

CBSE Board Examination – 2024
BIOLOGY (Theory)
Solved Paper
Class–12th

Maximum Marks: 70

Time allowed: 3 hours

General Instructions:

Read the following instructions carefully and follow them:

- (i) This question paper contains 33 questions. All questions are compulsory.
- (ii) Question paper is divided into FIVE sections. Section A, B, C, D and E.
- (iii) Section A – question numbers 1 to 16 are Multiple Choice type questions. Each question carries 1 mark.
- (iv) Section B – question numbers 17 to 21 are Very Short Answer type questions. Each question carries 2 marks.
- (v) Section C – question numbers 22 to 28 are Short Answer type questions. Each question carries 3 marks.
- (vi) Section D – question numbers 29 and 30 are Case-based questions. Each question carries 4 marks. Each question has subparts with internal choice in one of the subparts.
- (vii) Section E – question numbers 31 to 33 are Long Answer type questions. Each question carries 5 marks.
- (viii) There is no overall choice. However, an internal choice has been provided in section B, C and D of question paper. A candidate has to write answer for only one of the alternatives in such questions.
- (ix) Kindly note that there is a separate question paper for Visually Impaired candidates.
- (x) Wherever necessary, neat and properly labelled diagrams should be drawn.

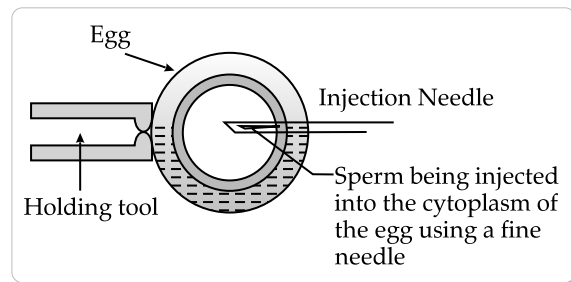
Delhi Set-1

57/5/1

SECTION – A

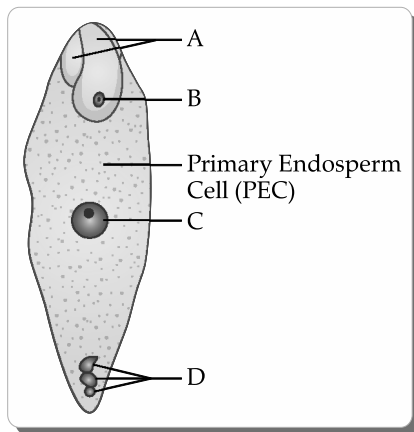
Question No. 1 to 16 are Multiple Choice type questions, carrying 1 mark each. 16×1=16

1. A single gene that controls the expression of more than one trait is said to show 1
(A) Multiple allelism
(B) Polygenic inheritance
(C) Incomplete dominance
(D) Pleiotropism
2. A person with trisomy of 21st chromosome shows 1
(i) Furrowed tongue
(ii) Characteristic palm crease
(iii) Rudimentary ovaries
(iv) Gynaecomastia
Select the correct option from the choices given below:
(A) (ii) and (iv)
(B) (i), (ii) and (iv)
(C) (ii) and (iii)
(D) (i) and (ii)
3. Observe the schematic representation of assisted reproductive technology given below:

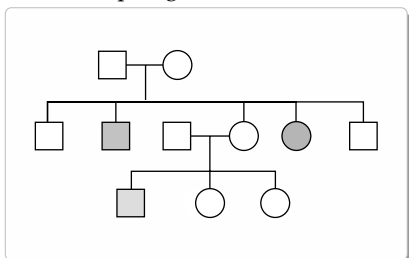


- Identify the most appropriate technique depicted in the above diagram. 1
- (A) IUT (B) IUI
(C) ICSI (D) ZIFT
4. Interferons are proteins secreted by 1
(A) RBC
(B) WBC
(C) Bacteria infected cell
(D) Virus infected cell
 5. During biological treatment of sewage, the masses of bacteria held together by fungal filaments to form mesh like structures are called 1
(A) primary sludge (B) flocs
(C) activated sludge (D) anaerobic sludge

6. Which one of the following statements is correct in the context of observing DNA separation by agarose gel electrophoresis? **1**
 (A) DNA can be seen in visible light.
 (B) DNA can be seen without staining in visible light.
 (C) Ethidium bromide stained DNA can be seen in visible light.
 (D) Ethidium bromide stained DNA can be seen under UV light.
7. A phenomenon where a male insect mistakenly identified the patterns of a orchid flower as the female insect partner and tries to copulate and thereby pollinates the flower is said to be: **1**
 (A) Pseudocopulation
 (C) Pseudopollination
 (B) Pseudoparthenocarpy
 (D) Pseudofertilisation
8. Identify the correct labellings in the figure of a fertilised embryo sac of an angiosperm given below: **1**



- (A) A – zygote, B – degenerating synergids, C – degenerating antipodals, D – PEN
 (B) A – degenerating synergids, B – zygote, C – PEN, D – degenerating antipodals
 (C) A – degenerating antipodals, B – PEN, C – degenerating synergids, D – zygote
 (D) A – degenerating synergids, B – zygote, C – degenerating antipodals, D – PEN
9. Study the pedigree chart of a family showing the inheritance pattern of a certain disorder. Select the option that correctly identifies the nature of the trait depicted in the pedigree chart. **1**



- (A) Dominant X-linked
 (B) Recessive X-linked

- (C) Autosomal dominant
 (D) Autosomal recessive
10. Match the following genes of the lac operon listed in column 'A' with their respective products listed in column 'B': **1**

A		B	
Gene		Products	
a.	'i' gene	(i)	β -galactosidase
b.	'z' gene	(ii)	lac permease
c.	'a' gene	(iii)	repressor
d.	'y' gene	(iv)	transacetylase

Select the correct option:

- a b c d
 (A) (i) (iii) (ii) (iv)
 (B) (iii) (i) (ii) (iv)
 (C) (iii) (i) (iv) (ii)
 (D) (iii) (iv) (i) (ii)
11. If both the parents are carriers for thalassaemia, the chances of an afflicted child to be born to them is: **1**
 (A) 25% (B) 50%
 (C) 75% (D) 100%
12. If the sequence of nitrogen bases of the coding strand in a transcription unit is 5' – ATGAATG – 3', the sequence of bases in its RNA transcript would be **1**
 (A) 5' – AUGAAUG – 3' (B) 5' – UACUUAC – 3'
 (C) 5' – CAUUCAU – 3' (D) 5' – GUAAGUA – 3'

Question numbers 13 to 16 consist of two statements Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:

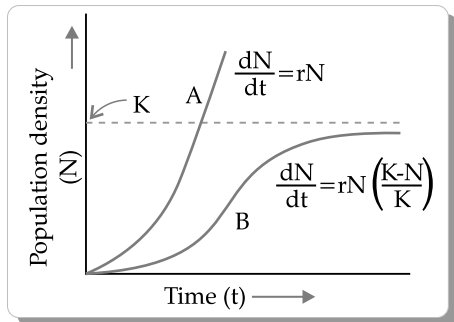
- (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
 (B) Both (A) and (R) are true, but (R) is not the correct explanation of (A).
 (C) (A) is true, but (R) is false.
 (D) (A) is false, but (R) is true.
13. **Assertion (A):** AIDS is a syndrome caused by HIV. **1**
Reason (R): HIV is a virus that damages the immune system with DNA as its genetic material.
14. **Assertion (A):** In molecular diagnosis, single stranded DNA or RNA tagged with radioactive molecule is called a probe. **1**
Reason (R): A probe always searches and hybridises with its complementary DNA in a clone of cells.
15. **Assertion (A):** In birds, the sex of the offspring is determined by males. **1**
Reason (R): Males are homogametic while females are heterogametic.
16. **Assertion (A):** Communities that comprise more species tend to be more stable. **1**
Reason (R): A higher number of species results in less year to year variation in total biomass.

SECTION – B

17. (a) "Farmers prefer apomictic seeds to hybrid seeds." Justify giving two reasons. **2**

OR

- (b) Mention one advantage and one disadvantage of amniocentesis. 2
18. 5' - G↓AATTC - 3'
3' - CTTAA↑G - 5'
- (a) Name the restriction enzyme that recognises the given specific sequence of bases. What are such sequence of bases referred to as? 1
- (b) What are the arrows in the given figure indicating? Write the result obtained thereafter. 1
19. Observe the population growth curve and answer the questions given below:



- (a) State the conditions under which growth curve 'A' and growth curve 'B' plotted in the graph are possible. 1
- (b) Mention what does 'K' in the graph represent. 1
20. Explain how are plants benefitted by their association with "*Glomus species*". 2
21. If the base adenine constitutes 31% of an isolated DNA fragment, then write what will be the expected percentage of the base cytosine in it. Explain how did you arrive at the answer given. 2

SECTION - C

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

Sl. No.	Organism	Bioactive Molecule	Use
1.	<i>Monascus purpureus</i>	a	b
2.	c	d	Antibiotic
3.	e	Cyclosporin A	f

23. (a) Tropical regions harbour more species than the temperate regions. How have biologists tried to explain this in their own ways? Explain. 3

OR

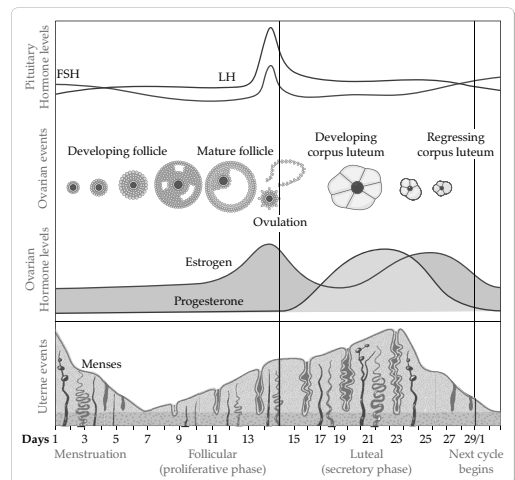
- (b) (i) What does an ecological pyramid represent?
(ii) The ecological pyramids may have an 'upright' or an 'inverted' shape. Justify with the help of suitable examples. 3
24. (a) What are transgenic animals?
(b) Name the transgenic animal having the largest number amongst all the existing transgenic animals.
(c) State any three reasons for which these types of animals are being produced. 3

25. If the cells in the leaves of a maize plant contain 10 chromosomes each, write the number of chromosomes in its endosperm and zygote. Name and explain the process by which an endosperm and a zygote are formed in maize. 3
26. (a) Why does DNA replication occur within a replication fork and not in its entire length simultaneously?
(b) "DNA replication is continuous and discontinuous on the two strands within the replication fork." Explain with the help of a schematic representation. 3
27. Explain the processing of heterogeneous nuclear RNA (hnRNA) into a fully functional mRNA in eukaryotes. Where does this processing occur in the cell? 3
28. The world is facing accelerated rates of species extinction largely due to human activities. Explain any three human activities responsible for accelerated rates of species extinction. 3

SECTION - D

Q. No. 29 and 30 are case based questions. Each question has three sub-questions with internal choice in one sub-question.

