA fragment. However, while drawing the above diagram, student committed a mistake. Identify the mistake and rectify it.

28. Given below is some information of a restriction enzyme:
- Isolated from H-strain *Bacillus amyloliquefacies*
 - This was the 3rd restriction enzyme isolated from the said organism.
- As per convention, what should be its name?

Answers

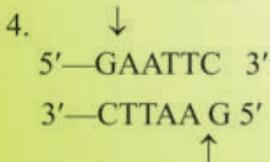
VSA

(1 Mark)

1. E. = *Escherichia* ; co = *coli*; R = Name of Strain; I = order in which enzyme is isolated from strain of bacteria.

2. Plasmid.

3. Gene cloning, gene transfer.



SOLUTION : LESSON 11

MCQ

5. c) 6. b) 7. B) 8. D) 9. B) 10. B) 11. A)

Ans 12.

I) a iii) c

SA-I

(2 Marks)

13. • Separation and Purification

- This process is essential because reaching into market, the product has to be subjected for clinical trial and quality control.

| <i>Plasmid DNA</i> | <i>Chromosomal DNA</i> |
|--|--|
| (i) Circular DNA | Linear DNA |
| (ii) Occurs in bacterial cells | Occurs in nucleus of eukaryotic cells and bacterial cell |
| (iii) Used as Vector in rDNA technology. | Not used as vector in rDNA technology. |

15.(A)—Plasmid, (B)—Nucleoid

Plasmid is used as vector to transfer the gene of interest in the host cell.

8. B—Gel Electrophoresis

E—Elution

SA-II

(3 Marks)

16.(i) Chemical treatment: treated with divalent cation such as Calcium) and exposure to cold and high temp. (42° C) alternatively (Bacterial cell)

(ii) Biolistics or gene gun. (Plant cell). In this method gold and tungsten particles, coated with DNA are bombarded with high velocity.

(iii) Micro-injection, (animal cell). In this method r DNA is directly injected into the nucleus of an animal cell.

17.(i) Have origin of replication(Ori)

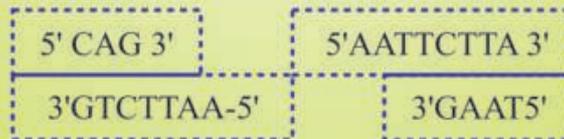
(ii) a selectable marker

(iii)at least one recognition site.

18. *Agrobacterium tumifaciens* is a pathogen in many dicot plants. It is able to deliver a piece of DNA (T-DNA) to transform normal plant cell into a tumor and directs these tumor cells to produce the chemicals required by pathogen.

19.(a) EcoRI

(b)



(c) These are named sticky ends, because they form hydrogen bonds with their complementary cut parts.

20.(a) Insertional inactivation

(b) β -galactosidase.

(c) Selection of recombinants due to inactivation of antibiotics requires simultaneous plating on two plates having different antibiotics.

LA

(5 Marks)

21.(i) Temperature, pH, substrates, salts, vitamins and oxygen.

(ii) Figure 11.7(a) simple stirred-tank bioreactor Page No. 204 NCERT book, Biology-XII

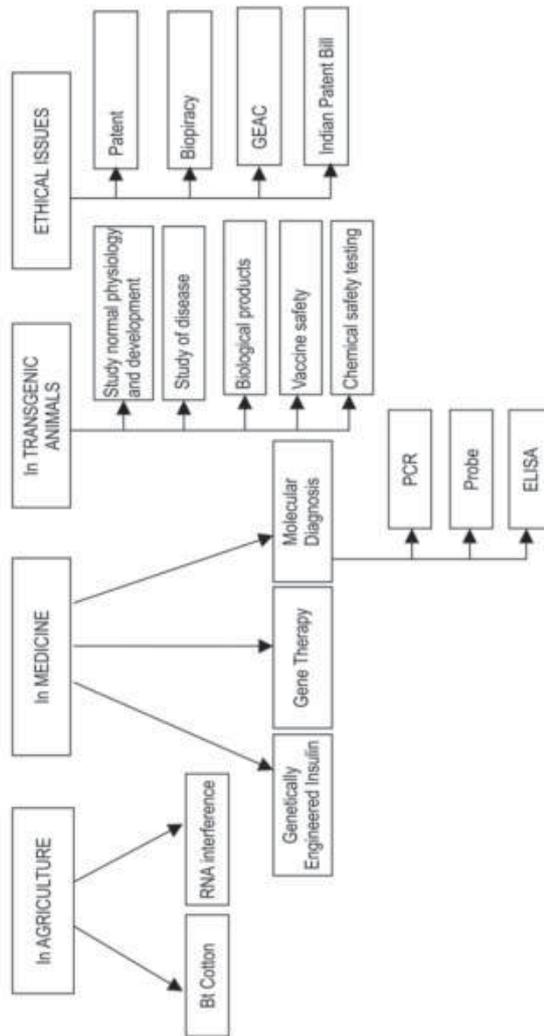
- (iii) The stirrer facilitates even mixing and oxygen availability throughout simple-stirred tank bioreactor, whereas in case of sparged stirred tank bioreactor, air is bubbled throughout the reactor for proper mixing.
22. (A) *Denaturation* : Heat denatures DNA to separate complementary strands.
(B) *Annealing* : Primers hybridises to the denatured DNA strands.
(C) *Thermus aquaticus*. This enzyme induces denaturation of double stranded DNA at high temperature.
(D) *Extension* : Extension of primers resulting in synthesis of copies of target DNA sequence. Enzyme Taq polymerase is isolated from the bacterium.
23. (a) 'Rop' codes for the proteins involved in the replication of plasmid
(b) *Selectable marker* : Ampicillin resistance gene. It will help distinguishing transformants from non-transformants after plating them on ampicillin containing medium.
(c) *Transformation* : It is the phenomenon by which the DNA isolated from one type of cell and introduced into another type, is able to bring about some of the properties of former to the later.
25. The test tube having recombinant DNA transformants will die on adding tetracycline,
26. No, the DNA bands will not be separated due to wrong electrode connection. DNA will not move towards negative electrode.
27. The mistake is that the loading wells have been drawn on the left side instead of right side.
28. Bam HIII





Chapter - 10

Biotechnology and its Applications



Biopesticides : Biological agents that are used to control weeds, insects and other pests.

cry Gene : The Bt toxins are coded by a gene named cry.

Cry Protein : The insecticidal protein which is produced by *Bacillus thuringiensis*.

Green Revolution : Substantial increase in crop yields due to use of high yielding varieties, use of fertilisers and pesticides, improved agricultural practices etc.

Genetically Modified Organisms (GMO) : The organisms which have altered genes in them. These are also known as transgenic organisms.

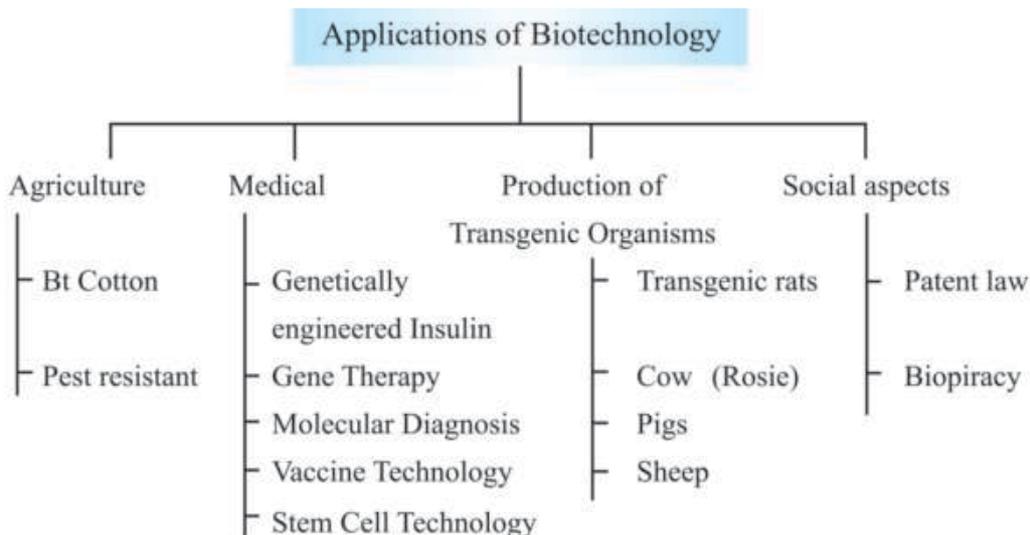
e.g. Bt Cotton, Bt Corn, Transgenic rat, Transgenic cow-Rosie

Molecular Diagnosis : Refers to early detection of diseases using recombinant DNA molecules and techniques like PCR and autoradiography.

RNA Interference (RNAi) : Process used to develop pest resistant plants. It involves silencing of a specific mRNA due to complementary double stranded RNA.

Sustainable Agriculture : It involves organic farming and other integrated management practices which maintain soil fertility while increasing crop productivity.

Use of GM Plants : Tolerant to abiotic stress, Reduced dependence on chemical pesticides, less post harvest-loss, Efficient use of minerals, enhanced nutritional value.



Bt. Cotton : The soil bacterium *Bacillus thuringiensis* produced crystal protein called cry protein that kills certain insects larvae such as tobacco budworm, armyworm, beetles and flies.

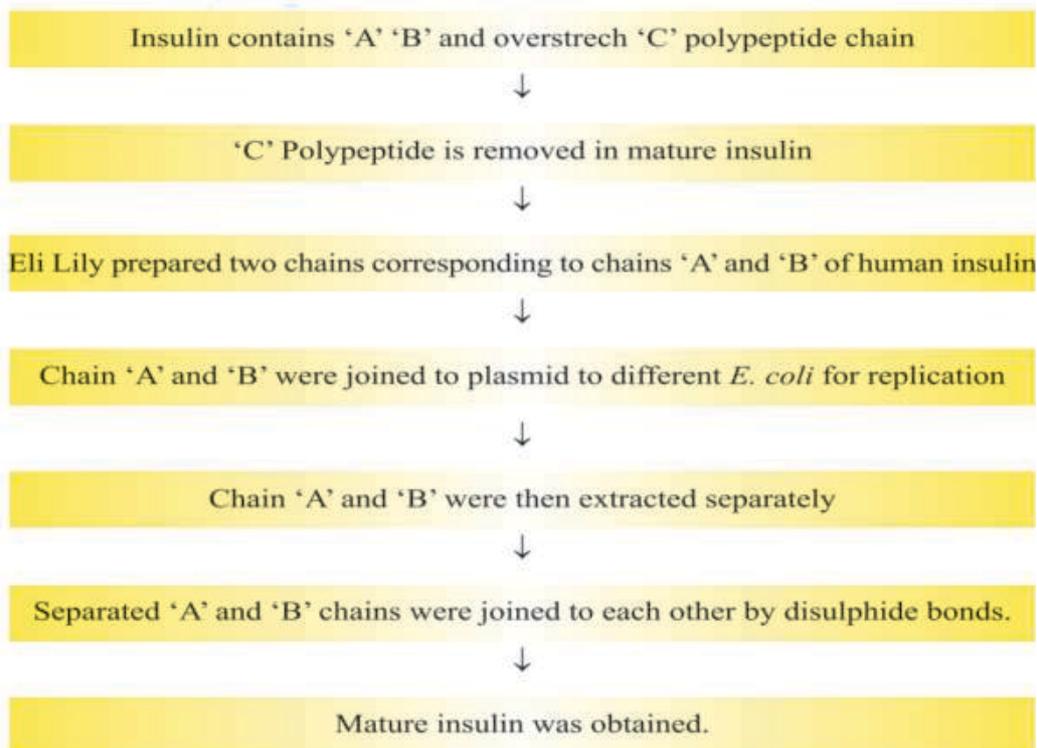
- Bt, toxin protein exists as inactive pro-toxins, but once an insect ingest this inactive toxin, it is converted into active form of toxin due to the alkaline pH of the gut which solubilize the crystal. This causes swelling and lysis of epithelial cells of midgut leading to death of insect larvae.
- Bt toxin genes were isolated from *Bacillus thuringiensis* and incorporated into the several crop plants such as cotton.
- The proteins encoded by the genes : cryIAc and cryIIAb control the cotton bollworms and cryIAb controls corn borer.

Pest Resistant Plants : A nematode *Meloidogyne incognitia* infects tobacco plants and reduces their yield.

- Nematode specific genes were introduced into the host plant using *Agrobacterium* as a vector.
- The introduction of DNA was such that it produced both sense and antisense RNA in the host cells.
- These two RNAs being complementary to each other formed a double stranded RNA (dsRNA) making it inactive.

- The nucleotide formed by the process called RNA interference (RNA i).
- The result was that the parasite could not survive in the transgenic host and the transgenic plant got protected for the parasite.

Genetically engineered insulin :



Gene Therapy : It is a technique of inserting genes into the cells and tissue of an individual to treat a hereditary disease.

- The first clinical gene therapy was given in 1990 to a four year old girl with adenosine deaminase (ADA) deficiency. ADA enzyme is required for proper functioning of immune system.
- This disorder is caused due to the deletion of the gene for adenosine deaminase enzyme.
- In some children ADA deficiency can be cured by bone marrow transplantation.
- Lymphocytes from the blood of patient are grown in a culture. A functional ADA cDNA is then introduced into these lymphocytes using retroviral vector. The lymphocytes are transferred into the body of patients.

- As these cells are not immortal, the patient required periodic infusion of such genetically engineered lymphocytes.
- If a functional gene is Introduced into a bone marrow cells at early embryonic stage. It could be a permanent cure of ADA deficiency.

Vaccine Production

Vaccine are used to protect many infectious diseases such as small pox, cholera, Hepatitis B. These are made up of killed or weakened pathogens like viruses and bacteria.

Vaccines are commonly produced through cell cultures or animals or recombinant DNA technology.

Vaccine production involves the following steps.

- Generating the antigens : The antigens are generated from the microbes. Virus are grown in primary cells *i.e.*, chicken egg (influenza vaccine) or on continuous cell lines *i.e.*, Human Cultured cells (Hepatitis B). Bacteria against which the vaccines are developed may be grown in bioreactors (Hib Vaccine)
- Isolation of antigens : Antigen are isolated from the cells used to generate it.
- Vaccine is made by adding adjuvant (to increase immune response of antigen), Stabilizers (to increase storage life) and preservatives to allow for the use of multi-dose vials).

Production of Vaccines through Recombinant DNA Technology : Injectable and edible vaccines may be produced through recombinant DNA technology.

- Gene for antigen is isolated from pathogen like Virus.
- This desired gene is introduced in the host cells (yeast).
- Antigen gene is incorporated with genetic material of host.
- The host cell is allowed to grow in the culture.

Agrobacterium tumefaciens is commonly used to deliver the antigen genes into plant cells. Antigens are produced in the plant cells. The edible part of the plants can be consumed to get vaccinated. The transgenic crop plants have the capability to produce vaccine at larger scale and cheaper price.

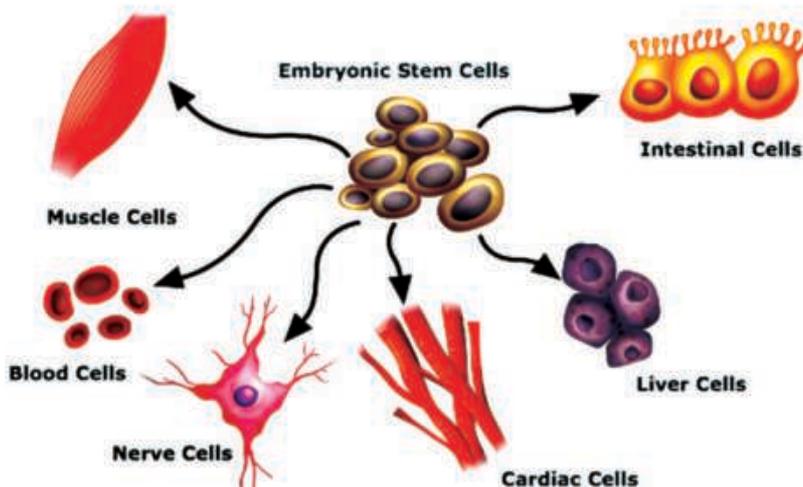
Stem Cells Technology

Stem Cells are undifferentiated cells which are able to grow into any type of tissue with specialized function. Stem cells are involved in development, growth and repair in multicellular organisms. Stem cells are used to treat many diseases such as type-I diabetes, heart diseases, cancer, Spinal injuries, arthritis, muscular dystrophy, Alzheimer. It can also be used to make new organs like heart, liver, kidneys, skin, even to produce transgenic animals.