29. In a human female, the reproductive phase starts on the onset of puberty and ceases around middle age of the female. Study the graph given below regarding menstrual cycle and answer the questions that follow:



- (a) Name the hormones and their source organ, which are responsible for menstrual cycle at puberty. 1
- (b) For successful pregnancy, at what phase of the menstrual cycle an early embryo (upto 3 blastomeres) should be Implanted in the Uterus (IUT) of a human female who has opted for Assisted Reproductive Technology (ART)? Support your answer with a reason. 1
- (c) Name the hormone and its source organ responsible for the events occurring during proliferative phase of menstrual cycle. Explain the event. 2

OR

- (c) In a normal human female, why does menstruation only occur if the released ovum is not fertilised? Explain. 2
30. Read the following passage and answer the questions that follow:
 "Mosquitoes are drastically affecting the human health in almost all the developing tropical countries. Different species of mosquitoes cause very fatal diseases so much so that many humans lose their life and if they survive, are unable to put in productive hours to sustain their life. With the result, the health index of the country goes down."
 (a) Name the form in which *Plasmodium* gains entry into (i) human body (ii) the female *Anopheles* body. 1
 (b) Why do the symptoms of malaria not appear in a person immediately after being bitten by an infected female *Anopheles*? Give one reason. Explain when and how do the symptoms of the disease would appear. 2

OR

- (b) Explain the events which occur within a female *Anopheles* mosquito after it has sucked blood from a malaria patient. 2
 (c) Name the species of mosquito other than female *Anopheles* and the disease, for which it carries the pathogen. 1

SECTION – E

31. (a) (i) Draw a schematic diagram of the cloning vector pBR 322 and label (1) Bam HI site (2) gene for ampicillin resistance (3) 'ori' (4) 'rop' gene.
 (ii) State the role of 'rop' gene.
 (iii) A cloning vector does not have a selectable marker. How will it affect the process of cloning?
 (iv) Why is insertional inactivation preferred over the use of selectable markers in cloning vectors? 5

OR

- (b) (i) Name the nematode (scientific name) that infects the roots of tobacco plant and reduces its yield.
 (ii) Name the vector that is used to introduce nematode-specific genes into the host plant

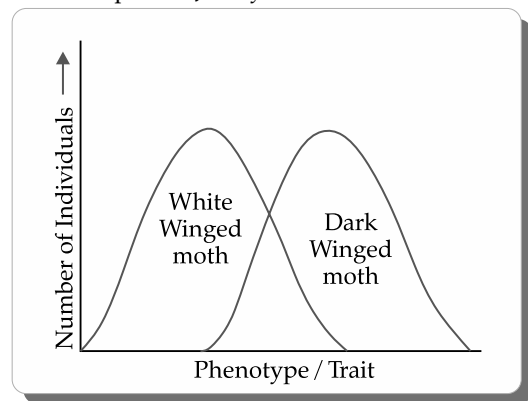
(tobacco).

- (iii) How do sense and anti-sense RNAs function?
 (iv) Why could parasite not survive in a transgenic tobacco plant? 5
32. (a) (i) Draw a diagram of a human sperm. Label any four parts and write their functions. 4
 (ii) In a human female, probability of an ovum to get fertilised by more than one sperm is impossible. Give reason. 1

OR

- (b) (i) With the help of labelled diagram only, show the different stages of embryo development in a dicot plant. 4
 (ii) Endosperm development precedes embryo development. Justify. 1

33.



- (a) Natural selection operates in different ways in nature.
 (i) Identify the type of natural selection depicted in the graph above. 1
 (ii) In England after industrialisation, the population of dark winged moths were more favoured than white winged moth. Explain. 2
 (iii) Anthropogenic action can enhance the rate of evolution. Explain with the help of an example. 2

OR

- (b) (i) Why did Hershey and Chase use ³⁵S and ³²P in their experiment? Explain. 1
 (ii) State the importance of (1) blending and (2) centrifugation in their experiment. 2
 (iii) Write the conclusion they arrived at the end of their experiment. 2

Delhi Set-2

57/5/2

Note: Except these, all other questions are available in Delhi - Set 1.

SECTION – A

2. How many base pairs will be there in 20 nucleosomes in a DNA double helix? 1
 (A) 4000 (B) 40
 (C) 20 (D) 2000
7. Which one of the following enzymes a fungal cell should be treated with to get the DNA along with other macro molecules released from it? 1
 (A) Isozymes (B) Cellulose
 (C) Ribonuclease (D) Chitinase
9. Which one of the following is **not** a characteristic

feature of "humus" that is formed during decomposition of detritus? 1

- (A) amorphous, colloidal, dark coloured substance
 (B) amorphous, colloidal, light coloured substance
 (C) substance resistant to microbial action
 (D) colloidal substance

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).

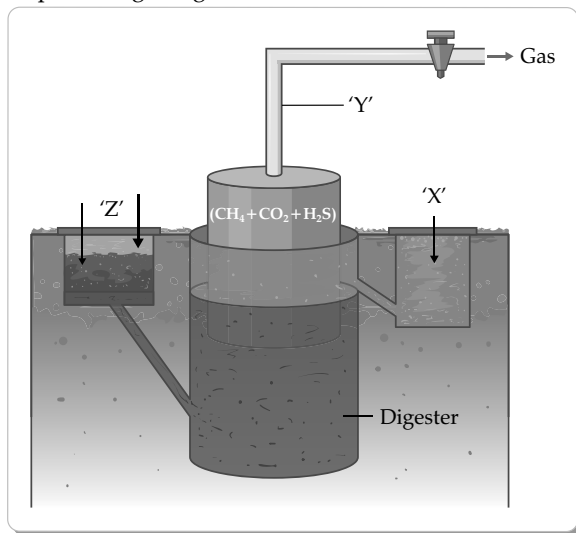
- (B) Both (A) and (R) are true, but (R) is not the correct explanation of (A).
 (C) (A) is true, but (R) is false.
 (D) (A) is false, but (R) is true.

14. **Assertion (A):** The sugar-phosphate backbone of two chains in DNA double helix show anti-parallel polarity. **1**

Reason (R): The phosphor-diester bonds in one strand go from a 3' carbon of one nucleotide to a 5' carbon of adjacent nucleotide, whereas those in complementary strand go vice versa.

SECTION - B

17. Answer the questions based on the typical biogas plant diagram given below:



- (a) Identify 'X', 'Y' and 'Z'.
 (b) Why is dung preferred for the production of biogas? **2**

SECTION - C

22. (a) How is the grazing food chain different from the detritus food chain?
 (b) "The detritus food chain may be connected to the grazing food chain at some levels in an ecosystem." Give an example in support of the statement. **3**
24. (a) Why must a cell be made 'competent' in biotechnology experiments? How does calcium ion help in doing so? **3**
 (b) State the role of "biolistic gun" in biotechnology experiments.
26. Expression of different genes for different traits may show dominance, incomplete dominance or co-dominance. Write about expression of such genes with the help of one example each. **3**

SECTION - E

32. (a) (i) Describe the events of spermatogenesis with the help of a schematic diagram. **5**
 (ii) Explain the role of hormones in spermatogenesis.

OR

- (b) (i) Show the development of megaspore mother cell upto the formation of mature embryo sac in flowering plants with the help of labelled diagrams only.
 (ii) How does geitonogamy differ from xenogamy?
 (iii) Name the type of flowers that are invariably autogamous. **5**

Delhi Set-3

57/5/3

Note: Except these, all other questions are available in Delhi - Set 1 + 2.

SECTION - A

2. Which one of the following chromosomal event will not result in genetic variation amongst the offsprings?
 (A) Independent assortment
 (B) Crossing over
 (C) Linkage
 (D) Mutation **1**
8. The source of 'Smack' is:
 (A) Leaves of *Cannabis sativa*
 (B) Flowers of *Datura*
 (C) Fruits of *Erythroxylum coca*
 (D) Latex of *Papaver somniferum* **1**
9. The first antibiotic was discovered accidentally by A while working on B. 'A' and 'B' are **1**
 (A) A-Waksman; B-*Streptococcus*
 (B) A-Fleming; B-*Penicillium notatum*
 (C) A-Waksman; B-*Bacillus brevis*
 (D) A-Fleming; B-*Staphylococci*

12. The human chromosome with the highest and least number of genes in them are respectively: **1**
 (A) Chromosome 21 and Y.
 (B) Chromosome 1 and X.
 (C) Chromosome 1 and Y.
 (D) Chromosome X and Y.

Question numbers 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.

14. **Assertion (A):** 'Biodiversity hotspots' are the regions which possess high levels of species richness, high degree of endemism. **1**

Reason (R): Total number of biodiversity hotspots in the world is 22 with two of these hotspots found in India.

SECTION – B

20. List the events that reduce the Biochemical Oxygen Demand (BOD) of a primary effluent during sewage treatment. 2

SECTION – C

23. (a) "Mother's milk is considered very essential for the new born infant." Justify. 1
 (b) What is a 'vaccine'? Explain the principle on which it works. 2
25. State why plant breeders are interested in artificial hybridisation programme. How do they carry out this process? 3
27. (a) Construct a pyramid of biomass in sea with phytoplankton and fishes. Explain giving reasons

about the characteristic of the constructed pyramid.

- (b) In which condition will the pyramid remain always upright?

SECTION – E

33. (a) Work out a dihybrid cross upto F_2 generation between pea plants bearing violet coloured axial flowers and white coloured terminal flowers using Punnett's square. Give their F_2 phenotypic ratio. State the Mendel's law of inheritance that was derived from such a cross. 5

OR

- (b) Explain the process of transcription in prokaryotes. How is it different from transcription in eukaryotes? 5

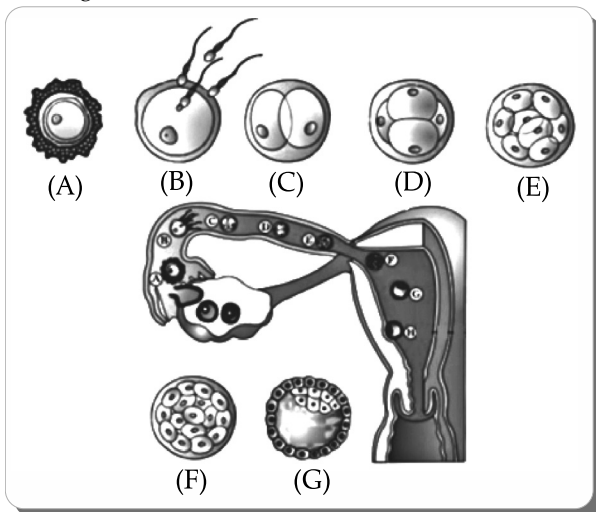
Outside Delhi Set-1

57/4/1

SECTION – A

Question No. 1 to 16 are Multiple Choice type questions, carrying 1 mark each. 16×1=16

1. In a fertilised ovule of an angiosperm, the cells in which n , $2n$ and $3n$ conditions respectively occur are:
 (A) antipodal, zygote and endosperm
 (B) zygote, nucellus and endosperm
 (C) endosperm, nucellus and zygote
 (D) antipodals, synergids and integuments
2. Select the option that gives the correct identification of ovum, morula and blastocyst in a human female reproduction system as shown in the following diagram: 1



- (A) Ovum – B, Morula – D, Blastocyst – F
 (B) Ovum – A, Morula – B, Blastocyst – G
 (C) Ovum – A, Morula – E, Blastocyst – G
 (D) Ovum – B, Morula – D, Blastocyst – G

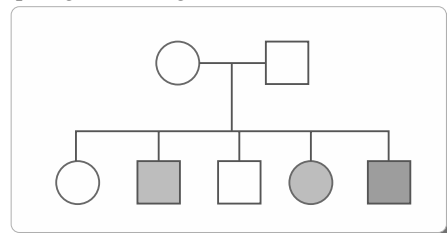
3. Study the table given below: 1

Contraceptive / Contraceptive Method		Mode of Action	
a.	The pill	I.	Prevent sperm reaching cervix

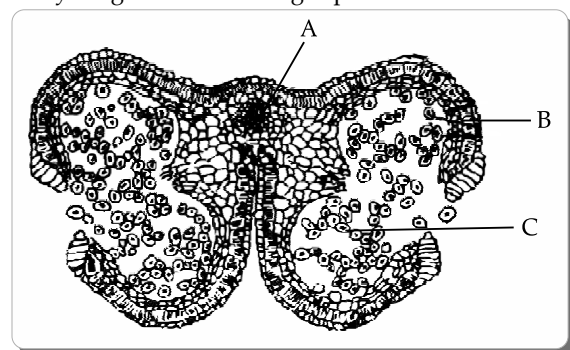
b.	Condom	II.	Prevent implantation
c.	Vasectomy	III.	Inhibits ovulation
d.	Copper-T	IV.	Semen contains no sperm

Select the option where contraceptive/contraceptive method are correctly matched with their mode of action.

- (A) a – III, b – II, c – I, d – IV
 (B) a – II b – III, c – I, d – IV
 (C) a – II, b – I, c – IV, d – II
 (D) a – IV, b – III, c – II, d – I
4. Identify the category of genetic disorder depicted in the pedigree chart given below: 1

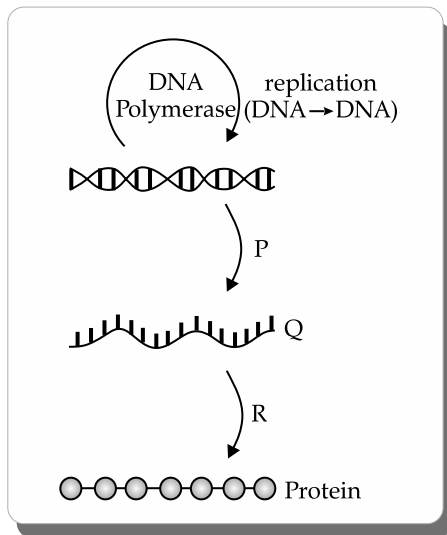


- (A) X-Linked recessive (B) X-Linked dominant
 (C) Autosomal recessive (D) Autosomal dominant
5. Which was the last of the 24 human chromosome to be completely sequenced? 1
 (A) Chromosome – 1 (B) Chromosome – 11
 (C) Chromosome – 21 (D) Chromosome – X
6. Study the following diagram of Transverse Section of a young anther of an angiosperm: 1



Select the option where parts 'A', 'B' and 'C' are correctly identified.

- (A) A-Connective, B-Endothecium, C-Pollen grain.
 (B) A-Endothecium, B-Connective, C-Pollen grain.
 (C) A-Pollen grain, B-Connective, C-Endothecium.
 (D) A-Endothecium, B-Pollen grain, C-Connective.
7. Turner's syndrome in humans occurs due to 1
 (A) Aneuploidy (B) Euploidy
 (C) Polyploidy (D) Autosomal abnormality
8. Which of the options has correct identification of 'P', 'Q' and 'R' in the illustration of 'Central Dogma' given below? 1



- (A) P-Replication, Q-rRNA, R-Transcription
 (B) P-Translation, Q-mRNA, R-Transcription
 (C) P-Replication, Q-mRNA, R-Translation
 (D) P-Transcription, Q-mRNA, R-Translation
9. Who proposed the mutation theory in favour of organic evolution? 1
 (A) Weisman (B) Louis Pasteur
 (C) Darwin (D) Hugo de Vries
10. Study the following list of bioactive substances and their action: 1

Bioactive Substance		Role	
a.	Statin	I.	Removal of oil stains
b.	Cyclosporin A	II.	Removal of clots from blood vessels
c.	Streptokinase	III.	Lowering of blood cholesterol
d.	Lipase	IV.	Immuno-suppressive agent

Select the option in which the bioactive substances are correctly matched with their action.

- (A) a-II, b-III, c-I, d-IV
 (B) a-III, b-IV, c-II, d-I
 (C) a-IV, b-I, c-II, d-III

(D) a-IV, b-II, c-I, d-III

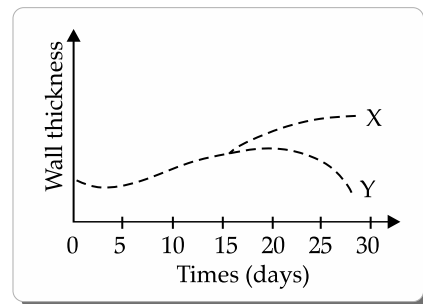
11. The 'molecular scissors' fall in the category of: 1
 (A) Cleaving enzyme (B) Endonuclease
 (C) Exonuclease (D) Restriction enzymes
12. ELISA technique is based on the principle of 1
 (A) DNA replication
 (B) antigen-antibody interaction
 (C) pathogen-antigen interaction
 (D) antigen-protein interaction

Question No. 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 and (R) is not the correct explanation of (A).
 (C) (A) is true, but (R) is false.
 (D) (A) is false, but (R) is true.
13. **Assertion (A):** A given fig species can be pollinated only by its partner' wasp. 1
Reason (R): The wasp pollinates the fig inflorescence while searching for suitable egg laying sites.
14. **Assertion (A):** Plasmids are autonomously replicating circular extra-chromosomal DNA. 1
Reason (R): Plasmids are usually present in Eukaryotic cells.
15. **Assertion (A):** Patents are granted by government to an inventor. 1
Reason (R): Patents prevent others from commercial use of an invention.
16. **Assertion (A):** Some aquatic ecosystems have inverted biomass pyramids. 1
Reason (R): More energy is required by the organisms occupying higher trophic levels.

SECTION - B

17. Study the graph given below that represents the changes in the thickening of the uterine wall in women 'X' and women 'Y' over a period of one month:



What does the graph with respect to woman 'X' and woman 'Y' indicate? Give suitable reason. 2

18. (a) Intensely lactating mothers generally do not conceive. Why?

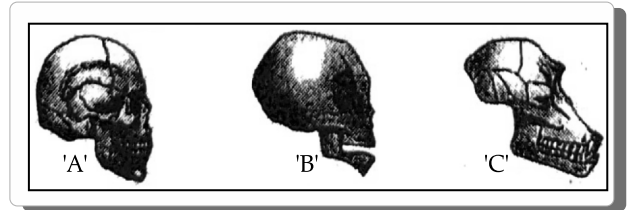
- (b) Our government has intentionally imposed strict conditions for MTP. Why? $2 \times 1 = 2$
19. (a) Name the source from which insulin was extracted in earlier times. Why is this insulin no more in use by the diabetic patients? $2 \times 1 = 2$
- (b) Why does the insulin synthesised in the human body undergo processing whereas the insulin produced by Eli Lilly company does not need to undergo any processing? Explain. $2 \times 1 = 2$
20. (a) Differentiate between grazing food chain and detritus food chain. 2

OR

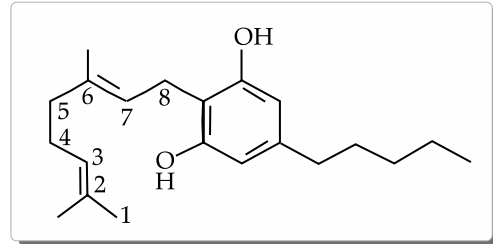
- (b) Explain Brood parasitism with the help of a suitable example. 2
21. (a) Biodiversity hotspots cover less than 2% of Earth's land area. Strict protection of these areas can reduce the rate of ongoing extinctions. Explain.
- (b) Name any two hotspots in India. 2

SECTION - C

22. Draw a well labelled diagram of sectional view of male gametophyte/microspore of an angiosperm and write the functions of any two parts labelled. (Any four labels). 3
23. (a) A man with blood group 'A' marries a woman with blood group 'AB'. The first child born to them has blood group 'B'. Work out a cross to find the genotype of the father. Give the possible blood groups and their genotypes of the children that could be born to this couple. (Use a Punnett square).
- (b) State the basis of 'ABO' blood grouping in humans. 3
24. (a) Whose skulls 'A', 'B' and 'C' are shown below? Which of the two are more similar to each other? 2



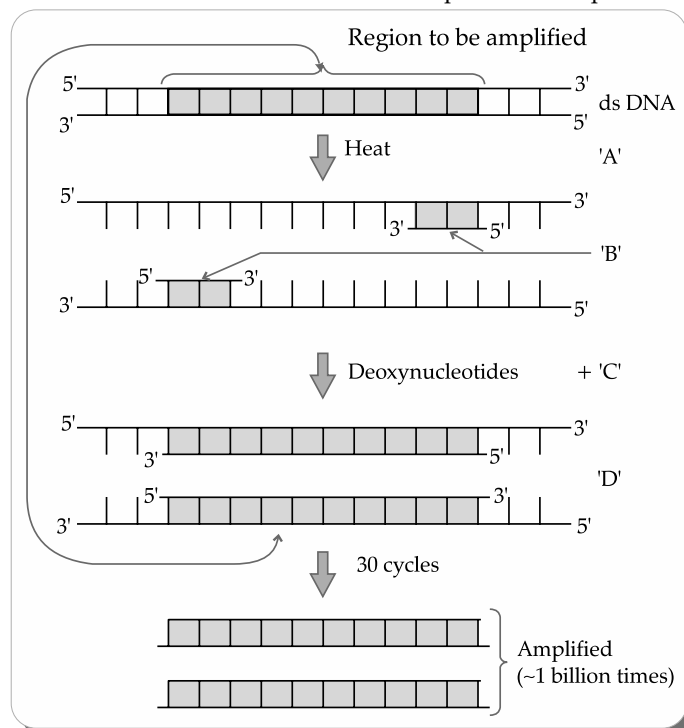
- (b) Name the (i) ape like (ii) man like primates that existed 1.5 million years ago. 1
25. (a) (i) Name the group of drugs whose skeletal molecule is shown below:



- (ii) How are such drugs consumed?
- (iii) Name the human body organ affected by the consumption of these drugs. $3 \times 1 = 3$

OR

- (b) Draw a schematic diagram of an antibody molecule and label any four parts. Mention their chemical nature. Name the cells which produce them. 3
26. Explain the role of the following during the sewage treatment:
- (a) flocs
- (b) anaerobic sludge digester 3
27. Study the steps shown below, that are carried during a specific technique:



- (a) Identify the steps 'A' and 'D' in the diagram.
 (b) What does 'B' represent?
 (c) Write what is 'C'? Name its source organism.
 (d) Mention the use of this technique in molecular diagnostics. 3

28. Explain the role of transgenic animals in:

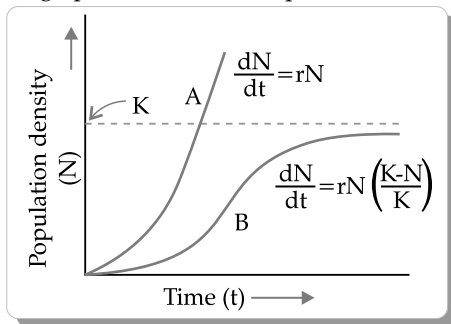
- (a) Production of biological products
 (b) Studying diseases
 (c) Chemical safety testing 3

SECTION – D

Question No. 29 and 30 are case based questions. Each question has three sub-questions with internal choice in one sub-question.

29. Populations evolve to maximise their reproductive fitness in the habitat in which they live. Ecologists suggest, the life history of organisms has evolved in relations to the constraints imposed by the biotic and abiotic components of the habitat in which they live. This gets reflected in the population growth pattern of all organisms including humans.

Study the population growth curves shown in the given graph and answer the questions that follow:



- (a) Identify the growth curves 'A' and 'B'. 1
 (b) Mention what does the dotted line in the graph indicate and state its importance also. 1

OR

- (b) Growth curve 'B' shows a different pattern from that of growth curve 'A'. Justify giving one reason. 1
 (c) (i) Which one of the two curves is more "realistic" and why?
 (ii) Which one of the two curves is relevant in present days with respect to human population in our country and why? 1+1

30. Read the following passage:

Generally, in eukaryotic cells the average length of a transcription unit along a DNA molecule is about 8,000 nucleotides, so the RNA product of the transcription is also that long. But it only takes about 1,200 nucleotides from the above RNA product to translate average sized polypeptide of 400 Amino acids.

- (a) Name this RNA product transcribed from the DNA that subsequently translates into a polypeptide of 400 amino acids. Mention the enzyme responsible for

transcribing this type of RNA from the DNA. 1

- (b) Name and explain the process the RNA molecule transcribed from 8,000 nucleotide long DNA undergoes to be able to translate a polypeptide of 400 amino acids. 2

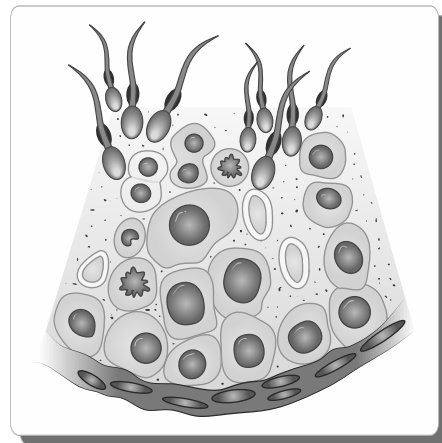
- (c) Write the number of RNA polymerases involved in the transcription of DNA in a prokaryote and eukaryotes. 1

OR

- (c) Mention the difference in the site of transcription in a prokaryote and eukaryote cell. 1

SECTION – E

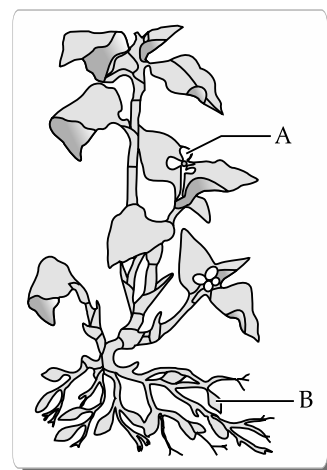
31. (a) The given diagram shows the sectional view of a seminiferous tubule of human testis:



- (i) Name and describe the process depicted in the diagram which results in the development of spermatozoa.
 (ii) Identify the cell where you are seeing a cluster of spermatozoa attached in the diagram. Write the function of the cell. 5

OR

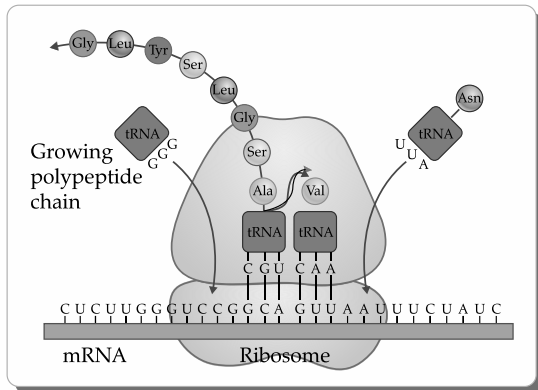
- (b)



Observe the picture of *Commelina* plant bearing two types of flowers given above.

- (i) Identify the two types of flowers labelled 'A' and 'B' in the picture. 1

- (ii) Compare the two types of flowers with reference to:
 (1) characteristic feature
 (2) modes of pollination 2
- (iii) List any two 'out breeding devices' in flowering plants. Explain why do plants develop such devices. 2
32. (a) Study the schematic diagram given below and answer the questions that follow:



- (i) Identify the polarity from 'X' to 'Y' in the mRNA segment shown. Mention how many more amino acids can be added to the polypeptide

- that is being translated and why. 1½
- (ii) Write the initiating codon for translation, its anticodon and the amino acid it codes for. 1½
- (iii) Explain the charging of an adaptor molecule. Why this molecule needs to be charged? 2

OR

- (b) (i) Why is sickle cell anaemia, a human blood disorder so named? 1
- (ii) Explain the genetic basis that results in the expression of this disorder. 2
- (iii) Work out a cross to explain how normal parents may have a sickle-cell anaemic child. 2
33. (a) Describe the life cycle of HIV from the time of its entry into the human body till full blown AIDS sets in. 5

OR

- (b) (i) Write the symptoms of malaria in human and explain what causes these symptoms. 2½
- (ii) Describe the different steps in the sexual mode of reproduction in the life cycle of a malarial parasite from the time of its initiation till where it is completed and ready to start a fresh cycle. 2½

Outside Delhi Set-2

57/4/2

Note: Except these, all other questions are available in Outside Delhi - Set 1.

SECTION – A

9. Homologous organs indicate 1
 (A) Convergent evolution
 (B) Divergent evolution
 (C) Adaptive radiation
 (D) Natural selection
11. Which of the chromosome in a human possesses the least number of genes? 1
 (A) 21st chromosome
 (B) 16th chromosome
 (C) X-chromosome
 (D) Y-chromosome

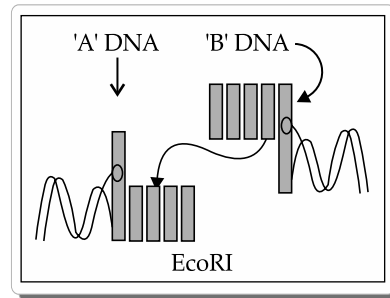
SECTION – B

17. What is artificial insemination in ART? Under what conditions is the person medically advised to go for it? 2
18. Why does a patient of ADA-deficiency require repeated infusions of genetically engineered lymphocytes? Suggest a possible permanent remedy. 2

SECTION – C

22. With reference to flower colour two independent crosses were made, one between true breeding garden pea plants and another between true breeding *Antirrhinum* plants. Write the phenotypes of their F₁-progeny. Justify your answer giving reason. 3

26.



The schematic representation as above is showing the linking of two DNA fragments.

- (a) Name 'A' and 'B' fragments. 1
- (b) Write the 'palindrom' recognised by EcoRI. 1
- (c) Where does EcoRI cut the palindrome? Write the events followed thereafter to form a recombinant DNA. 1
27. How do the following organisms act as bio-fertilisers? Explain. 3
- (a) *Mycorrhiza*
 (b) *Anabaena*.
 (c) *Rhizobium*

SECTION – E

31. (a) (i) Explain the following phases in the menstrual cycle of a human female: 3
- (1) Menstruation
 (2) Follicular phase
 (3) Luteal phase 3

- (ii) 'A proper understanding of the menstrual cycle can help immensely in family planning.' Do you agree with the statement? Provide reasons for your answer. 2

OR

- (b) (i) Why does endosperm development precede

embryo development in angiosperm seeds? State the role of endosperm in mature albuminous seeds. 2

- (ii) Draw a labelled diagram showing the different embryonic stages of a dicot plant, upto a fully mature embryo. 3

Outside Delhi Set-3

57/4/3

Note: Except these, all other questions are available in Outside Delhi - Set 1 + 2.

SECTION - A

5. Hugo de Vries proposed the mutation theory of organic evolution after his experiments on 1
- (A) Garden pea
(B) Evening primrose
(C) Fruit fly
(D) Four O'clock plant
6. A list of organisms is given in column 'R', whereas in column 'S' a list of products produced by them:

Column R' (Organisms)		Column 'S (Products)	
(a)	<i>Lactobacillus</i>	(i)	Cheese
(b)	<i>Saccharomyces cerevisiae</i>	(ii)	Curd
(c)	<i>Aspergillus niger</i>	(iii)	Citric acid
(d)	<i>Acetobacter acetic</i>	(iv)	Bread
		(v)	Acetic acid

Select the option where the organisms are correctly matched with the product.