Sources of Stem Cells : Stem cells can be obtained from inner cell mass of embryos, from bone marrow, umbilical cord and amniotic fluid.

There are three Categories of stem cells :

1. **Embryonic stem cells :** The embryo cells are removed easily and cultured in laboratory.
 2. **Tissue stem cells :** Bone marrow stem cells can be used to produce bone or cardiac muscle cells.
 3. **Reprogrammed stem cells :** Adult special cells are reprogrammed to act as embryonic cells with the help of genetic engineering. Organs for transplantation are developed by this technique.
- Embryonic stem cells have the ability to differentiate into any at the three germ layers-ectoderm, mesoderm or endoderm.
 - These cells are isolated from inner cells mass of the blastocyst, 4 to 5 days after *in vitro* fertilisation of an egg.
 - The cells are cultured and allowed to grow into cell lines.



The transgenic animals can be produced by stem cell technology the stem cells are isolated from the embryo of selected animal and the desired gene is inserted into these cells. Then, these cells are incorporated in the embryo of host. The embryo is now implanted into the uterus of host animal to grow normally.

Transgenic animals : The animals which carry foreign genes are called transgenic animals.

Steps to produce transgenic animals :

1. Identification and isolation of desired gene.
2. Selection of proper vector or direct transmission of desired gene.
3. Combining of desired gene with the vector using ligase enzyme.
4. Introduction of vector in cells/tissue/embryo/mature individual.
5. Expression of foreign gene in transgenic animal.

Advantages of transgenic animals :

1. Transgenic animals are used to produce the biological products. For example, Rosie (First transgenic cow) produced human alpha-lactalbumin protein enriched milk which was more balanced product for human babies than natural cow-milk.
2. Transgenic mice are used in testing of the vaccine safety before these vaccines are used on humans e.g. Polio Vaccine.
3. Transgenic animal are used to test the toxicity of substances.
4. These animals are used to study how genes contribute to the development of disease and also treatment. Example : cancer, Alzheimer's etc.
5. These animals are used to study the regulation of genes and their affect for normal functioning of the body and its development.

Patent : Patent is a set of exclusive right granted by a state (National Government) to an inventor or their assignee for a limited period of time to prevent others from commercial use of his invention. Biopatents are granted for biological entities and for products derived from them.

Criteria for grant of patents:-

1. **Novelty :** It implies that the innovation must be new.
2. **Non-obviousness :** It implies that it may not be documented but is otherwise well-known.

3. **Utility :** The discovered fact or product should be of a particular use for humans.

Controversies in India regarding patent and biopiracy :

Turmeric : In 1995, the US patent office granted a patent to the University of Mississippi medical centre for “Use of Turmeric in wound healing”. Dr. R.A. Mashelkar, an Indian scientist challenged the patent. It was established that the use of turmeric as healing agent was well-known in India for centuries and the patent was revoked.

Neem : The European Patent office, Munich granted a patent to the firm of W.R. Grace & Co. for ‘Fungicidal uses of neem oil’. The patent had been granted on an extraction of oil technique but not on the neem tree itself. In 1996, Vandana Shiva and Ajay Phadke who had reared neem in India, challenged the patent. Legal action was followed by India Government. Finally, the patent was revoked in 2005.

Basmati Rice : Basmati Rice is a variety of rice which is distinct for its unique aroma and flavour. In India, 27 varieties of basmati are grown.

In September 1997, a Texas company patented Basmati rice lines and grains through the US patent and trademark office. This act caused diplomatic crisis between India and US. Later due to revised decision by the United State patent office, the Texas company lost most of the claims of the patent. This was a case of biopiracy.

Questions

VSA

(1 Mark)

1. Which recombinant vaccine is currently being used in vaccination programme?
2. Name the technique based on the principles of antigen-antibody interaction used in detection of a virus (HIV).
3. The first transgenic cow, produced human protein - enriched milk. Name the cow and the protein found in milk.
4. The insulin produced using recombinant DNA technology is more advantageous than the insulin extracted from pancreas of slaughtered cattle and pigs. How ?

BIOTECHNOLOGY AND ITS APPLIANCES

MULTIPLE CHOICE TYPE QUESTIONS

5. Bt toxin is a
 - a) Intracellular lipid
 - b) Intracellular crystalline protein
 - c) Extracellular crystalline protein
 - d) Lipid
6. Cry-I AC endotoxins obtained from *Bacillus thuringiensis* are effective against.
 - A) Nematodes
 - B) Mosquitoes
 - C) Flies
 - D) Boll worm
7. In Bt Cotton, the Bt toxin present in plant tissue as protoxin is converted into active toxin due to.
 - A) Acidic pH of the insect gut
 - B) Alkaline pH of the insect
 - C) Presence of conversion factors in insect gut
 - D) Action of gut micro organism

8. The process of RNA interference has been used in the development of plants resistant to.

- A) Insects
- B) Nematodes
- C) Fungi
- D) Viruses

9. C-peptide of Human insulin is :

- A) A part of mature insulin molecule
- B) Responsible for formation of disulphide bridges
- C) Removed during maturation of proinsulin to insulin
- D) Responsible for its biological activity

10. Assertion : *Bacillus thuringiensis* forms protein crystals during particular phase of growth.

Reason : There crystal contain a toxic insecticidal protein that kills the certain insects.

- a) If both assertion and reason are true and reason is the correct explanation of assertion.
- b) If both assertion and reason are true but reason is not the correct explanation of assertion.
- c) If assertion is true but reason is false.
- d) If both assertion and reason are false.

11. Assertion : For toxicity testing, transgenic animal are made to carry genes which make them more sensitive.

Reason : Transgenic animals are exposed to toxic substance to be study to know their effect.

A,B,C,D are some as in above question

12. Gene therapy is most recent and advanced therapeutic treatment of defective gene. That has been diagnosed in a child/embryo. It involves insertion of normal healthy and functional gene into a person cells and tissues to treat the

Q12.

i) Gene therapy is “

- a) Correction of faulty gene
- b) Recovery of faulty gene
- c) Addition of a new gene
- d) Mutation of a gene

ii) Temporary treatment is to culture :

- a) Erythrocyte
- b) Lymphocytes
- c) Thrombocyte
- d) All of the above

iii) Permanent cure of ADA is :

- a) Culturing of the cells
- b) Transfer of new gene
- c) Bone marrow transplantation at embryo stage
- d) Culturing of enzyme

iv) ADA deficiency is a :

- a) Sexual disorder
- b) Mental disorder
- c) Physical disorder
- d) SCID

SA-I

(2 Marks)

13. Can a disease be detected before the appearance of its symptoms ?
14. How does a probe help molecular diagnosis.
15. GEAC is one of the organization set up by Indian Government. Write its full form. Give its two objectives.

SA-II

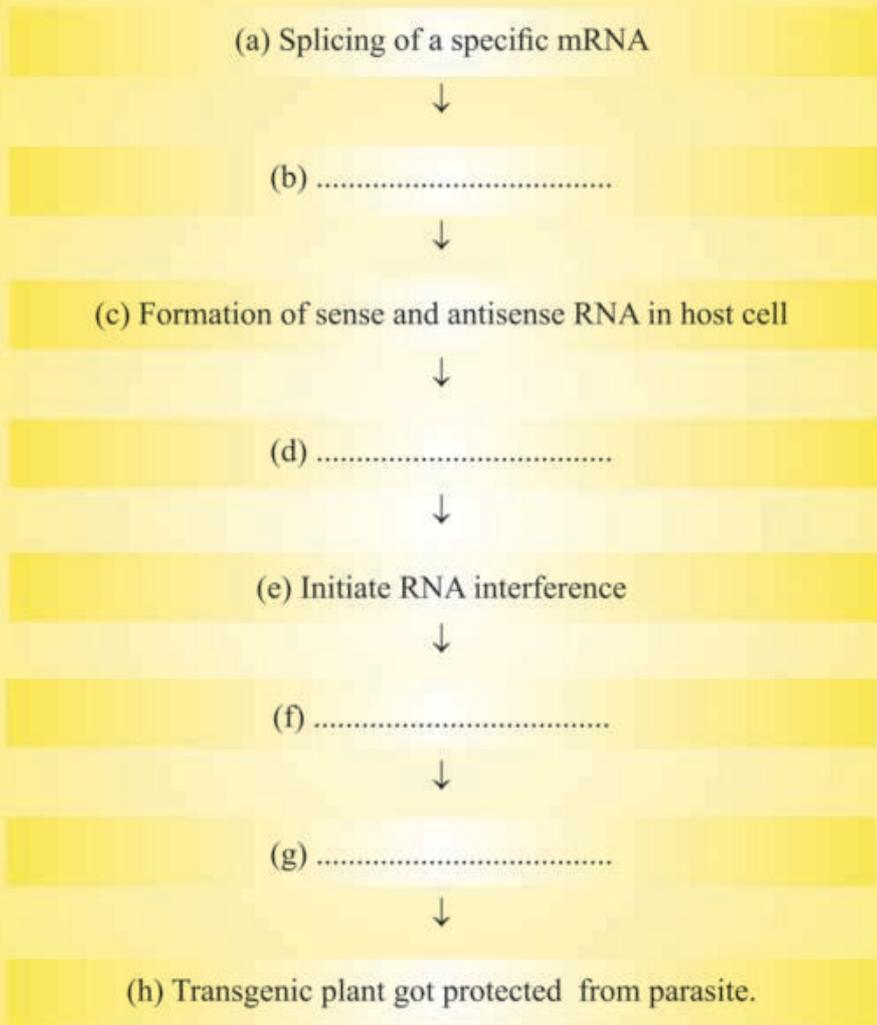
(3 Marks)

16. Some multinational companies and other organisations are using bioresources for commercial benefits, without proper authentication and compensation to concerned authorities.
 - (a) Give the term for this unauthorised act.
 - (b) Suggest any two ways to get rid of this.
17. A bacterium *Bacillus thuringiensis* produces a toxic protein named 'Cry protein' that is lethal to certain insects but not to bacterium.
 - (a) Why this toxin does not kill the bacteria ?
 - (b) What type of changes occur in the gut of insects on consuming this protein ?
 - (c) How man has exploited this protein for his benefit ?

18. Given below is an incomplete flow chart showing the process of production of nematode resistant tobacco plants based on RNAi technique.

(i) Write the missing steps in proper sequence.

(ii) At which level RNAi silences the gene ?



LA

(5 Marks)

19. The clinical gene therapy is given to a 4 years old patient for an enzyme which is crucial for the immune system to function.

(A) Lymphocytes of the Patient.



(B)



(C) Introduction of functional ADA cDNA into Lymphocytes.



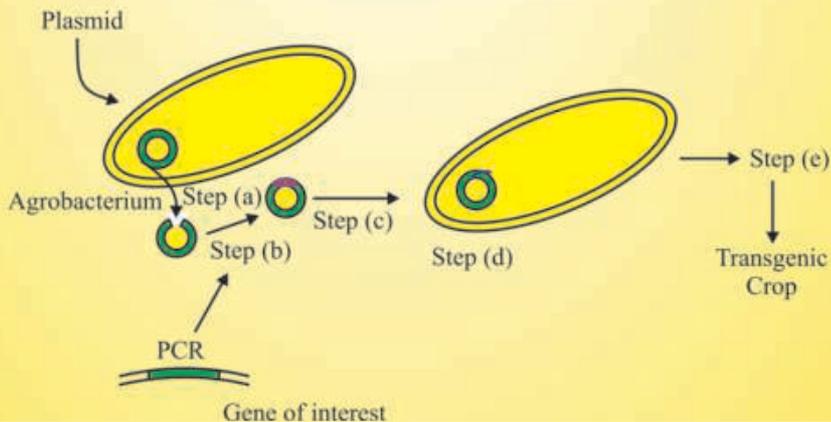
(D)

Observe the therapeutical flow chart and give the answer of the following:

- (a) Complete the missing steps (B) and (D)
- (b) Identify the disease to be cured.
- (c) Why the above method is not a complete solution to the problem ?
- (d) Scientists have developed a method to cure this disease permanently.

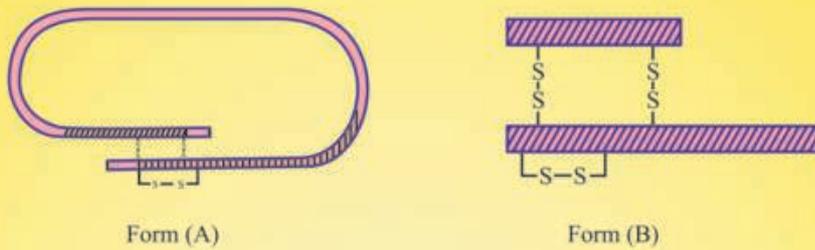
How ?

12. In the given figure, *Agrobacterium* is utilized for the production of a transgenic crop. Explain the steps a, b, c, d and e shown in the figure.



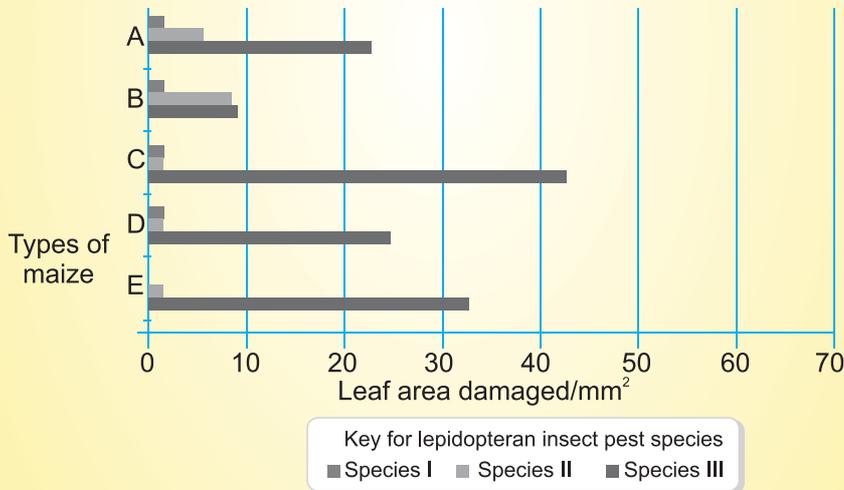
Case Based Questions

21. In the given figure, Form (A) and Form (B) represents different forms of a proteinaceous hormone secreted by pancreas in mammals.



- Name the hormone. What type of bonding is present between chains of this hormone ?
- What are these form (A) and form (B)? How these forms differ from each other ?
- Explain how was this hormone produced by Eli Lilly, an American company, using rDNA technology.

22. Insects in the Lepidopteran group lay eggs on maize crops. The tarvae on hatching feed on maize leaf and tender cob. In order to arrest the spread to three such Lepidopteran pests, Bt maize crops were introduced in an experimental field.



A study was carried out to see which of the three species of lepidopteran pests was most susceptible to Bt genes and its product.

The lepidopteran pests were allowed to food on the same Bt-maize crops grown on 5 fields (A-E).

The graph below shows the leaf area damaged by these three pests after feeding on maize leaves for five days.

Insect gut pH was recorded as 10, 8 and 6 respectively for Species I, II and III respectively.

- (a) Which of the three species is least susceptible to Bt toxin?
- (b) Name the gene used to make Bt-maize and its source organism.
- (c) Why is the effect of Bt toxin on lepidopteran species not similar in the three species?
- (d) How does the Bt toxin kill the insect, but not the bacterium?

Answers

VSA

(1 Mark)

1. Hepatitis B recombinant vaccine.
2. ELISA (Enzyme linked immuno-sorbent Assay)
3. Rosie, alpha-lactalbumin
4. Insulin obtained from animal source causes allergy.

SOLUTION LESSON 12

MCQ

5. B) 6. D) 7. B) 8. B) 9. C) 10. B) 11. d)

Q12:

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

SA-I

(2 Marks)

13. Yes, early detection of disease is possible by the use of recombinant DNA technology, PCR, ELISA.
14. A single stranded DNA/RNA tagged with a radioactive molecular probe is allowed to hybridise to its complementary DNA in a clone of cells. It followed by detection using autoradiography. The clone having the mutated gene will not appear on the photographic film.

15. GEAC—Genetic Engineering Approval Committee. Objectives of GEAC are :

- (i) To make decisions regarding validity of GM research.
- (ii) Safety of introducing GMO for public use.

SA-II

(3 Marks)

16.(a) Biopiracy

- (b) (i) Benefits of bio resources should be shared between developed and developing nations.
- (ii) Laws should be developed to prevent unauthorised exploitation of the bioresources.

17.(a) In bacteria, cry protein remains in inactive form as Prototoxin.