- (a) (b) (c) (d)
(A) (ii) (i) (iii) (v)
(B) (ii) (iv) (v) (iii)
(C) (ii) (iv) (iii) (v)
(D) (iii) (iv) (v) (i)
9. The commonly used vector for human genome sequencing was/were:
- (A) Retrovirus
(B) T-DNA
(C) BAC and YAC
(D) Plasmid Vector

SECTION - B

17. (a) Name the first developed transgenic cow.
(b) Explain the improvement in the quality of the milk produced by it. 2×1=2
19. (a) Mention any two ways by which HIV and Hepatitis-B can be transmitted to a healthy person.
(b) Why is an early detection of these diseases essential? 2×1=2

SECTION - C

22. Draw a schematic diagram of the *E.coli* vector pBR 322 and mark the following in it:
- (a) ori
(b) rop
(c) ampicillin resistant gene
(d) tetracycline-resistant gene
(e) restriction site Bam HI
(f) restriction site EcoRI 3
23. How has the use of *Agrobacterium* as vector helped in controlling *Meloidogyne incognita* infestation in tobacco plants? Explain in correct sequence. 3
27. A pea plant with purple flowers, when crossed with a plant with white, produced 50 plants with only purple flowers. On selfing these plants produced 482 plants with purple flower and 162 with white flowers. Explain the pattern of inheritance with the help of Punnet square. 3

SECTION - E

33. (a) (i) State the objective of adopting artificial hybridisation programme in plants. 5
(ii) Describe the steps followed in this technique.
- OR
- (b) (i) Describe the development of placenta during pregnancy in a human female. 2
(ii) Explain its role. 3



ANSWERS

Delhi Set-1

57/5/1

SECTION – A

1. Option (D) is correct.

Explanation: Pleiotropy is the phenomenon in which one gene controls many traits. For example, the gene in pea plants that controls the round and wrinkled texture of seeds also influences the phenotypic expression of starch grain size. 1

2. Option (D) is correct.

Explanation: Down syndrome is caused by trisomy of the 21st chromosome. The characteristic palm crease (ii) is a common physical feature of individuals with Down syndrome. However, rudimentary ovaries (iii) and gynaecomastia (iv) are not typically associated with Down syndrome. 1

3. Option (C) is correct.

Explanation: ICSI (intracytoplasmic sperm injection) is a laboratory procedure in which a single sperm (from a male partner) is injected directly into an egg (from a female partner). Then the fertilised egg is implanted into the woman's uterus. 1

4. Option (D) is correct.

Explanation: Interferons are proteins secreted by virus-infected cells. They help alert neighbouring cells to the presence of a viral infection, stimulate immune responses and enhance the body's ability to fight off viruses. 1

5. Option (B) is correct.

Explanation: During the biological treatment of sewage, flocs are masses of bacteria held together by fungal filaments to form mesh-like structures. This process typically occurs in the secondary treatment stage of wastewater treatment, where microorganisms are employed to break down organic matter present in the sewage. 1

6. Option (D) is correct.

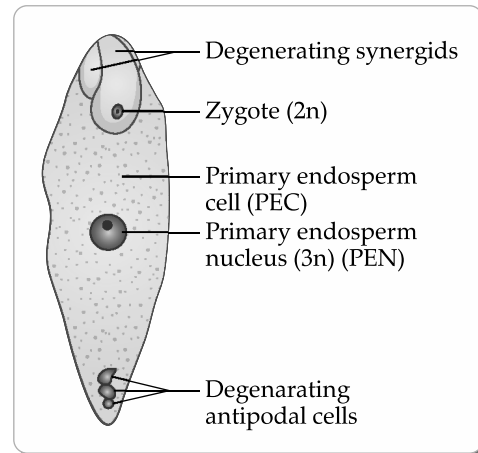
Explanation: Ethidium bromide intercalates between the base pairs of DNA molecules and when exposed to UV light, it fluoresces, emitting visible light. This fluorescence allows the visualisation of DNA bands appears orange in the gel. 1

7. Option (A) is correct.

Explanation: Pseudocopulation is a phenomenon in which a male insect mistakenly identifies the patterns or characteristics of a flower, often an orchid, as those of a female insect partner. In this process the flower mimics the sexual pheromones. 1

8. Option (B) is correct.

Explanation: In the given figure of a fertilised embryo sac of an angiosperm, the part labelled as A is degenerating synergids, B is zygote, C is primary endosperm nucleus and D is degenerating antipodals. 1



9. Option (B) is correct.

Explanation: The trait depicted in the pedigree chart is recessive X-linked.

X-linked recessive disorders are caused by gene variants on the X chromosome, and are more common in males than females. 1

10. Option (C) is correct.

Explanation: The correct matching pair is:

- (a) 'i' gene – (iii) repressor
- (b) 'Z' gene – (i) β -galactosidase
- (c) 'a' gene – (iv) transacetylase
- (d) 'y' gene – (ii) lac permease 1

11. Option (A) is correct.

Explanation: If both parents are carriers for thalassemia, they each have one normal allele and one mutated allele for the gene associated with thalassemia. When they have children, there's a 25% chance that both parents will pass on their mutated alleles, resulting in an affected child. 1

12. Option (A) is correct.

Explanation: Given the coding strand sequence: 5'-ATGAATG-3', the corresponding RNA transcript sequence would be 5'- AUGAAUG -3' as Thymine replaced by Uracil. 1

13. Option (A) is correct.

Explanation: HIV is a virus that causes AIDS and it damages the immune system using RNA as its genetic material. 1

14. Option (C) is correct.

Explanation: In molecular diagnosis, single-stranded DNA or RNA tagged with a radioactive molecule is indeed called a probe. Probes are used to detect specific nucleotide sequences, such as those associated with particular genes or pathogens, in a sample. A probe does not always search and hybridise with its complementary DNA in a clone

of cells. Probes are designed to hybridise with complementary sequences wherever they may be present, not specifically within a clone of cells. 1

15. **Option (D) is correct.**

Explanation: In most birds, the females are heterogametic (designated as Z W) and males are homogametic (designated as Z Z). Therefore, it is the female that determines the sex of the offspring based on whether she contributes a Z (resulting in a male offspring) or a W (resulting in a female offspring) chromosome. 1

16. **Option (B) is correct.**

Explanation: Communities with more species tend to be more stable than those with less species because they are able to resist occasional disturbance. David Tilman's long term experiments showed the plots with more species, experience less year to year variation in total biomass. 1

SECTION – B

17. (a) Advantages of apomictic seeds to a farmer are:

- (i) Reduces the cost of hybrid breeding programmes.
- (ii) Desired traits can be maintained without losing superiority of hybrids over parents. Farmers can replant these seeds year after year. 1+1

OR

(b) Advantage: Amniocentesis aids in detecting genetic defects in the fetus.

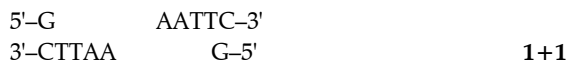
Disadvantage: Amniocentesis is also employed for determining the sex of the unborn child, contributing to an increase in cases of female foeticide. 1+1

18. (a) Restriction enzyme: EcoRI.

Palindromic sequences.

(b) The arrows indicate the restriction sites for EcoRI.

Result:



19. (a) Growth A is possible when the resources are sufficient and population has enough space to grow under no competition. Such curves are generally unrealistic in nature. Growth B is possible when the population have enough resources to grow which gradually deplete with time. 1

(b) 'K' is the carrying capacity of a habitat for members of a given sort of organism. 1

20. Plants benefit from their association with Glomus species through mycorrhizal symbiosis. Glomus fungi form mycorrhizal networks with plant roots, enhancing nutrient uptake, particularly phosphorus and nitrogen. This relationship improves plant growth, stress tolerance and overall health. Additionally, Glomus species contribute to soil structure and fertility, promoting sustainable ecosystems and agricultural productivity. 2

21. Given: Cytosine = 19%

According to Chargaff's rule in a DNA molecule $A+T+G+C=100\%$

Percentage of A = Percentage of T

Percentage of G = Percentage of C

Therefore, If A = 31% then, T = 31%

$G+C=38\%$

Therefore, the total percentage of adenine and thymine together is $31\% + 31\% = 62\%$.

Since the total percentage of all four bases (adenine, thymine, cytosine and guanine) in DNA is 100% and adenine and thymine together constitute 62%, the remaining percentage for cytosine and guanine together would be $100\% - 62\% = 38\%$.

Since guanine is equal to cytosine according to Chargaff's rules, we divide the remaining percentage (38%) by 2 to get the percentage of cytosine alone.

$38\% / 2 = 19\%$

Therefore, the expected percentage of cytosine in the DNA fragment is 19%. 2

SECTION – C

22. a– Statin

b– blood cholesterol lowering agent.

c– *Penicillium notatum*

d– Penicillin

e– *Trichoderma polysporum*

f– Immunosuppressive agent. $\frac{1}{2} \times 6$

23. (a) There are three different hypothesis proposed by scientists for explaining species richness in the tropics.

(i) Tropical latitude receives more solar energy than temperate regions, which lead to high productivity and high species diversity.

(ii) Tropical regions have less seasonal variations and have more or less constant environment. This promotes the niche specialisation and thus, high species richness.

(iii) Temperate regions were subjected to glaciations during ice age, while tropical regions remained undisturbed which led to an increase in the species diversity in this region. 1+1+1

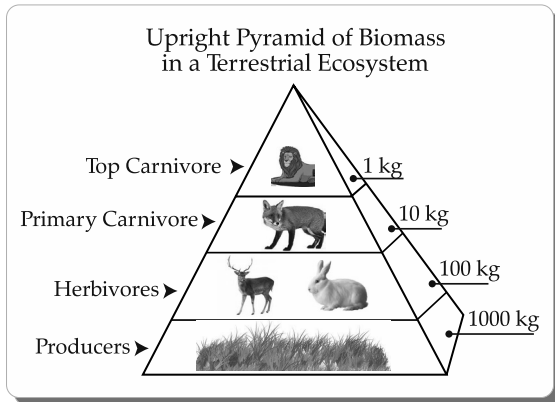
OR

(b) (i) Ecological Pyramids: The representation of a food chain in the form of a pyramid is called ecological pyramids. 1

(ii) Depending on the ecosystem and the specific trophic relationships within it, ecological pyramids can exhibit either an upright or an inverted shape.

(a) Upright Ecological Pyramid: In most ecosystems, ecological pyramids have an upright shape, meaning that energy or biomass decreases as we move up the trophic levels.

Example: Terrestrial ecosystems, such as forests or grasslands, typically have upright ecological pyramids. For instance, in a forest ecosystem, producers (plants) form the broad base of the pyramid, followed by primary consumers (herbivores), secondary consumers (carnivores) and so on. Each successive trophic level supports fewer organisms and less biomass, reflecting the loss of energy as it moves up the food chain.



(b) Inverted Ecological Pyramid: In some ecosystems, particularly aquatic ecosystems, ecological pyramids may exhibit an inverted shape, where biomass or energy increases as we move up the trophic levels.