- (b) Prototoxin becomes active toxin in alkaline pH of gut of insects. Toxins bind to surface of midgut and cause perforation, swelling, lysis of cells ultimately leading to death of insect.
- (c) Specific Bt toxin genes isolated from *Bacillus thuringiensis* and incorporated into several crop plants such as cotton and corn which become pest resistant against certain insects.

18.(i) (b) Using *Agrobacterium* as a vector, introduced into tobacco

- (d) dsRNA (double stranded RNA)
- (f) Silenced specific mRNA of the nematode
- (g) Parasite could not survive.

(ii) RNAi silences the gene at translation level

LA

(5 Marks)

19. Step (B) : Lymphocytes are grown in culture medium.

Step (D) : Infusion of genetically engineered lymphocytes into patients.

- (b) Adenosine deaminase (ADA) deficiency.
- (c) As genetically engineered lymphocytes are not immortal, the patient requires periodic infusion of cells.
- (d) If the gene isolated from bone marrow cells producing ADA is introduced into cells at early embryonic stages, it could be a permanent cure.

20. Step (a) Plasmid is removed and cut open with restriction endonuclease.

Step (b) Gene of interest is isolated from another organism and amplified using PCR.

Step (c) New gene is inserted into plasmid

Step (d) Plasmid is put back into *Agrobacterium*

Step (e) *Agrobacterium* based transformation.

21. (a) Insulin, Disulphide bonds

(b) Form (A) : Proinsulin

Form (B) : Mature insulin.

Proinsulin contains an extra stretch called C - peptide which is absent in mature insulin.

(c) Eli-Lilly company prepared two DNA sequences corresponding to A and B peptide chains of human insulin and introduced them in plasmid *E. coli* to produce insulin chains. Chains A and B were produced separately, extracted and combined by creating disulphide bonds to form insulin.

22. (a) Species III

(b) — Cry gene

— Source: *Bacillus thuringiensis*.

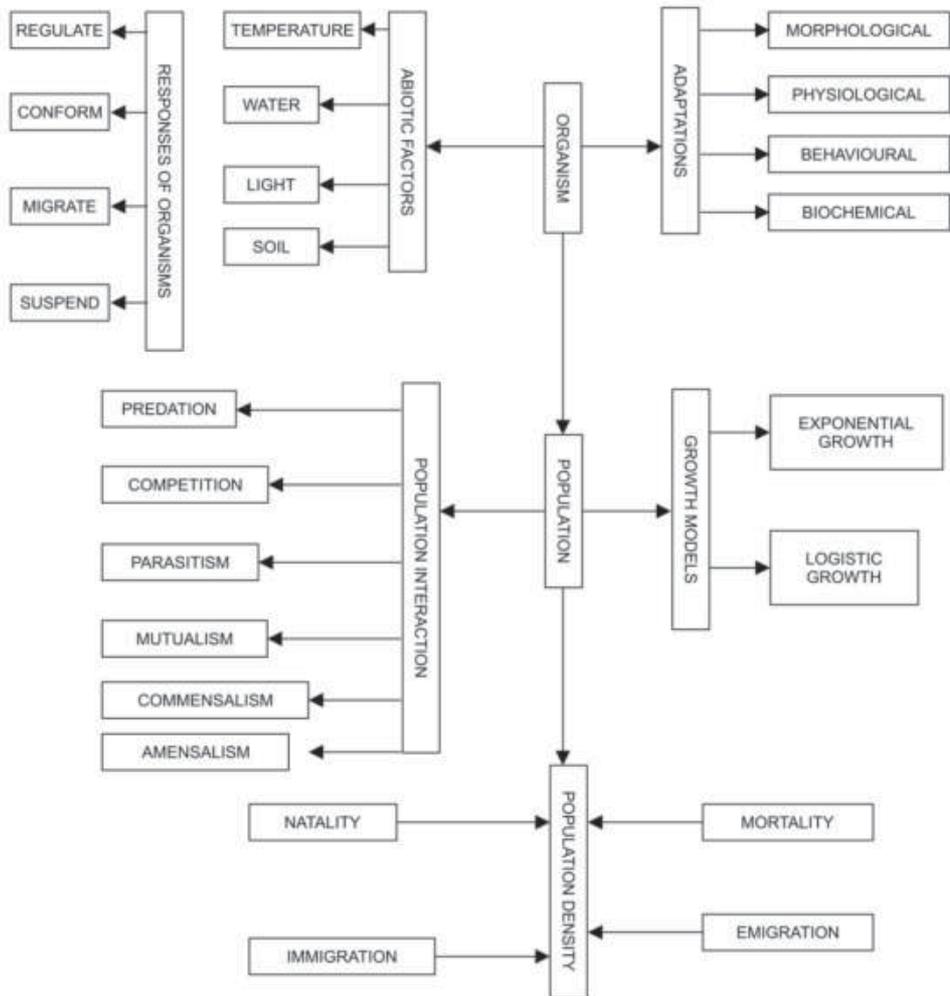
(c) pH in the gut of insects is different and toxin gets activated at optimum pH.

(d) Bt toxin gets activated in gut of insects and absent in bacterium.



Chapter - 11

Organisms And Population



Ecology : A branch of science that studies interactions among organisms and their physical environment. Ecology is basically concerned with four levels of biological organisation— Organisms, population, communities and biomes.

Ramdeo Misra is called as the Father of Ecology in India.

Word Ecology was coined by Alexander Von Humboldt.

Organisms : Organisms form the basic unit of study in ecology.

Species : Organisms with similar features and the potential to interbreed among themselves and produce fertile offspring, constitute a species.

Populations : Population is a group of individuals of the same species, inhabiting in a given area. Interspecific competition for basic needs operate among the individuals of population.

Biological Community : Biological community is constituted by an assemblage of the populations of all different species that live in an area and interact with each other. A biotic community has a distinct species composition and structure.

Population Attributes :

A population has certain attributes that an individual does not possess. Important characteristics of a population are :

(i) **Population density** : Population density of a species is the number of individuals of a species per unit area or volume

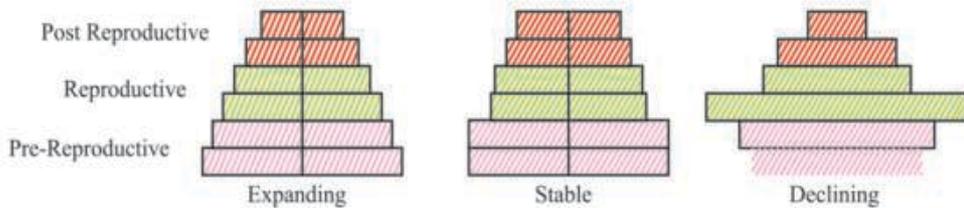
$$\text{Population density} = \frac{\text{Number of individual in a region (N)}}{\text{unit area in a region (S)}}$$

(ii) **Birth rate or Natality Rate** : It is expressed as the number of births per thousand individuals of a population per year

(iii) **Death rate or Mortality rate** : It is expressed as the number of deaths per thousand individual of a populations during a given period.

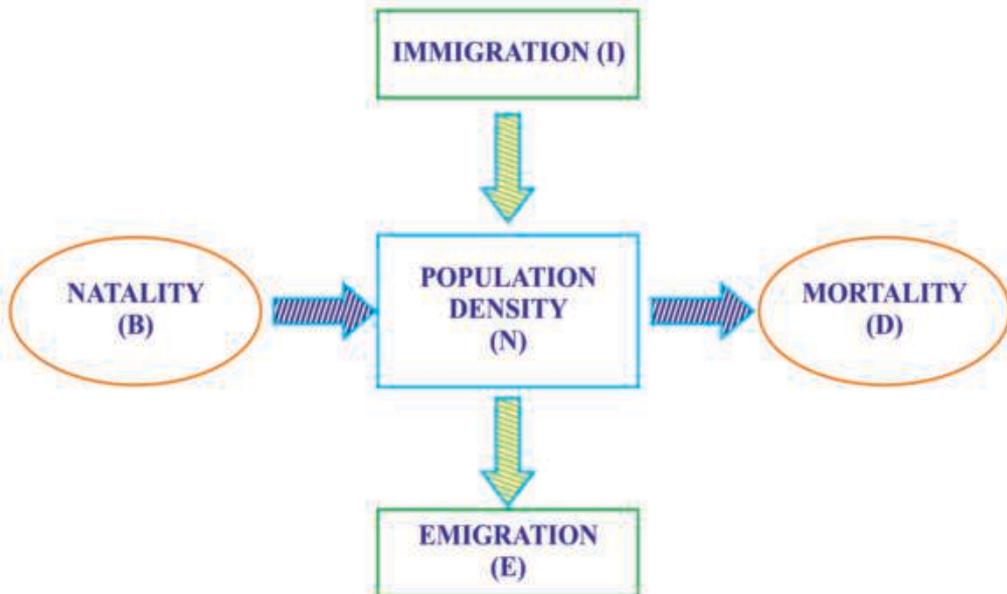
(iv) **Sex ratio** : It is expressed as the number of females per 1000 males of a population in given time.

Age Pyramids of Populations : A population at any given time is composed of individuals of different ages. If the age distribution is plotted for the population, the resulting structure is called an age pyramid. The shape of the pyramids reflects the growth status of the populations. Whether (a) it is growing (expanding) (b) Stable or (c) Declining. The pyramids for human population (males and females) are presented below :



Population Density : Average no of individuals per unit area.

Population Growth : If 'N' is the population density at time 't' then its density at time t + 1 is : $N_{t+1} = N_t + (B + I) - (D + E)$



Immigration : Number of individuals of the same species that have come into the habitat from elsewhere during a given period.

Emigration : Number of individuals of the population who have left the habitat and gone elsewhere during a given time period.

Growth Models : The two growth models are :

(i) **Exponential growth model** : If food and space for a population are unlimited and each species has the ability to grow, then the population grows in exponential or geometric fashion.

Exponential Growth Equation is $N_t = N_0 e^{rt}$

Where,

N_t = Population density after time t

N_0 = Population density at time zero

r = intrinsic rate of natural increase

e = the base of natural logarithms (2.71828)

Exponential growth : 'J' shape curve is obtained.

- When resources are not limiting the growth.
- Any species growth exponentially under unlimited resources conditions can reach enormous population densities in a short time.
- Growth is not so realistic.

(ii) **Logistic growth model** : A population growing in a habitat with limited resources (food and space) shows logistic growth :

Verhulst-Pearl Logistic Growth is described by the following equations :

$$dN/dt = rN (K-N / K)$$

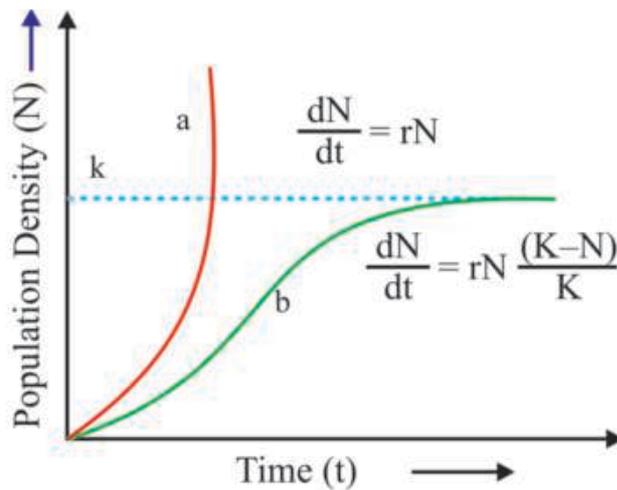
Where, N = Population density at time t

r = Intrinsic rate of natural increase

K = Carrying capacity

Logistic Growth: Sigmoid curve is obtained

- When resources are limiting the Growth.
- Resources for growth for most animal populations are finite and become limiting.
- The logistic growth model is a more realistic one



a- Exponential growth
b- Logistic growth

k- Carrying capacity

Population Interactions :

1. **Predation** : Interaction between species involving killing and consumption of prey is called predation. The species which eats the other is called the predator and the one consumed is termed as the prey. The predator keeps check on prey population. The reduction in predator population may lead to increase in prey population.

- Predators play important roles in ecosystem :
 - (a) Transfer of energy across trophic levels.
 - (b) Keep prey population under control : The invasive prickly pear cactus was brought under control by introduction of a cactus-feeding predator (moth) in Australia.
- Biological pest control methods : Used in agricultural are based on the ability of predator to regulate prey population.
- Maintain species diversity in a community.

Examples of Predation :

- (i) Carnivorous animals like tiger eating deers, snake eating frog
- (ii) Insectivorous plants like *Nepenthes*, *Drosera*, *Utricularia*

2. **Competition** : In this fitness of one species is significantly lower in presence of another species.

Gause's Competitive Exclusion Principle : Two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior one will be eliminated.

3. **Parasitism** : Parasitism is a kind of relationship between two species in which one derives its food from the other (host). Parasitism also involves shelter, in addition to food obtained by a parasite. Parasites may be ectoparasites or endoparasites. Ectoparasites live on the surface of their host while endoparasites live inside the body of the host.

Examples of Parasitism

- (i) *Cuscuta* growing on hedge plant
- (ii) Head lice and humans
- (iii) *Ascaris*, *Taenia*, *Plasmodium* causing diseases in humans

Example of Brood parasitism

- (i) Koel laying its eggs in crow's nest.

4. **Mutualism** : In mutualism both the interacting species are benefited mutually. It is also known as symbiosis.

Examples of Mutualism

- (i) Mycorrhiza living in roots of higher plants
- (ii) *Rhizobium* in root nodules of legumes
- (iii) Algae and fungi in lichens
- (iv) Orchid *Ophrys* and bee for pollination (Sexual deceit-resemblance of flower to female bee)

Co-evolution : (1) Fig species and wasp. Female wasp uses the fruit as an Oviposition (egg-laying) and also uses the developing seeds within the fruits for nourishing its larvae. Wasp pollinates the fig inflorescence while searching for egg laying site, in return fig offers developing seeds as food for developing larvae. (2) Mediterranean orchid *Ophrys* and bee.

5. **Amensalism** : Interaction between two different species, in which one species is harmed and the other is neither benefited nor harmed.

Example of Amensalism

- (i) *Penicillium* whose toxin kills many bacteria is neither benefited nor harmed

6. **Commensalism** : This is the interaction in which one species is benefited and the other is neither harmed nor benefited under normal conditions.

Examples of Commensalism

- (i) Clown fish living among tentacles of sea anemone
- (ii) Pilot fish (*Remora*) accompanies sharks
- (iii) Orchid growing on mango tree (epiphyte)
- (iv) Sea anemone on the shell of hermit crab
- (v) Barnacles on back of whales
- (vi) Egret and grazing cattle

Questions

VSA

(1 Mark)

1. Name the two intermediate hosts of human liver fluke.
2. Calculate the death rate if 6 individuals in a laboratory population of 60 fruitflies died during a particular week.
3. An organism has to overcome stressful condition for a limited period of time. Which strategies can it adopt to do so ?
4. What do phytophagous insects feed on ?

MULTIPLE CHOICE QUESTIONS

5. Which part of human body is a unique habitat for hundred of species of microbes?
 - a) Urinary bladder
 - b) Mouth
 - c) Intestine
 - d) Stomach

6. select the statement which explains best commensalism
- a) One organism is benefited
 - b) Both organisms are benefited
 - c) One organism is benefited, other is not affected
 - d) One organism is benefited, other is affected
7. Which of the following statement is not true for logistic growth.
- a) Resources are limited.
 - b) It is represented by sigmoid curve
 - c) Population density never reaches the carrying capacity.
 - d) The final phase is asymptote.
8. Select the incorrect match
- a) Predation-biological control
 - b) Competition-cuckoo bird
 - c) Commensalism- epiphyte
 - d) Mutualism-mycorrhizae
9. When a population grows in a habitat with limited resources then following phases of achievement are observed -
- a) Lag – Acceleration – Deceleration – Asymptote
 - b) Log – Deceleration – Acceleration – Asymptote
 - c) Log – Acceleration – Deceleration – Asymptote
 - d) Log – Acceleration – Asymptote – Deceleration

Assertion And Reason Questions

Read the assertion and reason carefully and work the correct option out of the options given below :

- a) If both assertion and the reason are true and the reason is a correct explanation of the assertion.
- b) If both the assertion and reason are true but reason is not a correct explanation of the assertion.
- c) If the assertion is true but the reason is false.

10. Assertion :- Female mosquito is not considered as parasite although it needs our blood for reproduction.

Reason : Parasitism is aimed to obtain either food or shelter.