Example: Marine ecosystem: In marine ecosystems, phytoplanktons are the primary producers in these ecosystems and support vast populations of zooplankton, which in turn support smaller populations of small fish, followed by larger predators. In this case, the biomass or energy at the higher trophic levels (zooplankton and fish) may exceed that of the lower trophic levels (phytoplankton), resulting in an inverted pyramid.

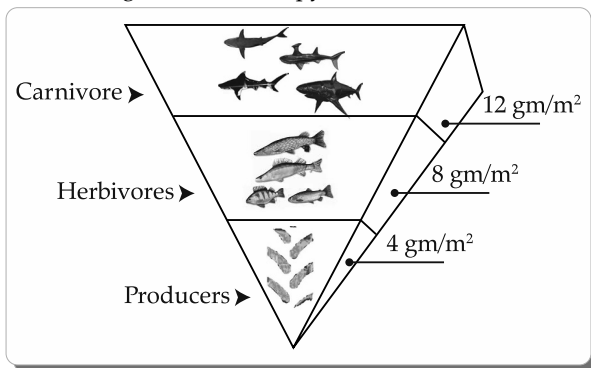


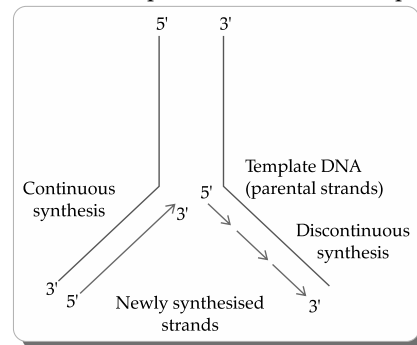
Figure: Pyramid of biomass in sea

24. **(a) Transgenic Animals:** These are the animals whose genome has been altered by the introduction of an extra (foreign) gene by manipulation. **1**
- (b)** Over 95% of all existing transgenic animals are mice. **½**
- (c)** **(i)** Normal physiology and development.
(ii) Study of disease.
(iii) Biological products.
(iv) Vaccine safety.
(v) Chemical safety testing. **(Any three)** **½ + ½ + ½**

25. **Endosperm (3n):** If the cells in the leaves of the maize plant contain 10 chromosomes each, the endosperm would contain 10 chromosomes \times 3 = 30 chromosomes. **1**
- Zygote (2n):** If the cells in the leaves of the maize plant contain 10 chromosomes each, the zygote would contain 10 chromosomes \times 2 = 20 chromosomes. **1**

The process by which an endosperm and zygote are formed in maize is called double fertilisation. It involves the fusion of two sperm cells from the pollen grain with two different nuclei in the embryo sac. One sperm cell fertilises the egg cell to form the diploid zygote, while the other sperm cell fuses with two polar nuclei to form the triploid endosperm nucleus.

26. **(a)** DNA being very long, requires high energy for opening along its entire length. **1**
- (b)** Schematic representation of DNA replication:



2

Explanation: **(a)** The process of DNA replication begins at a point called the origin of replication (ori), to form a replication fork.

- (b)** The separated strands act as templates for the synthesis of new strands.
- (c)** DNA replicates in the 5' \rightarrow 3' direction.
- (d)** dNTPs (Deoxyribonucleotide triphosphate) act as substrate and also provide energy for the polymerisation of nucleotides.
- (e)** DNA polymerase is an enzyme that assembles a new DNA strand that is complementary to the template strand.
- (f)** DNA polymerase continues to move along the template strand and add new nucleotides to the growing or complementary strand until the entire genome is replicated.
- (g)** The DNA polymerase forms one new strand (leading strand) in a continuous stretch in the 5' \rightarrow 3' direction (continuous synthesis).
- (h)** The other new strand is formed in small stretches (Okazaki fragments) in the 5' \rightarrow 3' direction (discontinuous synthesis).
- (i)** The Okazaki fragments are then joined together to form a new strand by an enzyme, DNA ligase. This new strand is called the lagging strand.
27. The hnRNA in eukaryotes needs to change for converting it into functional mRNA. The hnRNA contains both exons and introns. The exons are functional coding segments while introns are non-functional and non-coding sequences. This hnRNA undergoes processing where the introns are removed and exons are joined by a process called splicing. **1**
- Now, this transcribed hnRNA undergoes additional processing called capping and tailing. In capping, methyl guanosine triose phosphate is added to the

5' end and in tailing, 200–300 adenylate residues are added at 3' end of spliced RNA. 1

The processing of hnRNA into mature mRNA occurs predominantly within the nucleus of eukaryotic cells. Once the mRNA is fully processed, it is exported from the nucleus to the cytoplasm, where it can be translated into protein by ribosomes. 1

28. (i) **Habitat loss and fragmentation:** Habitats of various organisms are altered or destroyed by uncontrolled and unsustainable human activities such as deforestation, slash and burn agricultural, mining and urbanisation. This results in the breaking up of the habitat into small pieces, which effects the movement of migratory animals and also, decreases the genetic exchange between populations leading to a declination of species. For example:

- Tropical rain forests (loss from 14% to 6%). Thousands hectares of rain forests are being lost within hours.
- The Amazon rain forest is being cut for cultivating soya beans or for conversion of grass lands for cattle. (Any one e.g.) 1

(ii) **Over-exploitation:** Due to over-hunting and over-exploitation of various plants and animals by humans, many species have become endangered or extinct. Many species like Stellar's sea cow, Passenger pigeon, etc. extinct due to over exploitation. 1

(iii) **Alien species invasions:** Accidental or intentional introduction of non-native species into a habitat has led to the declination or extinction of indigenous species. Alien species cause decline or extinction of indigenous species. For example:

- The Nile Perch introduced in Lake Victoria (East Africa) caused extinction of more than 200 species of native fish, cichlid fish in the lake.
- Invasive weed species like carrot grass (*Parthenium*), Lantana and water hyacinth (*Eichhornia*) caused damage to our native species.
- The illegal introduction of the African Catfish (*Clarias gariepinus*) for aquaculture is posing a threat to the indigenous catfishes in our rivers.

(any one e.g.) 1

SECTION – D

29. (a) **Follicle-stimulating hormone (FSH):** Source: Pituitary gland

Luteinising hormone (LH): Source: Pituitary gland

Estrogen: Ovaries (specifically, the developing ovarian follicles)

Progesterone: Source: Ovaries (specifically, the corpus luteum)

(b) For successful pregnancy through Assisted Reproductive Technology (ART), such as in vitro fertilisation (IVF), the early embryo (up to 3 blastomeres) should be implanted in the uterus (UT) during the luteal phase of the menstrual cycle.

(i) During the luteal phase of the menstrual cycle, when progesterone levels are elevated, the endometrium (uterine lining) undergoes changes that prepare it for embryo implantation during assisted reproductive technology (ART) procedures such as in vitro fertilisation (IVF).

(ii) The thickened and enriched endometrium, along with the presence of optimal blood vessel development, creates an ideal environment for successful embryo implantation and subsequent pregnancy.

Implanting the early embryo, up to 3 blastomeres, during this phase ensures that the uterus is in a receptive state, maximising the chances of successful implantation and ultimately leading to a successful pregnancy. Therefore, in ART procedures, embryo transfer typically takes place during the luteal phase of the menstrual cycle.

(c) The hormone responsible for the events occurring during the proliferative phase of the menstrual cycle is estrogen. Estrogen is primarily produced by the developing ovarian follicles in the ovaries

Follicular (Proliferative) phase: In this phase, the primary follicle matures into Graafian follicles. This causes the regeneration of endometrium.

Estrogens stimulate

- Proliferation of ruptured uterine endometrium and mucous lining of oviduct and vagina.
- Development of secondary sexual characters.
- Estrogen inhibits the secretion of FSH and stimulates the secretion of LH. It also causes the thickening of the uterine endometrium. 2

OR

(c) After ovulation, the remains of the Graafian follicle get converted into the yellow endocrine mass called corpus luteum. It secretes progesterone. Progesterone hormone helps in maintenance and preparation of endometrium for the implantation of the embryo. During pregnancy all events of menstrual cycle stop and there is no menstruation.

In the absence of fertilisation, corpus luteum degenerates and becomes a whitish mass called corpus albicans. Since, it has no secretory ability, progesterone level in blood decreases. It leads to menstruation indicating a new cycle. 2

30. (a) (i) Entry into the human body: Plasmodium gains entry into the human body in the form of sporozoites. $\frac{1}{2}$

(ii) Entry into the female Anopheles body: Plasmodium gains entry into the female Anopheles body in the form of gametocytes. $\frac{1}{2}$

(b) The symptoms of malaria do not appear immediately after being bitten by an infected female Anopheles mosquito due to the incubation period of the malaria parasite within the human body which is 7-30 days. 1
One reason for the delay in symptom onset is that after being bitten by an infected mosquito, the Plasmodium parasites initially enter the bloodstream

in the form of sporozoites. These sporozoites travel to the liver, where they undergo replication and maturation within hepatocytes (liver cells). During this pre-erythrocytic phase, the parasites multiply without causing noticeable symptoms. This phase of the infection can last from several days to a few weeks, depending on the species of *Plasmodium*.

After the pre-erythrocytic phase, the matured parasites are released from the liver into the bloodstream, where they invade red blood cells (erythrocytes) and undergo further replication. It is during this erythrocytic phase of the infection that symptoms of malaria typically appear. The destruction of red blood cells by multiplying parasites leads to the release of toxins and triggers an immune response, resulting in symptoms such as fever, chills and headache, fatigue and muscle aches. 1

OR

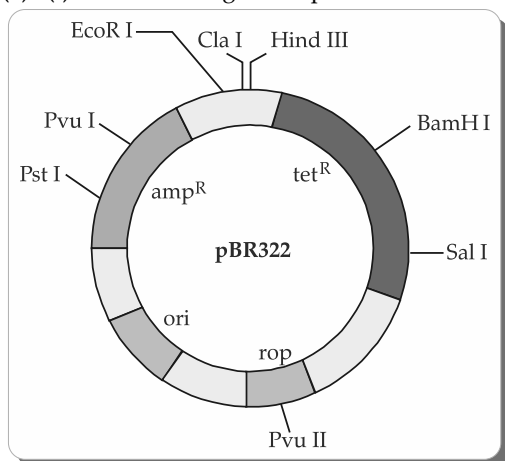
- (b) (i) When a female *Anopheles* mosquito feeds on the blood of an infected human host, it ingests red blood cells (RBCs) containing gametocytes, the sexual stage of the malaria parasite.
- (ii) After ingestion, further development of the gametocytes occurs in the mosquito's stomach wall, where male and female gametes fuse to form a zygote. The zygote undergoes further development and differentiation to form sporozoites.
- (iv) These sporozoites migrate from the stomach wall to different organs in the mosquito's body cavity. Many of them penetrate the salivary glands of the mosquito, where they become concentrated and await transmission to a new host.
- (v) When the infected female *Anopheles* mosquito bites a healthy person, it injects saliva containing sporozoites into the person's bloodstream. This transmission of sporozoites along with saliva initiates the infection of the new human host with malaria.