11. Assertion : The monarch butterfly is highly distasteful to its predator

Reason : This is evolved to lessen the impact of its prey

SA-I

12. Differentiate between commensalism and amensalism (2 Marks)

13. Write any two adaptations evolved by parasites.

14. Why abingdon tortoise became extinct in Galapagos Islands after introduction of Goats.

15. Why do clown fish and sea anemone pair up? What is this relationship called?

SA-II

(3 Marks)

16. How will you measure population density in following cases ?

(i) fish in a lake

(ii) tiger census in a national park

(iii) single huge banyan tree with large canopy.

LA

(5 Marks)

17. Orchid flower, Ophrys co-evolves to maintain resemblance of its petal to female bee. Explain how and why does it do so ?

Answers

VSA

(1 Mark)

1. Snail and fish.

2. $6/60 = 0.1$ individuals per fruitfly per week.

3. (i) Migration

(ii) Suspension of active life by hibernation/aestivation/spore formation.

4. Plant sap and other parts of the plant.

Answer

5. c) 6. e) 7. c) 8. b) 9. a) 10. a) 11. c0

SA-I

(2 Marks)

12. **Commensalism:** interaction in which one species benefits and the other is neither harmed nor benefited. E.g cattle egret and grazing cattle.

Amensalism: Interaction in which one species is harmed and the other is neither harmed nor benefited. E.g Penicillium toxins kills many bacteria is neither benefited nor harmed.

13. Loss of unnecessary sense organs, presence of adhesive organs, suckers to cling host, loss of digestive system, high reproductive capacity (any2)

14. Due to greater browsing efficiency of goats.

15. Interaction-commensalism.

SA-II

(3 Marks)

16. (a) fish caught per trap.

(b) number per unit area

(c) percentage cover in biomass.

LA

17. • employs 'sexual deceit'

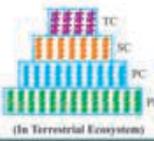
• one petal bears uncanny resemblance to female of the bee.

• Male bee is attracted to what it perceives as a female 'pseudo-copulates,' during which pollen dusted on male bee's body.

• Male bee transfers pollen to another flower when the same been pseudo-copulates with another flower.

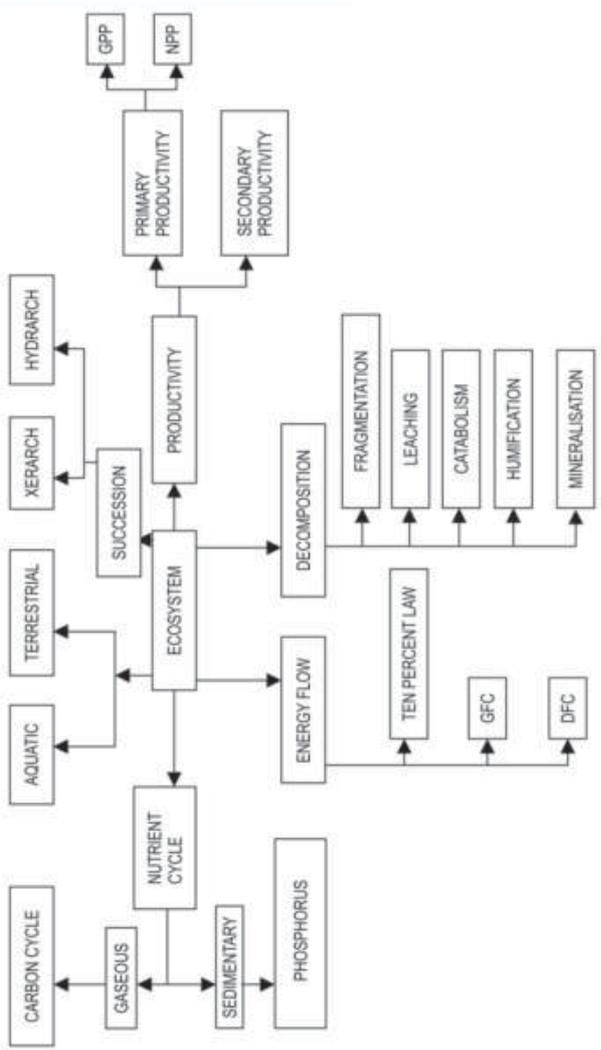
• *Ophrys* does so because pollination success will be reduced unless it co-evolves with female bee.





Chapter - 12

Ecosystem



Ecosystem : It is the basic functional unit of biosphere in which living organisms interact among themselves and with their surrounding physical environment.

Stratification : Vertical distribution of different species occupying different levels in an ecosystem. Trees occupy top vertical strata, shrubs the second layer and herbs the third layer and herbs/grasses occupy the bottom layers.

Primary Production : Amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis.

Gross Primary Productivity : Rate of production of organic matter during photosynthesis.

Net Primary Productivity : $NPP = GPP - R$ (Gross primary productivity minus the respiration losses).

Secondary Productivity : Rate of formation of new organic matter by consumers.

Detritus : Dead leaves, twigs, animal remains etc. constitute detritus.

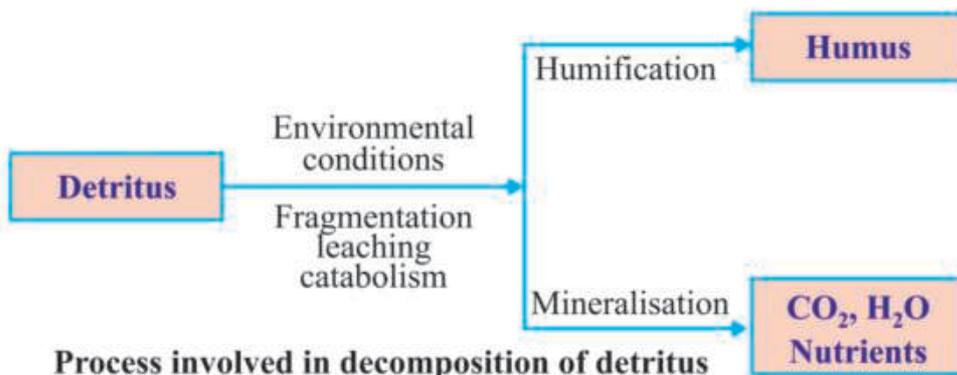
Detrivore : Organisms who break down detritus into smaller particles, e.g., earthworm.

Process of Decomposition : The decomposers break down complex organic matter into inorganic substances like carbon dioxide, water and nutrients.

This process is called decomposition. Steps of decomposition are :

- (i) **Fragmentation :** Break down of detritus into smaller particles by detritivores (earthworm).
- (ii) **Leaching :** Water soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts.
- (iii) **Catabolism :** Bacterial and fungal enzymes degrade detritus in simple inorganic substances.

- (iv) **Humification** : Accumulation of a dark coloured amorphous substance called humus which is highly resistant to microbial action and rich in nutrients.
- (v) **Mineralisation** : The humus is further degraded by some microbes and release of inorganic nutrients occur.



Factors affecting decomposition :

Decomposition is controlled by :

- (a) **Chemical composition of detritus** : The decomposition will be slower if detritus is rich in lignin and chitin and will be faster if detritus is rich in nitrogen and water soluble substance (sugar).
- (b) **Climatic factors** : In warm and moist environment, the process of decomposition increases whereas low temperature and anaerobiosis inhibit the decomposition.

Energy Flow : Energy flow is the key function in the ecosystem. The plants (producers) capture only 2-10 percent of the photosynthetically active radiation (PAR). Unidirectional flow of energy takes place from the sun to producers and then to consumers. About 10% energy flows from one trophic level to another.

Grazing Food Chain (GFC) : It begins with producers.

| | | | | |
|------------|---|--------------------|---|----------------------|
| Grass | → | deer | → | Lion |
| (Producer) | | (Primary Consumer) | | (Secondary consumer) |

Detritus Food Chain : (DFC) It begins with dead organic matter. It includes decomposers (Fungi, Bacteria). They meet their energy and nutrient requirements by degrading detritus. Decomposers are also known as saprotrophs.

Food Web : A number of food chains interconnected with each other forming a web-like pattern.

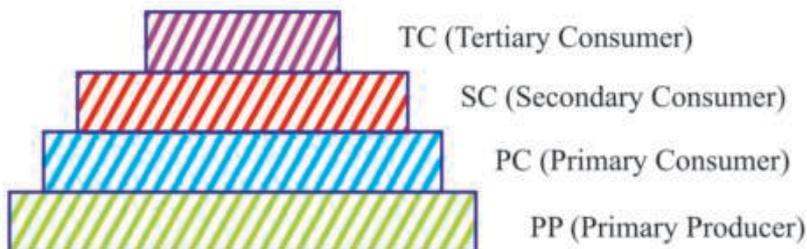
Ten Percent Law of Energy Transfer : Proposed by Lindeman. At each step of food chain, when energy is transferred from one trophic level to the next trophic level, only 10 percent of energy is passed on to the next trophic level.

Standing State : Amount of all the inorganic substances present in an ecosystem per unit area at a given time.

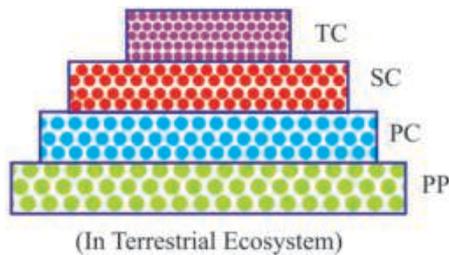
Standing Crop : Amount of living material present in different trophic levels at a given time. It is measured as the mass of living organisms or the number in a unit area.

Ecological Pyramids : The sequential graphic representation of an ecological parameter (energy/number/biomass) depicting different trophic levels in a food chain.

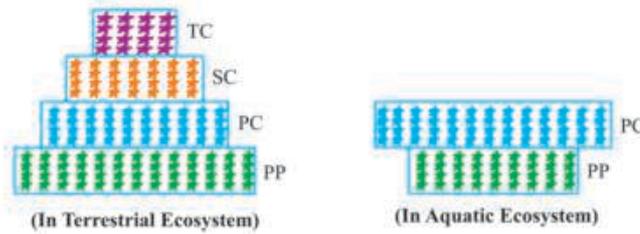
(i) Pyramid of Numbers : (Grassland Ecosystem)



(ii) Pyramid of Energy : (Always upright in all Ecosystems)



(iii) Pyramid of Biomass



Questions

VSA

(1 Mark)

1. If we count the number of insects on a tree and number of small birds depending on those insects and also the number of larger birds eating the smaller, what kind of pyramid of number would we get ?
2. What is the unit of measurement of productivity.
3. Out of 1,000,000 J of sunlight, how much energy will be converted by primary producers into NPP.

Multiple choice Question:

4. Which of the following occupy top vertical strata of forest ecosystem?
 - a) Shrubs
 - b) Herbs and grasses
 - c) Phytoplankton
 - d) Trees.
5. Decomposition is favoured by
 - a) Warm and moist environment
 - b) Aerobic Environment
 - c) Rich enwound of nitrogen and water soluble substance like sugar in detritus.
 - d) All of the above
6. If 20 J energy is available at producer level, then how much energy will be transferred to the lion in the food chain :
 Producer – Dear – Lion.
 - a). 0.2 J
 - b) 0.02 J
 - c) 0.002J
 - d) 2J.

7. Pyramid of numbers is
- a) Always upright
 - b) Always inverted
 - c) Either upright or inverted
 - d) Neither upright nor inverted

Assertion And Reason Question

Read the assertion and reason carefully and mark the correct option out of the options give below :

- a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.
- b) If both assertion and reason are true but reason is not a correct explanation of the assertion.
- c) If the assertion is true but the reason is false.
- d) If both the assertion and reason are false.

8. Assertion : Despite occupying about 70% of surface the productivity of oceans is only 55 billion tons.

Reason : Light and minerals are limiting factor for productivity of ocean.

9. Assertion : Amount of nutrient present in soil at any given time, in an ecosystem is rafferred as standing state.

Reason : Each tropic level has a certain mass of living material at a particular time, known as standing crop.

SA-I

(2 Marks)

10. What is the shape of pyramid of biomass in sea ? Why so ?
11. Give an example of an ecological pyramid which is always upright. Justify your answer.

12. What is the effect on decomposition rate if :

- (a) Detritus is rich in lignin and chitin
- (b) Detritus is rich in nitrogen and sugars

SA-II

(3 Marks)

13. Name any four ecosystem services. Who gave the price tags on nature's life support services? Which is the most important ecosystem service provider?

14. In the pyramid of biomass drawn below, name the two crops (i) one which is supported (ii) one which supports. In which ecosystem is such a pyramid found.



LA

(5 Marks)

15. Detrivores like earthworm are involved in the process of decomposition of dead plants and animals. Describe the different steps involved in the process of decomposition.

Answers

VSA

(1 Mark)

* Inverted Pyramid of Number.

Answer

$\text{g}^{-2}\text{yr}^{-1}$ or $(\text{Kcal m}^{-2})\text{yr}^{-1}$

10,000 J

d) 5. d) 6. a) 7. c) 8. a) 9. b)

SA-I

(2 Marks)

10. Inverted, because biomass of fishes far exceeds that of phytoplankton.

11. Pyramid of energy is always upright and can never be inverted, because when energy flows from a trophic level to the next trophic level some energy is always lost as heat at each step.

12. (a) Decomposition rate is slower.

(b) Decomposition rate is faster.

SA-II

(3 Marks)

13. (i) Forest (ecosystem) purify water and air

(ii) Mitigate Droughts and floods

(iii) Nutrient cycling

14. (iv) Generate fertile soil

(v) Provide habitat for wildlife

(vi) Pollinate flowers

(vii) Maintain Biodiversity

(viii) Provide aesthetic, cultural and spiritual values

- Robert Constanza and his colleagues gave price tags to ecosystem services.
- Most important ecosystem services provider : Soil formation.

15.(i) Supported trophic level is formed by zooplanktons

(ii) Supporting trophic level is formed by phytoplanktons ecosystem.

It is found in aquatic ecosystem.

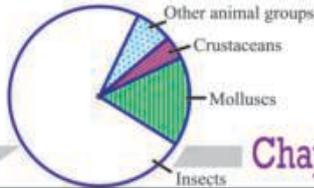
LA

(5 Marks)

16. The dead remains of plants and animals called detritus undergo decomposition and are converted into simpler substances. The steps of this process are fragmentation, leaching, catabolism, humification, mineralisation.

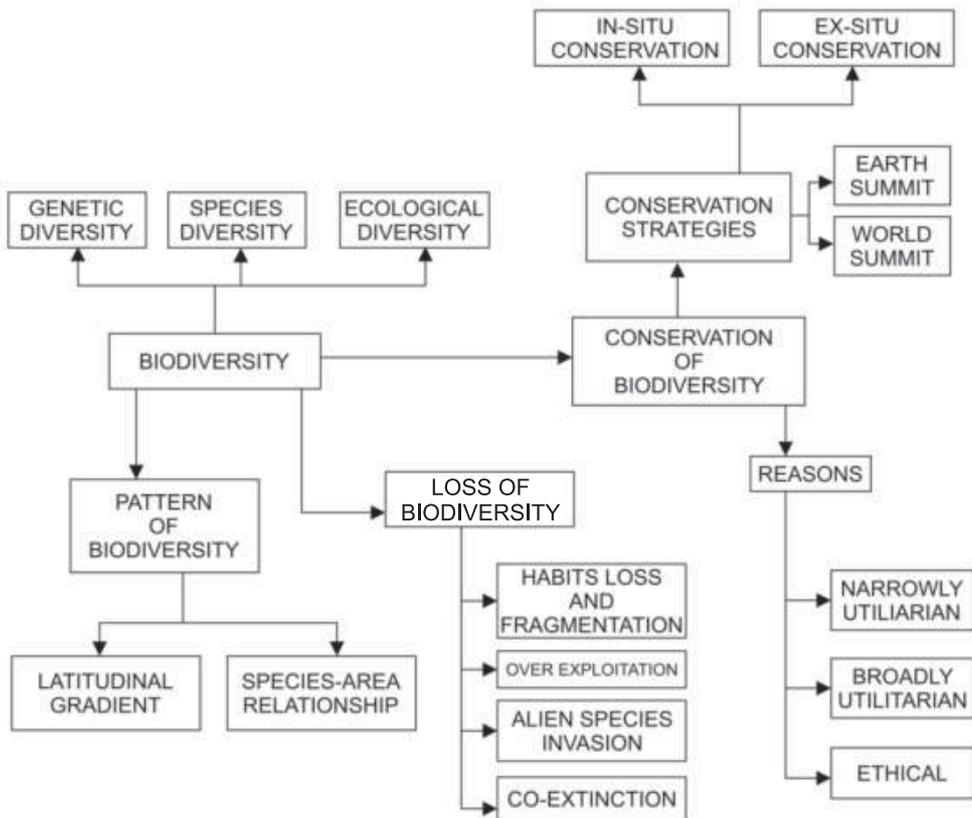
Steps involved : Refer content in chapter.





Chapter - 13

Biodiversity and Conservation



Biodiversity : Term coined by socio-biologist Edward Wilson and was also used by Walter G Rosen for the diversity of life forms. Biodiversity refers to the sum total of diversity that exists at genetic, species and ecosystem level of biological organisation.

Three inter-related levels of Biodiversity : Genetic diversity, Species diversity, Ecological diversity.

- **Genetic diversity** : Diversity in the number and types of genes, as well as chromosomes present in different species and the variations in the genes and their alleles in the same species. It helps in speciation.
eg. : Rauwdfia Vomitoria
- **Species diversity** : Varieties in the number and richness of the species of a region.
- **Ecological diversity** : Variety in the types of ecosystems.

IUCN : International Union for Conservation of Nature and Natural Resources. It is situated in Morges, Switzerland.

India has : More than 50,000 genetically different varieties of rice; 1000 varieties of mango;

- India has 1,42,000 known species of plants and animals (Around 45,000 species of plants and rest of animals).
- India has 8.1% share of global biodiversity.
- India is one of 12 Mega diversity countries of the world.

Patterns of Biodiversity : Biodiversity is not uniform but shows uneven distribution.

Altitudinal Patterns of Biodiversity

- In general, species diversity decreases as we move away from the equator towards the poles.
- With very few exceptions, tropics (latitudinal range of 23.5° N to 23.5°S) harbour more species than temperate or polar areas.
- Colombia located near the equator has nearly 1,400 species of birds while New York at 41° N has 105 species and Greenland at 71° N only 56 species.
- India has more than 1,200 species of birds.
- A forest in a tropical region like Equador has up to 10 times as many species of vascular plants as a forest of equal area in a temperate region like the Midwest of the USA.
- The largely tropical Amazonian rain forest in South America has the greatest biodiversity on the earth.

Reasons for greater biological diversity in tropics

- (a) Tropical latitudes have remained relatively undisturbed for millions of years and thus had a long evolutionary time for species diversification.
- (b) Topical environments are less seasonal, relatively more constant and predictable which promote niche specialisation and lead to greater species diversity.
- (c) There is more solar energy available in the tropics, which contributes to higher productivity and indirectly leads to greater biological diversity.

The importance of species diversity to the ecosystem

- (1) Ecosystems with higher biodiversity are more productive than ecosystems with lower biodiversity. David Tilman showed in his experiments that increased diversity contributes to higher productivity.
- (2) Biodiversity is essential for the stability of an ecosystem. Communities with more species are more stable than those with less species.
- (3) Rich biodiversity is also essential to make an ecosystem more functional and survival of the human race on the earth.

(Rivet popper hypothesis proposed by Paul Ehrlich).

Species-Area relationships

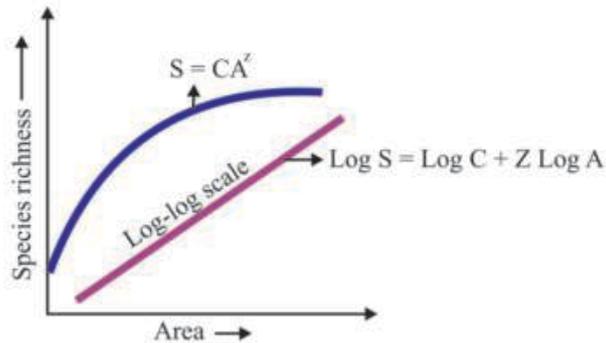
- German naturalist and geographer Alexander von Humboldt observed that within a region, species richness increases with increasing explored area, but only up to a limit.
- The relation between species richness and area for a wide variety of taxa (angiosperm plants, birds, bats, freshwater fishes) turns out to be a rectangular hyperbola.
- On a logarithmic scale, the relationship is a straight line described by the equation

$$\log S = \log C + Z \log A$$

Where S = Species richness, A = Area; Z = slope of the line (regression coefficient) C = Y-intercept.

- Value of Z lies in the range of 0.1 to 0.2, regardless of the taxonomic group or the region.

- The species-area relationships among very large areas like the entire continents has much steeper slope of the line (Z values in the range of 0.6 to 1.2).



Causes of Biodiversity Losses [The Evil Quartet]

- Habitat loss and fragmentation :** This is most important cause of plants and animals extinction. For example: Tropical rain forest is being destroyed faster. The Amazonian rain forest is called the lungs of the planet. It is being cut for cultivating soyabeans.
- Over exploitation :** Many species extinctions are due to over exploitation by humans e.g. extinction of Steller's sea cow, passenger pigeon in last 500 years.
- Alien species invasions :** When alien species are introduced in new habitat, some of them turn invasive and cause decline or extinction of indigenous species, e.g. Carrot grass (*Parthenium*), *Lantana* and water hyacinth (*Eichhornia*) posed threat to native species.
- Co-extinctions :** When a species becomes extinct, the plant and animal species associated with it in an obligatory may also become extinct.

Example 1 : When a host fish species becomes extinct, its assemblage of parasites also becomes extinct.

Example 2 : This is true in case of plant pollinator mutualism where extinction of one species leads to extinction of other species in nature.

Reasons for Conservation of Biodiversity

1. Narrowly utilitarian : Humans derive countless direct economic benefits from nature food (cereals, pulses, fruits), firewood, fibre, construction material, industrial products (tannins, lubricants, dyes, resins, perfumes) and products of medicinal importance.

2. Broadly utilitarian : Biodiversity plays a major role in many ecosystem services that nature provides like oxygen, pollination, flood and soil erosion control.

3. Ethical : Every species has an intrinsic value, even if it may not be of any current economic value to us. We have a moral duty to care for their well-being and pass on our biological legacy in good order to future generations.

Types of Conservation Strategies

In-situ conservation : Conservation and protection of the whole ecosystem and its biodiversity at all levels in order to protect the threatened species. Endangered species protected in natural conditions.

- **Sacred Groves :** Tracts of forest are set aside and all the trees and wildlife within are venerated and given total protection. *e.g.* some forest in Khasi and Jaintia hills in Meghalaya, Aravalli hills of Rajasthan.
- **Biodiversity Hot Spots :** An areas with high density of biodiversity or megadiversity (high level of species richness and high degree of endemism) *e.g.* Out of 34 hot spots in world, 3 occur in India, i.e., Western Ghats and Sri Lanka, Indo-Burma (North-East India) and Himalaya.
- **Protected Areas :** Ecological or Biogeographical areas where biological diversity with natural and cultural resources are protected. *e.g.* National parks, sanctuaries and Biosphere reserves.

National Parks : Areas reserved for wild life where they are able to obtain all the required natural resources and proper habitats. India has 90 national parks at present. Example Corbett national park, Kaziranga national park.

Sanctuaries : An area where animals are protected from all types of exploitation and habitat disturbance. India has 492 sanctuaries at present.

Biosphere Reserve : Large tracts of protected land with multiple use preserving the genetic diversity of the representative ecosystem by protecting wild life, traditional life styles of the tribals and varied plant and animal genetic resources. India has 14 biosphere reserves.

Ex-situ conservation : Conservation and protection of selected rare plants or animals in places outside their natural habitat.

- **Offsite collections :** Live collections of wild and domesticated species in Botanical gardens, Zoological parks etc.
- **Gene Banks :** Institutes which maintain stock of viable seeds, live growing plants, tissue culture and frozen germplasm with the whole range of genetic variability.

Cryopreservation : Preservation of seeds, embryos etc. at -196°C in liquid nitrogen.

Red Data Book : Record of threatened species of plants and animals maintained by IUCN. It has 8 categories → Extinct, Extinct in wild, critically endangered, Vulnerable, lowest risk, data deficient, Not evaluated.

Important Wild Life Protection in India :

- **Project tiger :** Started in 1973 to check depletion in population of tiger. Jim Corbett National Park.

Endemic Species : Species which are confined to a particular region and not found anywhere else.

Exotic or Alien Species : New species which enter a geographical regions.

Bioprospective : Exploration of molecular, genetic and species level diversity for products of economic importance.

International efforts for Biodiversity conservation :

- **World Conservation Union (formerly IUCN) :** provides leadership, common approach and expertise in the area of conservation.
- **The Earth Summit :** Historical convention on Biological diversity held in 1992 at Rio de Janeiro, Brazil.
- **The World Summit on Sustainable Development :** Held in 2002 in Johannesburg, South Africa to pledge to reduce biodiversity losses at global and local levels.

The Biological Diversity Act, 2002 :

The Biological Diversity Act, 2002 is the Indian response to the conservation of biological diversity. The main objectives of the Act are :

1. Conservation of biological diversity.

2. Sustainable use of its components

3. Fair and equitable sharing of the benefits arising out of utilisation of genetic resources. In exercise of the powers conferred by Sec-62 of the Biological Diversity Act 2002 and in super session of the National Biodiversity authority Rules, 2003, the central government of India made some rules, which come into force on 15th April 2004.

Ramsar sites : Named after city Ramsar in Iran where the Ramsar convention was signed in 1971 to develop awareness about the importance of wetlands.

Wetlands : These are the areas where water is the primary factor, controlling the environment and the plants and animals life found there in. They occur where the water table is at or near the surface of land or where the land is covered by water.

- These sites are mentioned for the conservation and sustainable utilisation of wetlands and recognising their ecological function, economic, cultural, scientific and recreational values.

Ramsar site in India : Chandra Taal (H.P), Chilka lake (Odisha) Deepor beel (Assam), Loktak Lake (Manipur), Sambhar lake in Rajasthan and Wular lake (J and K) etc.

Threats to wetland : Loss of vegetation, Saliniation, excessive inundation, water pollution, invasive species, excessive development and road buildings.

Questions

VSA

(1 Mark)

1. Habitat loss and fragmentation has caused severe damage to a particular type of ecosystem. Name it.
2. What trend is observed in respect of species diversity when we move from equator to poles ?
3. Which region is considered as the one with highest biodiversity on earth? What is the name given to such region forests ?

Biodiversity and Conservation

M.C.Q.

4. The active chemical drug reserpine is obtained from.
 - a) Atropa
 - b) Papaver
 - c) Datura
 - d) Rouwolfia
5. Which technique can be used for preservation of gametes of threatened species.
 - a) PCR technique
 - b) CTAB
 - c) Cryopreservation
 - d) In site conservation.
6. Which of these are invasive weeds?
 - a) Carrot grass (Parthenium)
 - b) Gandhari (Lantana)
 - c) Water hyacinth (Eicchornia)
 - d) All of these.
7. Which group is most vulnerable to extinction?
 - a) Fishes
 - b) Reptiles
 - c) Amphibians
 - d) Birds

Assertion And Reason Questions:

Read the assertion and reason carefully and mark the correct option out of the options given below:

- a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.

b) If both assertion and reason are true but reason is not a correct explanation of the assertion.

c) If the assertion is true but the reason is false.

d) If both the assertion and reason are false.

8. Assertion : Insects are the most diversified organisms on earth.

Reason : Insect have compound eyes.

9. Assertion : India is one of the 12 mega biodiversity countries of the world.

Reason : India has only 2.4% of the world's land area. It shares 8.1% of the global species diversity.

10. Assertion : Removal of key species from an ecosystem leads to destruction of ecosystem.

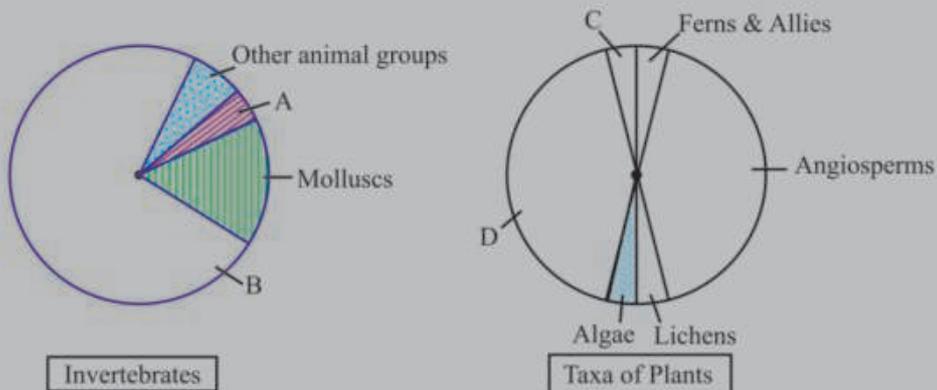
Reason : Key species drive major ecosystem functions.

SA-I

(2 Marks)

11. Study the pie-diagram and answer the questions which follows :

What do A, B, C and D represent in these diagrams.

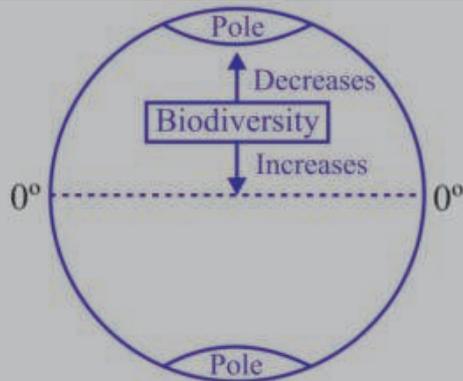


SA-II

(3 Marks)

12. Hot spots are the regions of exceptionally high biodiversity. But they have become regions of accidental habitat loss too. Name the three hotspots of our country. Why are they called 'biodiversity hotspots' ?

13. Study the diagram of the earth given below. Give the name of the pattern of biodiversity therein. Suggest any two reasons for this type of occurrence.



14. What is so special about tropics that might account for their greater biological diversity ?

LA

(5 Marks)

15. Describe at least two approaches each for ex-situ conservation and in situ conservation as a strategy for biodiversity conservation.

Answers

VSA

(1 Marks)

1. Tropical Rain Forest.
2. In general, species diversity decreases as we move away from the equator towards poles.
3. Amazonian rain forests. They are also called the 'Lungs of the planet'.

Answer :

4. d) 5. c) 6. d) 7. c) 8. b) 9. a) 10. a)

SA-I

(2 Marks)

11. A → Crustaceans
 B → Insects
 C → Mosses
 D → Fungi

SA-II

(3 Marks)

12. Western Ghats and Sri Lanka; Indo-Burma; Himalaya called 'biodiversity hot spots' as they show
- High level of species richness
 - High degree of endemism
 - Under constant threat of extinction.
13. Latitudinal gradients
- More solar energy available in tropics, more productivity.
 - Tropical environments are less seasonal, so more predictable.
14. (a) Speciation is a function of time, unlike temperate regions subjected to frequent glaciations in the past, tropical latitude have remained relatively undisturbed for million of years and thus had long evolutionary time for species diversification.
- Tropical environment are less seasonal, more constant and predictable.
 - More solar energy available in the tropics contributing to high productivity leading to greater diversity.

LA

(5 Marks)

15. In situ conservation :

- Identification and maximum protection of 'hotspots'
- Legal protection to ecologically rich areas.
- Biosphere reserves, national parks and sanctuaries
- Sacred groves.

Ex situ Conservation :

- Creation of zoological parks, botanical garden, wild life sanctuaries.
- Cryopreservation
- Seed bank.

Choose the option with all true statements from the given options:

- (A) (i), (ii) and (iv) (B) (ii), (iii) and (iv)
(C) (ii), (iv) and (v) (D) (i), (iii) and (iv)

3. During the process of transcription, after binding to a promoter, RNA polymerase catalyses and makes the bases in the template strand of DNA available for base pairing, with the bases of:

- (A) Deoxyribonucleotide triphosphate
(B) Deoxyribonucleoside triphosphate
(C) Ribonucleotide triphosphate
(D) Ribonucleoside triphosphate

4. Which of the following is not an example of aneuploidy?

- (A) Turner's syndrome (B) Down's syndrome
(C) Phenylketonuria (D) Klinefelter's syndrome

5. Colostrum secreted by the mother's mammary glands in a human female during the initial days of lactation is rich in antibody:

- (A) IgE (B) IgD
(c) IgA (d) IgG

6. Select the statements that are true from the pollination mechanism in flowering plants from the given options.

- (i) In Vallisneria, the female flowers are pollinated by pollen grains inside the water.
(ii) In Zostera, pollen grains are released on the surface of water.
(iii) In most of the water-pollinated species, pollen grains are covered by a mucilaginous coating.
(iv) Pollination by water is quite rare and limited to about 30 genera.

Choose the correct answer:

- (A) (i) and (ii) (B) (ii) and (iii)
(C) (iii) and (iv) (D) (i) and (iv)

For Questions number 13 to 16, two statements are given one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.