$\frac{1}{2} \times 4$

- (c) **Aedes aegypti**: It carries the pathogens responsible for dengue fever. 1

SECTION – E

31. (a) (i) Schematic diagram of pBR322:



- (ii) The rop gene encodes a small regulatory protein,

Rop (repressor of primer), in pBR322 plasmids. The primary role of this protein is to control the copy number of the plasmid within the bacterial host. 1

- (iii) The absence of a selectable marker in a cloning vector complicates the process of cloning by making it difficult to distinguish between cells that have incorporated the vector with the desired DNA insert and those that haven't. Selectable markers, like antibiotic resistance genes, help in the growth and selection of transformed cells, simplifying the process by allowing the isolation of only those cells that have successfully taken up the vector. 1
- (iv) Insertional inactivation is favoured over the use of selectable markers in cloning vectors because it facilitates the straightforward identification of recombinant plasmids without requiring extra selection procedures. With insertional inactivation, the cloning vector harbours a reporter gene interrupted by the insertion site for DNA fragments. Successful insertion of a DNA fragment disrupts the reporter gene, causing a loss of function that can be visually observed. This approach streamlines the cloning process and eliminates the necessity for antibiotic selection, making it more convenient and economical.

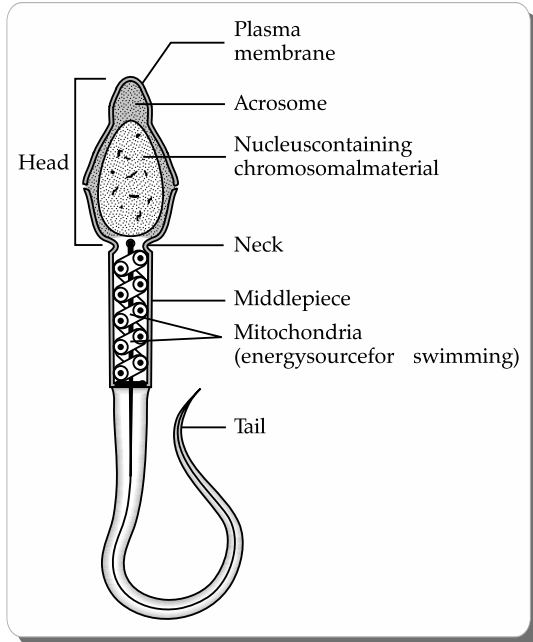
OR

- (b) (i) *Meloidogyne incognita*. 1
- (ii) Vector used is *Agrobacterium tumefaciens*. 1
- (iii) **Sense RNA**: Sense RNA refers to the RNA sequence that is complementary to the coding strand of DNA. It has the same sequence as the mRNA that will be translated into a protein. Sense RNA is transcribed from the template strand of DNA during transcription. 1

Antisense RNA: Antisense RNA is the RNA sequence that is complementary to the coding (sense) strand of DNA and to the sense RNA. Antisense RNA molecules are often involved in the regulation of gene expression by binding to complementary sequences in mRNA or sense RNA through base pairing. This binding can inhibit translation or induce degradation of the target mRNA, leading to reduced protein expression. 1

- (iv) Parasites might not survive in transgenic tobacco plants due to the expression of nematode-specific genes introduced into the plant. These genes could encode proteins or RNAs that disrupt the parasite's life cycle, development, or its ability to infect the plant. Moreover, transgenic tobacco plants may demonstrate heightened resistance mechanisms, including modifications in cell wall composition or heightened production of defensive compounds, which can impede parasite infection and survival. 1

32. (a) (i) Structure of human sperm:



(Any four parts)

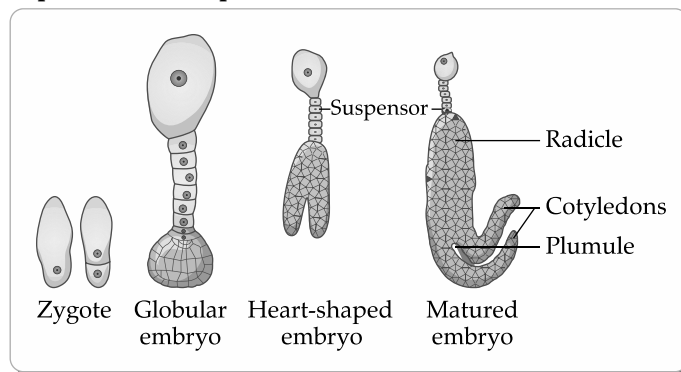
(b) Functions of parts:

- Head:** The head of the sperm contains the nucleus, which houses the genetic material (DNA) necessary for fertilisation. The head is covered by a cap-like structure called the acrosome, which contains enzymes that aid in penetrating and fertilising the egg.
- Midpiece:** The midpiece of the sperm contains numerous mitochondria, which provide the energy (in the form of ATP) needed for the sperm's movement (motility). Mitochondria are essential for powering the beating motion of the sperm's tail.
- Tail (Flagellum):** The tail, also known as the flagellum, is responsible for the sperm's locomotion. It propels the sperm forward through the female reproductive tract towards the egg, allowing it to reach and penetrate the egg for fertilisation.
- Neck:** The neck of the sperm connects the head to the midpiece and plays a role in facilitating the movement of genetic material from the head to the tail during sperm maturation and motility. 4

(ii) During fertilisation, the sperm induces changes in the zona pellucida and blocks the entry of other sperms. This ensures monospermy that only one sperm fertilises the ovum and prevents polyspermy. 1

OR

(i) Stages in embryo development in a dicot plant:



(ii) Endosperm development precedes embryo development in flowering plants to provide essential nutrients and support for the growing embryo. The formation of endosperm through the fusion of male and female gametes ensures the establishment of a nutritive tissue that supplies the developing embryo with carbohydrates, proteins and other essential nutrients. Once the endosperm is established and functional, embryo development commences, utilising the nutrients provided by the endosperm for its growth and differentiation. This sequential process ensures proper nourishment and support for the developing embryo, ultimately contributing to the successful formation of viable seeds. 1

33. (a) (i) Directional selection 1

(ii) **Before Industrialisation (1850s):** There were more white-winged moths (*Biston betularia*) on trees than dark-winged or melanised moths (*Biston carbonaria*).

The reason for this was the presence of white coloured lichen covering the trees, providing camouflage for the white-winged moths against predators. In contrast, the dark-winged moths stood out against the light background and were more easily spotted and preyed upon.

After Industrialisation (1920): The situation reversed, with more dark-winged moths and fewer white-winged moths observed.

This change occurred due to the darkening of tree trunks caused by pollution from industrial smoke and soot. The presence of pollutants inhibited the growth of lichens on tree trunks.

As a result, the light-coloured lichens disappeared and the tree trunks became darker. In this altered environment, the white-winged moths were now easily spotted against the dark background by predators, while the dark-winged moths were better camouflaged and had a survival advantage.

This example of industrial melanism illustrates how environmental changes resulting from industrialisation can drive evolutionary shifts in populations, favouring individuals with traits that provide better camouflage and survival advantages in the altered environment. **2**

- (iii) Anthropogenic actions, which are activities produced or caused by humans, can indeed enhance the rate of evolution and have significant impacts on natural developments. For example
- (a) **Industrial Melanism:** The example of industrial melanism illustrates how anthropogenic activities, such as industrial pollution emitting smoke and soot, can lead to changes in the environment that drive evolutionary shifts in populations. In this case, the darkening of tree trunks due to pollution favoured the survival of dark-winged moths over white-winged moths, demonstrating how human-induced environmental changes can influence the evolution of species.
- (b) **Use of Herbicides and Pesticides:** Anthropogenic activities such as the widespread use of herbicides and pesticides in agriculture have led to the selection of resistant varieties of plants and the development of antibiotic-resistant bacteria. This rapid evolution of resistance in response to human interventions demonstrates how anthropogenic actions can accelerate the rate of evolutionary change in populations, often within short time scales. **2**

OR

- (b) (i) Hershey and Chase used radioactive isotopes of

sulphur-35 (³⁵S) and phosphorus-32 (³²P) in their experiment to distinguish between protein and DNA in bacteriophages.

Sulphur-35 (³⁵S) labels proteins, as proteins contain sulphur but no phosphorus. By incorporating ³⁵S into the protein component of the bacteriophage, Hershey and Chase could track the location of proteins during viral infection.

Phosphorus-32 (³²P) labels DNA, as DNA contains phosphorus but no sulphur. By incorporating ³²P into the DNA component of the bacteriophage, Hershey and Chase could track the location of DNA during viral infection.

Using these radioactive isotopes, Hershey and Chase were able to determine that only the DNA of the bacteriophage, not the protein, enters the bacterial cell during infection. **1**

- (ii) **Blending:** Blending facilitated the physical separation of bacteriophage protein coats from bacterial cells after viral infection. **1**

Centrifugation: Centrifugation enabled the separation of bacteriophage protein coats from bacterial cells and their contents. By subjecting the bacteriophage infected bacterial suspension to centrifugation, the heavier bacterial cells and their contents, including any viral DNA or RNA, were pelleted to the bottom of the tube, while the lighter protein coats remained in the supernatant. **1**

- (iii) Based on the experiment, Hershey and Chase concluded that DNA, not protein, is the genetic material responsible for heredity and inheritance. **2**

Delhi Set-2

57/5/2

SECTION – A

2. **Option (A) is correct.**

Explanation: In general, a nucleosome typically encompasses approximately 200 base pairs (bp) of the DNA helix. However, in the context of human nucleosomes, specifically, they consist of around 146 base pairs of the DNA helix. Therefore, for 20 nucleosomes:

$$\begin{aligned} \text{Number of base pairs} &= 200 \text{ base pairs/nucleosome} \times 20 \text{ nucleosomes} \\ &= 200 \times 20 = 4,000 \text{ base pairs} \end{aligned}$$

4. **Option (B) is correct.**

Explanation: A single-step large mutation leading directly to speciation is referred to as "saltation." Saltation implies a sudden and drastic alteration in the phenotype or genotype, potentially resulting in the emergence of a new species.

7. **Option (D) is correct.**

Explanation: Chitinase is the enzyme that degrades chitin, a major component of the fungal cell wall. Treating fungal cells with chitinase helps to break

down the cell wall, releasing DNA along with other macro molecules from the cell.