- (A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (B) Both Assertion (A) and Reason (R) are true and Reason (R) is not the correct explanation of the Assertion (A).
- (C) Assertion (A) is true, but Reason (R) is false.
- (D) Assertion (A) is false, but Reason (R) is true.
13. **Assertion (A):** To generate only, a part of the plant from ka cell is totipotency.
Reason (R): Suitable special nutrient media and sterile conditions are required in 'in vitro' conditions for the division of cells in explants.
14. **Assertion (A):** Biogas plants are more often built in rural areas.
Reason (R): The excreta or gobar of cattle is rich in Methanobacterium.
15. **Assertion (A):** Gene pairs present on the same chromosome may be tightly linked or loosely linked.
Reason (R): Frequency of recombination between gene pairs on different chromosomes as a measure of the distance between genes can be used for 'mapping' their position on the chromosomes.
16. **Assertion (A):** Cu-T, Cu-7 and LNG-20 are the most widely used copper-releasing IUDs.
Reason (R): Cu-Ions in IUDs effectively suppress sperm motility and the fertilising capacity of sperms.

SECTION B

17. (a) Give an account of the generalised structure of an antibody molecule produced by B-lymphocytes in response to the pathogen.

OR

(b) Other than public awareness and counselling, enlist four measures taken up by NACO, WHO and other NGOs to prevent the spread of HIV infection in the society.

18. Given below are the diagrammatic representations of the replicating fork of DNA in *E. coli*. Study the diagrams and answer the questions that follow.

(i)

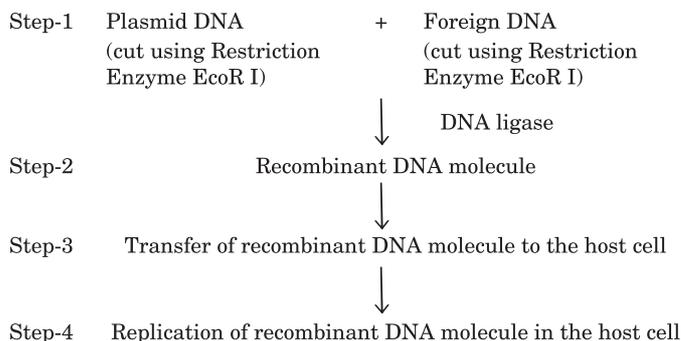
(ii)

(iii)

- (a) Which one of the three diagrams (i), (ii) or (iii) is the correct representation of the replicating fork of DNA replication? Explain your answer.
- (b) Name the enzyme used in *E. coli* to join the newly synthesised fragments of DNA.
19. (a) Explain what is meant by the term amniocentesis. How is the technique misused in India?

OR

- (b) Name any two VGDs which might occur in a human female. State any two complications in a female if it is left untreated
20. The basic scheme of the essential steps involved in the process of recombinant DNA technology is summarised below in the form of a flow diagram. Study the given flow diagram and answer the questions that follow :



- (a) Name the specific enzyme that might have been used to make the multiple copies of foreign DNA before undergoing Step-1 of the process.
- (b) How does the use of restriction enzyme EcoR I in Step-1 facilitate the action of DNA ligase to form the recombinant DNA molecule? Explain.
- (c) Name the most commonly used host in the above process.
21. (a) Explain how the interaction between a fig tree and its tight one-to-one relationship with the pollinator species of wasp is one of the best examples of mutualism.

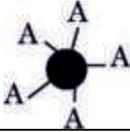
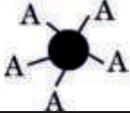
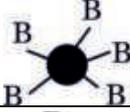
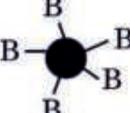
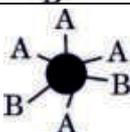
OR

- (b) Correctly depict (also indicate the trophic level) and describe the ecological pyramid of number with number with 32 birds dependent on 20 insects feeding on one banyan tree.

SECTION C

22. Explain the neuroendocrine mechanism involved in the process of parturition in a human female leading to the expulsion of the baby out of the uterus through the birth canal.
23. During a medical investigation, an infant was found to possess an extra copy of chromosome no. 21. Identify the disorder the child is suffering from. Describe the symptoms the child is likely to develop later in life.
24. (a) Write the full form of BOD.
- (b) Define BOD. Explain how it is a measure of the organic matter present in the water body.

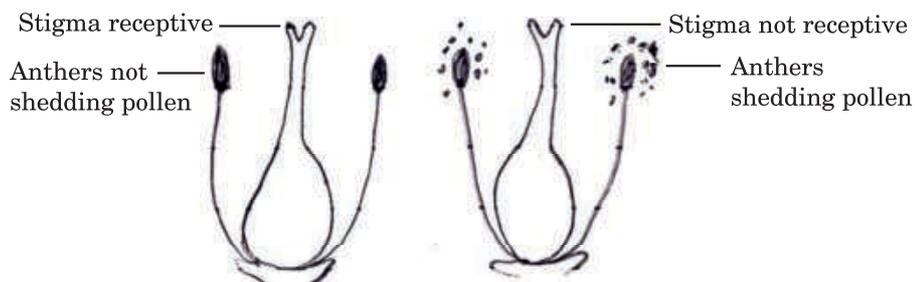
25. Enlist three advantages of genetically modified plants.

| Genotype | RBC | Phenotype |
|-----------|---|-----------|
| $I^A I^A$ |  | A |
| $I^A i$ |  | A |
| $I^B I^B$ |  | B |
| $I^B i$ |  | B |
| $I^A I^B$ |  | AB |
| ii |  | O |

Study the diagram above and answer the following questions:

- How many alleles are involved in blood grouping?
 - A person having 'AB' blood group has both dominant alleles. What is this inheritance type called?
 - A man with 'A' blood group marries a woman with 'B' blood group. Can they have a child with 'O' blood group? Explain with the help of a cross.
27. Explain how the loss of habitat and fragmentation drives plants and animals to extinction with the help of an example of habitat loss in the Tropical Rain Forest. Also write the effect of fragmentation of a habitat on the population decline.
28. Many of the flowering plants producing hermaphrodite flowers have developed many devices to discourage self-pollination and to encourage cross-pollination. Given below is a picture of one such outbreeding device

in a flowering plant. Study the picture and answer the questions that follow:



Flowers present on different plants of same species

- Explain how the given type of pollination is advantageous to the plant.
- Can this flowering plant show geitonogamy? Justify your answer.

SECTION D

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

29. Highly conserved proteins such as Haemoglobin and Cytochrome-C provide the best biochemical evidences to trace evolutionary relationships between different groups.

Cytochrome-C is formed of 104 amino acids. Cytochrome-C is the respiratory pigment present in all eukaryotic cells. It has evolved at a constant rate during evolution. In chimpanzees and humans, Cytochrome-C genes are identical. The given data shows the evolution of the Cytochrome-C gene in different mammals from kangaroos, cows, rodents to humans:

| Groups | Nucleotide substitution in the gene of Cytochrome-C | Millions of years ago |
|----------------|---|-----------------------|
| Human/Kangaroo | 100 | 125 mya |
| Human/Cow | 75 | 120 mya |
| Human/Rodent | 60 | 75 mya |

- (a) Select the correct option for the time of separation of two groups and the number of nucleotide substitutions in the gene of Cytochrome-C:

| Options | Time of separation of two groups during evolution | Number of nucleotide substitutions |
|---------|---|------------------------------------|
| (i) | Lesser | Greater |
| (ii) | Greater | Lesser |
| (iii) | Greater | Greater |

- (b) What do you infer about the type of evolution (convergent or divergent) for the given pair of groups and why?
- (i) Human and Kangaroo
(ii) Human and Rodent
- (c) (i) Define convergent evolution.

OR

- (c) (ii) Define divergent evolution.

30. In 2021, 5-3 percent of 15 to 16-year-olds worldwide (13-5 million individuals) had used Cannabis in the past year according to UNODC. The adolescent brain is still developing and drug use can have long-term negative effects. Early drug use initiation can lead to faster development of dependence than in adults and other problems in adulthood. Parts of the Amazon Basin are at the intersection of multiple forms of organised crimes that are accelerating devastation, with severe implications for the security, health and well-being of the population across the region. The direct impact of coca cultivation on deforestation is minimal, but indirectly it acts as a catalyst for "Narco-deforestation". The laundering of drug trafficking profits into land speculation etc. is posing a growing danger to the world's largest rainforest.

- (a) Which age group or period of growth people are more vulnerable to drug abuse?
- (b) Explain the negative impact of coca cultivation on the world's largest rainforest.

- (c) (i) From which part of the plant are cannabinoids mainly obtained?
Mention any one negative effect of this drug on adolescents.

OR

- (c) (ii) State the scientific name of the plant from which coca alkaloids are derived and state one negative impact of use of excessive dosage of cocaine.

SECTION E

31. (a) Define transgenic animals. Explain in detail any four areas where they can be used for human benefit.

OR

- (b) Describe the structure and working of a sparged stirred-tank bioreactor.
32. (a) (i) Describe the population growth curve applicable in a population of any species in nature that has unlimited resources at its disposal.
(ii) Explain the equation of this growth curve
(iii) Name the growth curve and depict a graphical plot for this type of population growth.

OR

- (b) (i) Explain the conclusion drawn by Alexander von Humboldt during his extensive explorations in the wilderness of South American jungles.
(ii) Give the equation of the Species-Area relationship.
(iii) Draw a graphical representation of the relation between species richness and area for a wide variety of taxa such as birds, bats, etc.
33. (a) (i) Explain the structure of a typical monocotyledonous embryo of a flowering plant.
(ii) How are multiple embryos formed in a citrus fruit? What is the mechanism known as?

OR

- (b) (i) Name and explain the structural organisation of the male sex accessory ducts in the human male reproductive system.
(ii) Describe the role of gonadotropin FSH in the regulation of spermatogenesis.

PRACTICE QUESTION PAPER (SOLUTION) CLASS-XII

SECTION A

1. (D) Octamer
2. (D) (i), (ii) and (iv)
3. (D) Ribonucleoside triphosphate.
4. (C) Phenylketonuria
5. (C) IgA
6. (C) (iii) and (iv)
7. (D) Numbat – Anteater
8. (B) Chitinase
9. (A) Tt × it
10. (C) A polypeptide of 24 amino acids will be formed.
11. (C) Clostridium sp
12. (A) 1:1
13. (D) Assertion (A) is false, but Reason (R) is true.
14. (A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
15. (C) Assertion (A) is true, but Reason (R) is false.
16. (D) Assertion (A) is false, but Reason (R) is true.

SECTION B

17. (a) Each antibody molecule has four peptide chains/an antibody molecule is represented as H₂L
 - Two small chains called light chains
 - Two longer chains called heavy chains
 - It has an antigen binding site at N end (amino end)
 - It has disulphide bond between different parts of proteins or proteins of different chains Or diagram of antibody.

OR

- (b) ● Ensuring availability of HIV free blood in blood banks
- Ensuring the use of only disposable needles and syringes in public and private hospitals and clinics
 - Free distribution of condoms.
 - Controlling drug abuse.
 - Advocating safe sex.
 - Promoting regular check-ups for HIV in susceptible populations.
 - Preventing infection during blood transfusions in patients.
 - Monitoring of pregnant women for HIV
18. (a) Diagram (ii) is the correct replicating fork
- The DNA – dependent DNA polymerase catalyse polymerisation only in one direction, that is 5' 3'
 - On one template strand with polarity 3' 5' DNA synthesis is continuous and on other template strand with polarity 5' 3' DNA replication is discontinuous.
- (b) DNA ligase
19. (a) Amniocentesis : Some of the amniotic fluid of the developing foetus is taken to analyse the fetal cells and dissolved substances.
- Misuse : Sex-determination of foetus which lead to increase in female foeticide

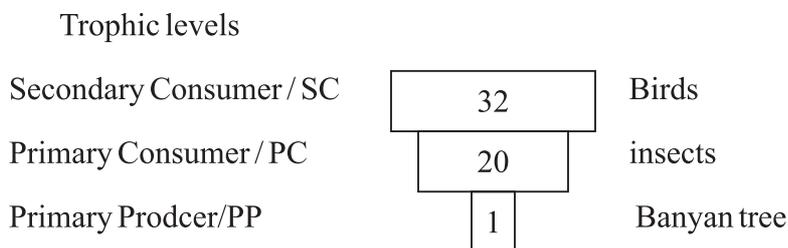
OR

- (b) Gonorrhoea, chlamydiasis, genital warts, trichomoniasis, syphilis, genital herpes, hepatitis-B, AIDS
- Pelvic inflammatory diseases (PID), abortions, still births, ectopic pregnancies, infertility or even cancer of the reproductive tract
20. (a) Tag polymerase
- (b) It forms overhanging stretches called sticky ends, which facilitates hydrogen bond formation with their complementary cut parts by DNA ligase.
- (c) *Escherichia coli/E.coli*

21. (a) Fig species can be pollinated only by its "partner" wasp species and no other species, the female wasp uses the fruit not only as an oviposition (egg-laying) site, but also uses the developing seeds within the fruit for nourishing the larvae, the wasp pollinates the fig inflorescence while searching for suitable egg-laying site.

OR

- (b) Ecological pyramid of number.



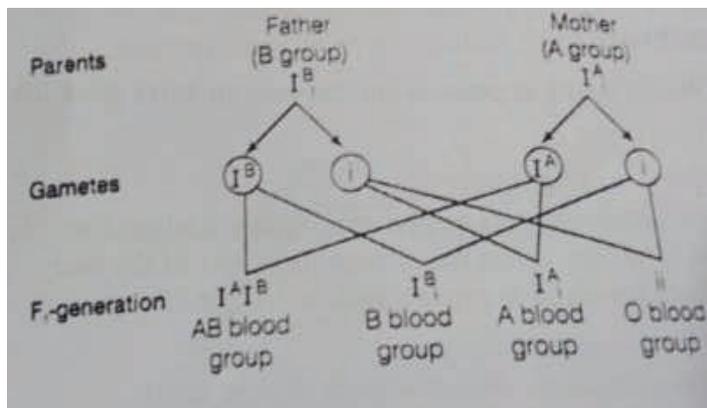
SECTION C

22. The signals of parturition originate from the fully developed fetus and the placenta, which induce mild uterine contractions called fetal ejection reflex, this triggers release of oxytocin from the maternal pituitary, Oxytocin acts on the uterine muscles and causes stronger uterine contractions, which in turn stimulates further secretion of oxytocin, the stimulatory reflex between the uterine contraction and oxytocin secretion continues resulting in stronger and stronger contractions which leads to expulsion of the baby out of the uterus through the birth canal.
23. Disorder is Down's Syndrome
- Symptoms :
- Short statured with small round head
 - furrowed tongue
 - partially open mouth.
 - palm is broad with characteristics palm crease
 - II retarded physical growth/psychomotor development/mental development
24. (a) BOD – Biochemical Oxygen Demand

- (b) The amount of the oxygen that would be consumed if all the organic matter in 1 litre of water were oxidised by bacteria

The greater the BOD of waste water more is its polluting potential

23. ● Made crops more tolerant to abiotic stresses (cold, drought, salt, heat).
● reduced reliance on chemical pesticides (pest resistant crops).
● helped to reduce post-harvest losses.
● increased efficiency of mineral usage by plants (this prevents early exhaustion of fertility of soil).
● enhanced nutritional value of food (eg, golden rice Le vitamin 'A' enriched rice).
● tailor-made plants to supply alternative resources to industries in the form of starches, fuels and pharmaceuticals.
26. (a) Three alleles Gamene
(b) Co-dominance.
(c) Yes, they can have a child with 'O' blood group



27. The Amazon rain forest is being cut and cleared for cultivating soya beans or for conversion of grasslands for raising beef cattle which threaten survival of many species.

When large habitats are broken up into small fragments mammals and birds requiring large territories, and certain animals with migratory habits are badly affected leading to their extinction or population decline.

28. (a) The given type of pollination prevents inbreeding depression/ prevents loss of fertility/promote hybrid vigour/ improve genetic variability
- (b) ● The plant will not show geitonogamy
● because in this flowering plant pollen release and stigma receptivity are not synchronised/as the flowers are present on different plants.

SECTION D

29. (a) (iii) Greater, Greater
- (b) (i) Divergent evolution
(ii) Divergent evolution
- both indicates common ancestry as in both cases cytochrome C is the respiratory pigment.
- (c) (i) Convergent evolution: Different structures evolving for the same function and hence having similarity.

OR

- (c) (ii) Divergent evolution: Same structure developed along different directions due to adaptations to different needs.
30. (a) 15-16 years or Adolescence period (12-18 years of age)
- (b) Clearing of forest/deforestation/Narco-deforestation/extinction of species / promotes monoculture that will further lead to loss of
- (c) (i) Inflorescence/flower tops/leaves/resin
Affects the cardiovascular system of the body/any other correct effect

OR

- (c) (ii) *Erythroxylum coca*
Causes hallucinations.

SECTION E

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

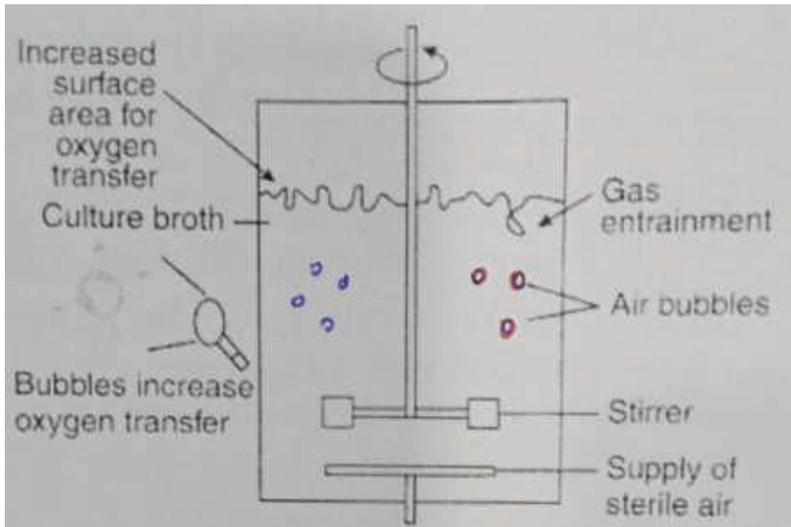
Areas of benefits are

- Normal physiology and development, Transgenic animals can be specifically designed to allow the study of how genes are regulated and how they affect the normal functions of the body and its development like study of complex factors involved in growth such as insulin-like growth factor.
- Study of disease, transgenic animals are used to increase understanding of how genes contribute to the development of disease like cancer or cystic fibrosis
- Biological products, transgenic animals that produce useful biological products can be created and the products can be used to treat diseases like (α-1-antitrypsin) human protein can be produced to treat emphysema / Rosie, produced human protein enriched milk containing alpha lactalbumin which is a balanced product for human babies or any other examples.
- Vaccine safety, transgenic mice are being developed for use in testing the safety of vaccines before they are used in humans like transgenic mice are being used to test the safety of the polio vaccine (or any others example)
- Chemical safety testing, transgenic animals are modified to carry gene which make them more sensitive to toxic substances than non-transgenic animals so transgenic animals are exposed to the toxic substances and the effects studied

OR

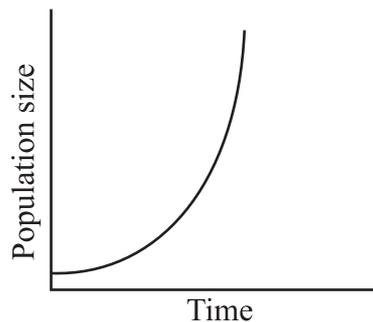
- (b)
- Vessels or large containers which provide optimal conditions to produce the desired product.
 - The stirrer facilitates even mixing, and oxygen availability throughout the bioreactor.
 - Air is bubbled through the reactor to increase the oxygen transfer area.
 - It has foam control system, a temperature control system, pH control system, salts, vitamins, sampling ports so that small volume of culture can be withdrawn periodically.

OR



Sparged stirred tank bioreactor (NCERT Page No. 174)

32. (a) (i) When resources in the habitat are unlimited each species has the ability to realize fully its innate potential to grow in number, the population grow in an exponential or geometric fashion. It results in a J-shaped curve when we plot population density in relation to time.
- (ii) $\frac{dN}{dt} = (b - d) \times N$ / $\frac{dN}{dt} = rN$ / $N_t = N_0 e^{rt}$
 r = intrinsic rate of natural increase
 N = size of the population
 b = birth rate
 d = death rate
- (iii) Exponential growth curve



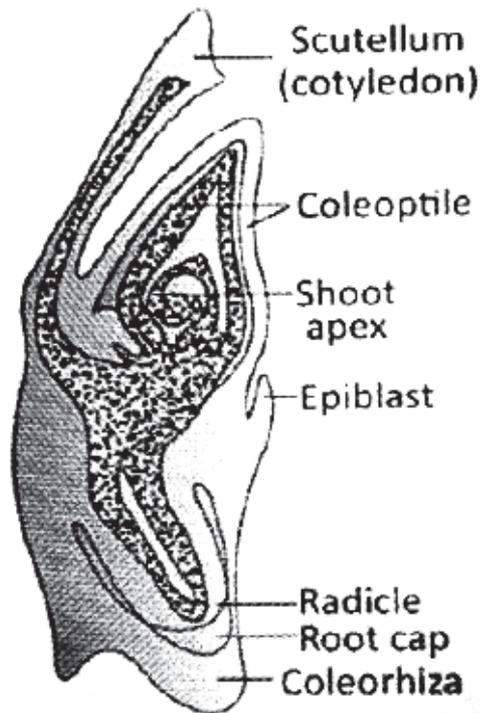
OR

(b) (i) • Within a region species richness increases with increasing explored area, but only up to a limit

$$(ii) \log S = \log C + 2 \log A/S = CAZ$$

33. (a) (i) Embryo of a monocotyledon seed has one cotyledon called scutellum, situated towards one side (lateral) of the embryonal axis at the lower end, the embryonal axis has the radical and root cap, enclosed in an undifferentiated sheath coleorhiza, The portion of the embryonal axis above the level of attachment of scutellum is epicotyl, and a few leaf primordia enclosed in a hollow foliar structure the coleoptile

OR



(ii) Some of the Nuclear cells surrounding the embryo sac start dividing, and protrude into the embryo sac and develop into embryos.

Apomixis/Polyembryony

OR

(b) (i) ● Rete testis, The seminiferous tubules of the testis open into the Vasa efferentia through rete testis

- Vasa efferentia, leave the testis and open into epididymis located along the posterior surface of each testis

- Epididymis, the epididymis leads to Vas deferens

- Vas deferens, this ascends to the abdomen and loops over the urinary bladder.

(ii) FSH acts on Sertoli cells, stimulates secretion of some factors which help in the process of spermiogenesis (which is a part of spermatogenesis).

PRACTICE QUESTION PAPER 1 (UNSOLVED)

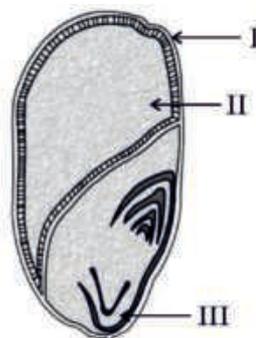
CLASS - XII

Time : 3 Hours

Maximum Marks : 70

SECTION - A

1. Given below is a diagram of T.S. of a monocot seed with parts I, II & III labelled:



Choose the option where parts I, II and III are identified correctly.

- | I | II | III |
|-----------------|------------|------------|
| (A) Pericarp, | Endosperm, | Scutellum |
| (B) Pericarp, | Endosperm, | Coleorhiza |
| (C) Scutellum, | Pericarp, | Coleorhiza |
| (D) Coleorhiza, | Scutellum, | Pericarp |
2. The number of autosomes present in a human secondary spermatocyte
(A) 44 (B) 22 (C) 23 (D) 46
3. A child with blood group A has father with blood group B and the mother with blood group AB. Choose the option that gives the correct genotypes of father, mother and the child :

| | Father | Mother | Child |
|-----|-----------|-----------|-----------|
| (A) | $I^A i$ | $I^B i$ | $I^A i$ |
| (B) | $I^A I^B$ | $I^A i$ | $I^A I^A$ |
| (C) | $I^B i$ | $I^A I^B$ | $I^A i$ |
| (D) | $I^A I^B$ | $I^A I^B$ | $I^A I^A$ |

Choose the option that correctly matches the items of Column-I with those of Column-II:

- | | | | |
|-----|-------|-------|-------|
| | (a) | (b) | (c) |
| (A) | (i) | (ii) | (iii) |
| (B) | (iii) | (ii) | (i) |
| (C) | (ii) | (iii) | (i) |
| (D) | (i) | (iii) | (ii) |

9. For commercial and industrial production of citric acid, which one of the following microbes is used?
- (A) *Aspergillus niger* (B) *Lactobacillus sp*
(C) *Clostridium butylicum* (D) *Saccharomyces cerevisiae*
10. If Meselson and Stahl's experiment is continued for 80 minutes (till IV generation) then what would be the ratio of DNA containing N¹⁵/N¹⁵ : N¹⁵/N¹⁴ : N¹⁴/N¹⁴ in the medium?
- (A) 1 : 1 : 0 (B) 0 : 1 : 3
(C) 0 : 1 : 8 (D) 1 : 4 : 0
11. Select the correct statement from the following biotechnological procedures :
- (A) The polymerase enzyme joints the gene of interest and the vector DNA.
(B) Gel electrophoresis is used for amplification of a DNA segment
(C) PCR is used for isolation and separation of gene of interest.
(D) Plasmid DNA acts as vector to transfer the piece of DNA attached to it.
12. The decrease in the T-Lymphocytes count in human blood will finally result in
- (A) decrease in antigens (B) decrease in antibodies
(C) increase in antibodies (D) increase in antigens

Question number 13 to 16 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, 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.
13. Assertion (A) : Corpus luteum secretes the hormone, progesterone.
Reason (R) : Hormone Progesterone is essential for maintenance of the endometrium.
14. Assertion (A) : The number of white winged moths decreased after industrialisation in England.
Reason (R) : Effects of industrialisation were more marked in rural areas of England.
15. Assertion (A) : *Streptococcus pneumoniae* and *Haemophilus influenzae* are responsible for causing infectious disease in human beings.
Reason (R) : A healthy person acquires the infection by inhaling the aerosols released by an infected person.
16. Assertion (A) : Restriction endonuclease recognises palindromic sequence in DNA and cuts them.
Reason (R) : Palindromic sequence has two unique recognition sites Pst I and Pvu I recognised by restriction endonuclease.

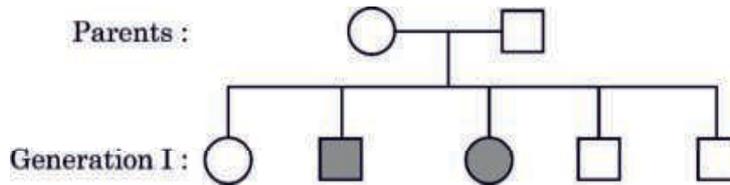
SECTION - B

17. Student to attempt either option (A) or (B) :
- (A) (i) Write two crucial changes, the seed undergoes while reaching maturity that enable them to be in a viable state until the onset of favourable conditions.
(ii) Name the oldest viable seed excavated from Arctic Tundra as per the records.

OR

- (B) (i) Pea flower produce assured seed sets. Give reason.
(ii) In case of Polyembryony, an embryo 'P' develops from a synergid and the embryo 'Q' develops from the nucellus. State the ploidy of embryo 'P' and 'Q'.

18. Study the given pedigree chart in which neither of the parents shows the trait but the trait is present in both male and female children.



Answer the following questions:

- (a) Write about the trait, also explain the inheritance of such trait in the progeny on the basis of given pedigree chart.
- (b) Give one example of such trait in human beings.
19. Student to attempt either option (A) or (B).

(A) Describe any two situations where a medical doctor would recommend injection of a preformed antibodies (antitoxins) into the body of a patient.

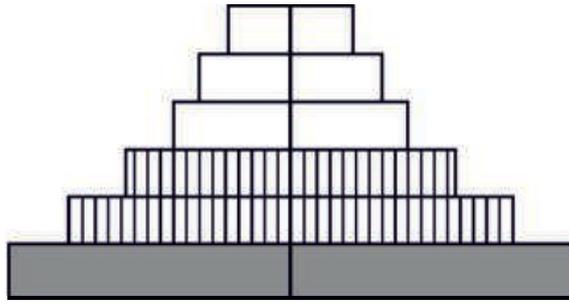
OR

(B) The symptoms of malaria do not appear immediately after the entry of Osporozoites into the human body when bitten by female Anopheles mosquito. Explain why it happens.

20. Observe the given sequence of nitrogenous bases on a DNA fragment and answer the following questions :

5' GTCTTAAGAAT 3'

- (a) Name the restriction enzyme which can recognise the DNA sequence.
- (b) Write the sequence after restriction enzyme cut the palindrome.
- (c) Why are the ends generated after digestion called as 'Sticky Ends'?
21. Student to attempt either option (A) or (B).
- (A) Identify the type of pyramid given below and write two identifying features of such a pyramid



OR

- (B) (i) Construct an ideal pyramid of energy when 10,00,000 Joules of sunlight is available.
 (ii) Mention the energy obtained by the fourth level of this pyramid.

SECTION - C

22. (a) A bilobed dithecous anther has 200 microscope mother cells per microsporangium. How many male gametophytes can be produced by this anther?
 (b) Write the composition of intine and extine layers of a pollen grain.
23. (a) List two reasons that make copper releasing IUDs as effective contraceptives.
 (b) Explain how the intake of oral contraceptive pills prevent pregnancy in humans.
24. Using a Punnett square work out the distribution of an autosomal phenotypic feature in the first filial generation after a cross between a homozygous female and a heterozygous male for a single locus.
25. How does the process of Natural Selection affect Hardy-Weinberg equilibrium? Explain with the help of graphs.
26. Samples of blood and urine of a sportsperson are collected before any sports event for drug tests.
 (a) Why there is a need to conduct such tests?
 (b) Name the drugs the authorities usually look for.
 (c) Write the generic names of two plants from which these drugs are obtained.

27. (a) The insulin synthesised in our body is different from that synthesised by Eli Lilly company using recombinant DNA technology. Differentiate between them.
- (b) Why the insulin extracted from an animal source is not in use these days?
28. (a) Draw a graph for a population whose population density has reached the carrying capacity.
- (b) Out of the two population growth curves, which one is considered a more realistic for most populations? Why?
- (c) Draw a growth curve where resources are not limiting for the growth of a population and give its equation.

SECTION-D

Question Nos. 29 and 30 are case based questions.

29. Immunity in our body is of two types: (i) Innate immunity and (ii) acquired immunity. Innate immunity is a non-specific defence mechanism, whereas acquired immunity is pathogen-specific; it is called specific immunity too. Acquired immunity is characterised by memory. Antibodies are specific to antigens and there are different types of antibodies produced in our body: they are IgA, IgE, IG and IgM. It shows primary response when it encounters the pathogen for the first time and secondary response during the subsequent encounters with the same Antigen/Pathogen.

- (a) Name the two types of specialised cells which carry out the primary and secondary immune response.
- (b) Why is the antibody-mediated immunity also called as humoral immune response?

Attempt either sub-part (c) or (d):

- (c) The organ transplants are often rejected if not taken from suitable compatible persons.
- (i) Mention the characteristic of our immune system that is responsible for the graft rejection.

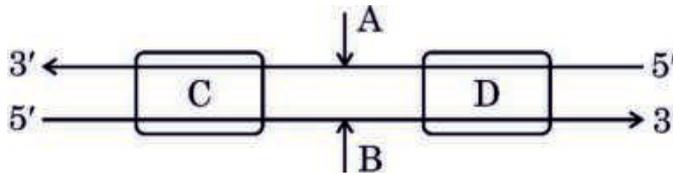
(ii) Name the type of immune response and the cell involved in it.

OR

(d) How is active immunity different from passive immunity?

30. The process of copying the genetic information from one strand of DNA into RNA is termed as transcription. The principle of complementarity of bases governs the process of transcription, also except that uracil comes in place of thymine.

Study the complete transcription unit given below and answer the following questions:



- (a) Name the main enzyme involved in the process of transcription.
(b) Identify coding strand and template strand of DNA in the transcription unit.

Attempt either sub-part (c) or (d):

- (c) Identify (C) and (D) in the diagram, mention their significance in the process of transcription.

OR

- (d) Describe the location of (C) and (D) in the transcription unit.

SECTION-E

31. Student to attempt either option (A) or (B).

- (A) (i) Describe the process of megasporogenesis in an angiosperm.
(ii) Draw a diagram of a mature embryo sac of an angiosperm. Label its any four parts.

OR

- (B) The reproductive cycle in the female primates is called menstrual cycle. The first menstruation begins at puberty.

Answer the following questions:

- (i) Name the four phases of menstrual cycle in a proper sequence.
 - (ii) How long does the menstrual phase last in a menstrual cycle?
 - (iii) When and why hormones estrogen and progesterone reach their peak levels respectively, in the menstrual cycle?
 - (iv) Give the significance of LH surge.
32. Student to attempt either option (A) or (B).
- (A) (i) Explain how is a bacterial cell made 'competent' to take up recombinant DNA from the medium.
 - (ii) Explain the steps of amplification of gene of interest using PCR technique.

OR

- (B) (i) What are transgenic animals?
 - (ii) Why are these animals being produced? Explain any four reasons.
33. Student to attempt either option (A) or (B).
- (A) (i) Explain giving three reasons why tropics show greatest levels of species diversity.
 - (ii) Draw a graph showing species-areas relationship. Name the naturalist who studied such relationship. Write the observation made by him.

OR

- (B) (i) The world is facing the accelerated rate of species extinctions due to human activities. Explain any three major causes of biodiversity losses.
- (ii) Describe 'Ex situ' approach for conserving biodiversity. Give any two examples.

PRACTICE QUESTION PAPER 2 (UNSOLVED)

CLASS - XII

Time : 3 Hours

Maximum Marks : 70

SECTION - A

1. Cistron is a segment of DNA coding for a :
(A) Polypeptide only
(B) mRNA only
(C) Polypeptide, tRNA and rRNA
(D) mRNA, tRNA and rRNA
2. In a pedigree chart, if two unaffected individuals have a child with the trait, what is the most likely mode of inheritance for this trait?
(A) Autosomal dominant (B) Autosomal recessive
(C) X-linked dominant (D) X-linked recessive
3. If a natural population with 200 individuals is in Hardy-Weinberg equilibrium for a gene with two alleles A and a, with the gene frequency of allele A of 0.8, the genotype frequency of Aa will be:
(A) 0.8 (B) 0.16 (C) 0.32 (D) 0.64
4. Select the statement that are true for a typical monocotyledonous embryo from the given options.
(i) Scutellum is present towards the centre of the embryonal axis.
(ii) Embryonal axis of the lower end has radicle and root cap covered by coleoptile.
(iii) The portion of embryonal axis above the level of attachment of scutellum is epicotyl.
(iv) Shoot apex and few leaf primordia of embryo are enclosed in a hollow foliar structure.

Choose the correct answer from the following:

- (A) (i) and (ii) (B) (ii) and (iii)
(C) (iii) and (iv) (D) (i) and (iv)

5. Given below are a few statements with reference to the human sperm.
- (i) Sperm head contains a large nucleus and a lot of cytoplasm.
 - (ii) Mitochondria in the middle piece of a sperm provides ATP for the sperm motility.
 - (iii) Posterior part of the sperm head is covered by acrosome.
 - (iv) Spermatids undergo maturation into spermatozoa by the process of spermiogenesis.
 - (v) Acrosomal secretions help in the entry of the sperm into the ovum at the time of fertilization.

Choose the option with all true statements from the given options:

- (A) (i), (ii) and (iv)
 - (B) (ii), (iii) and (iv)
 - (C) (ii), (iv) and (v)
 - (D) (i), (iii) and (iv)
6. A normal couple produces half the sons as haemophilic and half the daughters as carriers. Choose the option that correctly indicates the chromosome on which the gene for this trait is located.
- (A) X-chromosome of father
 - (B) Y-chromosome of father
 - (C) One X-chromosome of mother
 - (D) Both the X-chromosomes of the mother
7. If the sequence of bases in DNA is ATTCGATG, then the sequence of bases in the transcript will be :
- (A) CAUCGAAU
 - (B) UAAGCUAC
 - (C) AUUCGAUG
 - (D) GUAGCUUA
8. In a translational unit UTRs are present at:
- (A) 5' end (after start codon) and 3' end (after stop codon).
 - (B) 5' end (before start codon) and 3' end (before stop codon).
 - (C) 5' end (after start codon) and 3' end (before stop codon).
 - (D) 5' end (before start codon) and 3' end (after stop codon).
9. The lymphoid organ located within the lining of respiratory, digestive and urinogenital tract is :
- (A) GEAC
 - (B) MALT
 - (C) NACO
 - (D) RCH

10. Land reptiles which went back into water about 200 mya to evolve into fish-like reptiles were
(A) Ichthyosaurus (B) Tyrannosaurus
(C) Stegosaurus (D) Brachiosaurus
11. Certain viruses used as biological control agents belong to the genus:
(A) Nucleopolyhedrovirus (B) Adenovirus
(C) Tobacco Mosaic Virus (D) Rhinovirus
12. The cloning site present in the ampicillin resistance gene of E. coli cloning vector pBR322 is:
(A) BamHI (B) EcoRI (C) PstI (D) SalI

For Questions number 13 to 16, two statements are given-one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.

- (A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false, but Reason (R) is true.
13. Assertion (A): An antibody is a protein molecule made by the lymphocytes.
Reason (R): An antibody binds to a specific foreign antigen and neutralizes its odd effects.
14. Assertion (A): Male contraceptive 'Nirodh' works on the principle of avoiding chances of ovum and sperm meeting.
Reason (R): It is made of thin rubber/latex sheath and is used to cover the penis before coitus.
15. Assertion (A): In dihybrid crosses involving sex-linked genes in Drosophila generation of non-parental gene combinations are observed.
Reason (R): Two genes present on different chromosomes show linkage and recombination in Drosophila.

16. Assertion (A): Isolated single cells can be fused to produce somatic hybrids.

Reason (R): Cells selected for somatic hybridisation have desirable characters.

SECTION - B

17. (a) Why are restrictions imposed on MTP in India? Up to how many weeks or trimesters, is MTP considered relatively safe for a female, if necessary to perform, by a medical practitioner?

OR

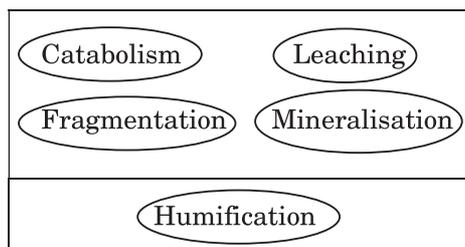
- (b) Expand PID. Name any two common viral infections transmitted through sexual contact in human females.
18. (a) (i) Explain why the milk produced by the mother during the initial days of lactation is considered to be very essential for the newborn infant.
- (ii) What is the term used for the milk produced during the initial days of lactation?

OR

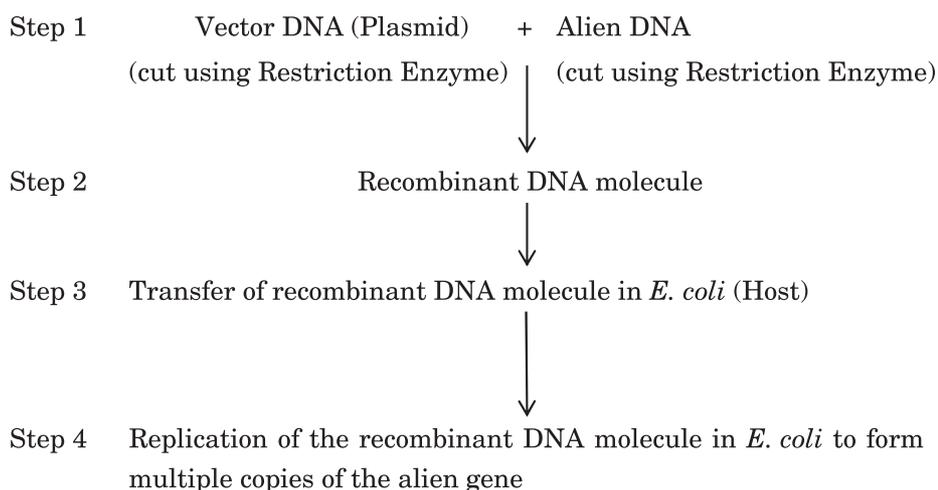
- (b) Many children in the metro cities are suffering from a very common exaggerated response of the immune system to certain weak antigens in air.
- (i) What is the term used for the above mentioned disease?
- (ii) Name the main type of antibody produced by the immune system in response to this disease.
- (iii) Which two main inflammation-causing chemicals are produced by the mast cells in such an immune response?
19. (a) How is the interaction between Ophrys and its specific bee pollinator one of the best examples of co-evolution? Explain.

OR

- (b) Arrange the given important steps of decomposition in their correct order of occurrence in the breakdown of complex organic matter and explain the fourth step in the process.



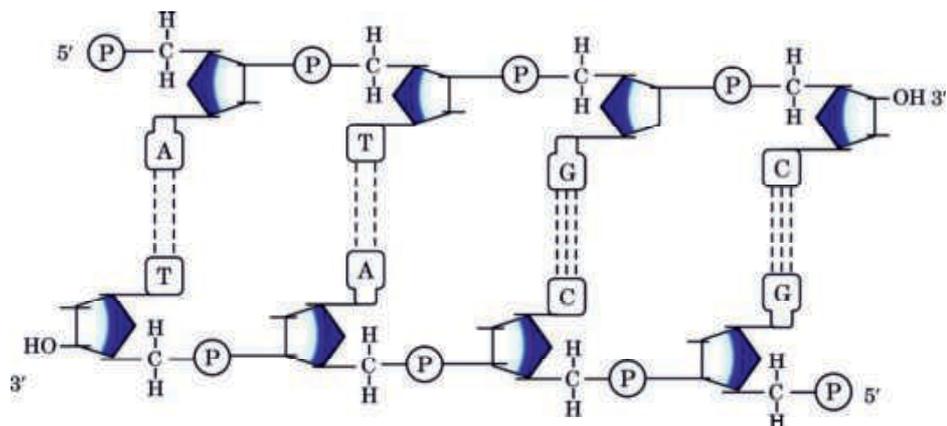
20. The basic scheme of the essential steps involved in the process of recombinant DNA technology is summarised below in the form of a flow diagram. Study the given flow diagram and answer the questions that follow.



- (a) What is the technical term used for Step 4 in the above process?
- (b) Which of the given two combinations of restriction enzyme should be used in Step 1? Justify your answer.
- (i) EcoR I to cut the plasmid and Hindu III to cut the alien DNA.
- (ii) EcoR I to cut the plasmid and alien DNA.

21. Study the given molecular structure of double-stranded polynucleotide chain of DNA and answer the questions that follow.

- (a) How many phosphodiester bonds are present in the given double-stranded polynucleotide chain?



- (b) How many base pairs are there in each helical turn of double helix structure of DNA? Also write the distance between a base pair in a helix.
- (c) In addition to H-bonds, what confers additional stability to the helical structure of DNA?

SECTION C

22. (a) What do you mean by activated sludge in an STP?
 (b) Explain the biological treatment of the major part of the sludge transferred from the large aeration tank into the anaerobic sludge digesters before its final release into the natural water bodies.
23. Explain the beneficial role of the following, produced as a result of the processes of biotechnology, to mankind:
 (a) Cow named Rosie (b) alpha-1-antitrypsin
24. Answer the following questions with respect to the sex determining mechanism observed in honey bee.
 (a) What is the type of cell division involved in the formation of gametes in a female bee and a male bee respectively?
 (b) Name the type of sex determination system observed in honey bees.
 (c) What is the sex of honey bee formed from the unfertilised eggs? Write the number of chromosomes present in it.

25. (a) Alien species are highly invasive and are a threat to indigenous species. Substantiate this statement with the help of any two examples.
- (b) State any two criteria for determining biodiversity hotspots.
26. Explain how the addition of lactose in the medium regulates the switching on of the lac operon in bacteria.
27. (a) Name and explain the role of inner and middle walls of the human female uterus.
- (b) Write the location and function of fimbriae in human female.
28. Flowering plants with hermaphrodite flowers have developed many reproductive strategies to ensure cross-pollination. Study the given outbreeding devices adopted by certain flowering plants and answer the questions that follow.

| Stigma \ Pollen grains | Pollen grains of Plant A | Pollen grains of Plant B | Pollen grains of Plant C |
|------------------------|--------------------------|--------------------------|--------------------------|
| Stigma of Plant A | × | ✓ | ✓ |
| Stigma of Plant B | ✓ | × | ✓ |
| Stigma of Plant C | ✓ | ✓ | × |

Note:

All plants belong to the same species.

x - No pollen tube growth/inhibition of pollen germination on stigma.

- Pollen germination on stigma.

- (a) Name and define the outbreeding device described in the above table.
- (b) Explain what would have been the disadvantage to the plant in the absence of the given strategy.

SECTION D

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

29. Read the following passage and answer the questions that follow.

According to evolutionary theory, every evolutionary change involves the substitution of a new gene for the old one and the new allele arises from the old one. Continuous accumulation of changes in the DNA coding for proteins leads to evolutionary differences. The chemical composition of DNA is basically the same in all living beings, except for differences in the sequence of nitrogenous bases. Given below are percentage relative similarities between human DNA and DNA of other vertebrates:

| S.No. | Vertebrates | Percentage similarities |
|-------|---------------|-------------------------|
| 1. | Chimpanzee | 100 |
| 2. | Gibbon | 94 |
| 3. | Rhesus Monkey | 88 |
| 4. | Lemur | 47 |
| 5. | Treeshrew | 28 |
| 6. | Mouse | 21 |
| 7. | Hedgehog | 19 |
| 8. | Chicken | 10 |

- (a) What is the term used for the substitution of a new gene for the old one and the new allele arising from the old one during evolutionary process?
- (b) Which one of the following holds true for the data provided in the above table?
- (A) Greater the evolutionary distance, greater are the differences in the nitrogenous bases.
- (B) Lesser the evolutionary distance, greater are the differences in the nitrogenous bases.
- (C) Greater the evolutionary distance, lesser are the differences in the nitrogenous bases.
- (D) Lesser the evolutionary distance, lesser are the differences in the nitrogenous bases.

- (c) (i) To which category of evolution (divergent or convergent) does the following relationship belong to? Justify your answer.

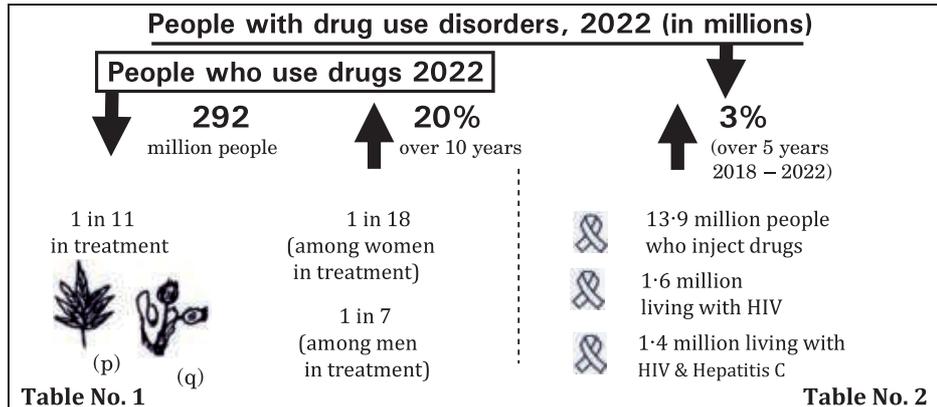
Human and Rhesus Monkey

OR

- (c) (ii) Differentiate between Convergent and Divergent evolution.

30. Read the following passage and answer the questions that follow.

Prevention is the frontline response to drug use. Effective interventions address the underlying conditions to drug use, such as a lack of connection to family or community, instability, insecurity, trauma, mental health issues, etc. When addressed, these factors can effectively prevent the initiation of drug use and the progression to drug use disorders. Study the few key figures of drug use given below and answer the questions that follow.



- (a) What do you infer from the figures in Table No. 1 about the people with drug use disorders, 2022 (in million)? State any two of your observations.
- (b) How are Hepatitis C and HIV related to drug use disorders by people, as shown in Table No.2? State the correlation between the two.
- (c) (i) Give the scientific name of (p) shown in Table No. 1.

OR

- (c) (ii) Give the scientific name of (q) shown in Table No. 1.

SECTION E

31. (a) (i) Explain how human pro-insulin is processed in the cell to become a fully mature functional insulin.
(ii) Describe how human insulin is produced using the techniques of genetic engineering.

OR

- (b) (i) Explain the working of a simple stirred-tank bioreactor.
(ii) Describe what is meant by downstream processing.
32. (a) (i) Describe the Species-Area relationship for $S=CA^Z$. What is the significance of 'Z' in Species-Area relationship?

OR

- (b) (i) Describe the logistic population growth curve with the help of a suitable graphical representation.
(ii) Write the equation of Verhulst-Pearl logistic growth curve and explain what 'K' and 'r' suggest in the given equation.
33. (a) (i) Explain the structure of a mature embryo sac of a typical flowering plant.
(ii) How is triple fusion achieved in these plants?

OR

- (b) Describe changes in the ovary and the uterus as induced by the changes in the level of pituitary and ovarian hormones during menstrual cycle in a human female.