9. **Option (A) is correct.**

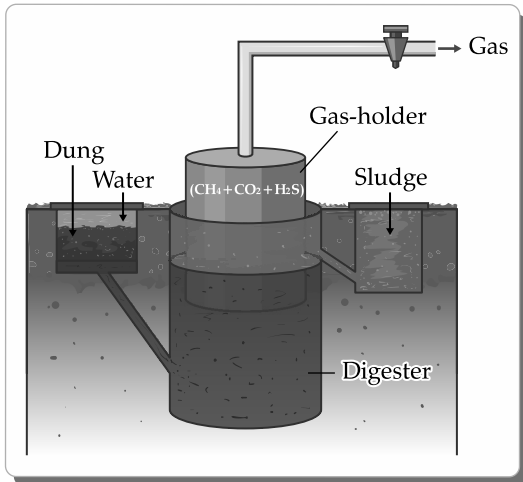
Explanation: Humus is dark coloured colloidal substance called humus. Humus is resistant to microbial action and so decomposes very slowly. Being colloidal in nature it serves as a reservoir of nutrients.

14. **Option (A) is correct.**

Explanation: The DNA double helix features an antiparallel arrangement, where the sugar-phosphate backbones of the two strands run in opposite directions. This means that one strand runs from 5' to 3' while the complementary strand runs from 3' to 5'. The phosphodiester bonds within each strand connect the sugar of one nucleotide to the phosphate of the next, forming a continuous backbone.

SECTION – B

17. (a) In the given diagram of a biogas plant, X is sludge, Y represents biogas outlet pipe and Z represents dung + water. $\frac{1}{2} + \frac{1}{2} + \frac{1}{2}$



- (b) Cattle dung is preferred for the production of biogas due to its high content of organic matter and methane-producing bacteria called *Methanobacterium*. 1/2

SECTION - C

22. (a) Differences between grazing food chain and detritus food chain:

Grazing food chain	Detritus food chain
Energy is derived from the sun through photosynthesis by primary producers (plants).	Energy comes from organic matter or detritus generated in trophic levels of the grazing food chain.
It begins with primary producers.	It begins with detritus, such as dead bodies of animals or fallen leaves.
Grass → Rabbit → Fox	Leaf litter → Bacteria → Earthworm → Bird

2

- (b) The detritus food chain may be connected to the grazing food chain at some levels in an ecosystem. For example:

Leaf litter → Bacteria → Earthworm → Bird

In this example, the detritus food chain (involving earthworms as detritivores) is connected to the grazing food chain through the consumption of detritus by organisms that are part of the grazing food chain. 1

24. (a) In biotechnology experiments, the cells must be made competent so that they can take up the hydrophilic DNA molecule inside them from the external medium. Treatment of bacterial cells with divalent calcium cations makes them competent and helps them to take up the DNA through the pores in the cell wall. 1 1/2

- (b) Biolistic gene or gene gun is a method of introducing alien DNA into the plants cells. In this method, the host cells are bombarded with high-velocity micro-particles of gold or tungsten coated with DNA molecules, facilitating genetic modification without the need for complex tissue culture 1 1/2

26. The expression of different genes for different traits can exhibit various patterns, including dominance, incomplete dominance, or co-dominance.

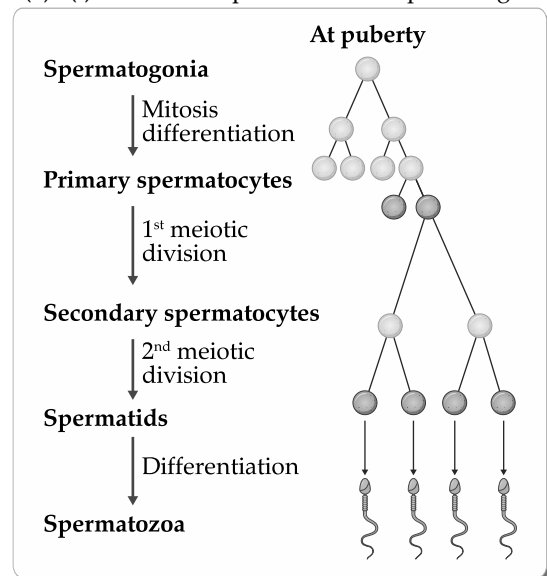
- (i) **Dominance:** Dominance occurs when one allele completely masks the expression of the other allele in a heterozygous individual. In this case, the dominant allele is expressed phenotypically, while the recessive allele remains hidden. For example Mendel's pea plant experiments with flower color. In pea plants, the allele for purple flowers (P) is dominant over the allele for white flowers (p). When a plant inherits one allele for purple flowers (PP) and one allele for white flowers (pp), it will have purple flowers because the dominant purple allele masks the expression of the recessive white allele. 1

- (ii) **Incomplete Dominance:** It is an inheritance in which heterozygous offspring shows an intermediate character between two parental characteristics. For example Flower colour in snapdragon (dog flower or *Antirrhinum* sp.). In snapdragons, the allele for red flowers (R) is incompletely dominant over the allele for white flowers (r). When a plant inherits one allele for red flowers (RR) and one allele for white flowers (rr), it will have pink flowers, exhibiting a blend of the red and white colours. 1

- (iii) **Co-dominance:** It is the inheritance in which both alleles of a gene are expressed equally and independently in a hybrid, i.e., both the alleles are dominant. For example ABO blood grouping in humans. ABO blood groups are controlled by the gene. The gene (I) has three alleles I^A , I^B and i . However, a person can have any two of these three alleles. I^A and I^B both are dominant alleles while i is a recessive allele. The alleles I^A and I^B produce antigen A and antigen B respectively on the RBC surface while allele i doesn't produce any antigen. When I^A and I^B are present together they both express their types of surface antigen A and B. This is due to co-dominance. 1

SECTION - E

32. (a) (i) Schematic representation of spermatogenesis:



3

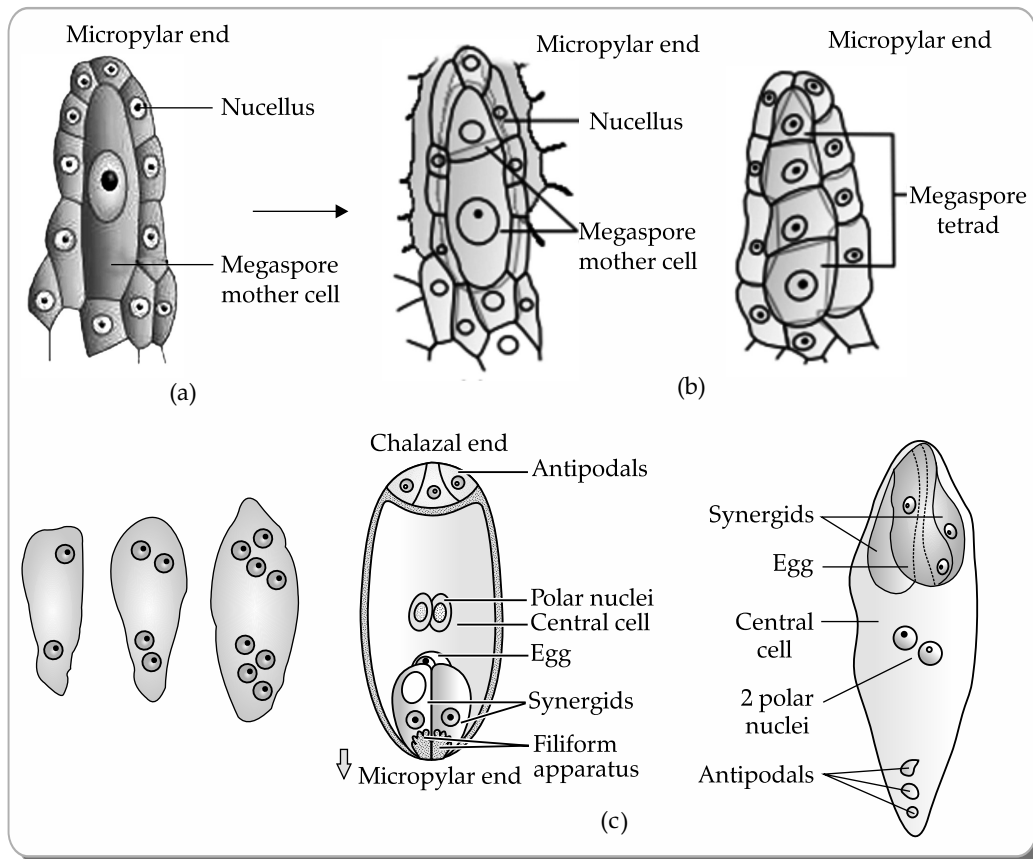
- (ii) GnRH acts on the anterior pituitary to secrete luteinising hormone (LH) and follicle stimulating hormone (FSH).
- LH acts at the Leydig cells and stimulates the synthesis and secretion of androgens. Androgens, in turn, stimulate the process of

spermatogenesis.

- FSH acts on the Sertoli cells and stimulates the secretion of some factors which help in the process of spermiogenesis. 2

OR

(b) (i)



3

(ii) Parts of the ovule showing a large megaspore mother cell, (a) a dyad and a tetrad of megaspores; (b) 2, 4 and 8-nucleate stages of embryo sac and a mature embryo sac; (c) A diagrammatic representation of the mature embryo sac. Geitonogamy occurs when pollen from the anther of one flower is transferred to the stigma of another flower on the same individual plant. Xenogamy, on the other hand, occurs when pollen from the anther of one flower is transferred to

the stigma of a flower on a different individual plant of the same species. 1

(iii) The type of flowers that are invariably autogamous are called cleistogamous flowers. Cleistogamous flowers are a type of closed, self-pollinating flower where the anthers and stigma are in close proximity, often within the same flower. 1

Delhi Set-3

57/5/3

SECTION – A

2. **Option (C) is correct.**

Explanation: When genes are tightly linked, they tend to be inherited as a unit, reducing the likelihood of genetic variation among the offspring.

8. **Option (D) is correct.**

Explanation: Heroin, commonly called smack (chemical name diacetylmorphine) is a white, odourless, bitter crystalline compound. This is obtained by acetylation of morphine, which is extracted from the latex of the poppy plant (*Papaver somniferum*).

9. **Option (B) is correct.**

Explanation: The first antibiotic, penicillin, was discovered accidentally by Alexander Fleming while he was working with the mold *Penicillium notatum*.

12. **Option (C) is correct.**

Explanation: The human chromosome with the highest number of genes is chromosome 1, which contains approximately 2,968 genes. On the other hand, the Y chromosome has the least number of genes among the autosomes, with around 56 protein-coding genes.

14. Option (A) is correct.

Explanation: Biodiversity hotspots are the regions characterised by high levels of species richness and a high degree of endemism. Globally, there are 22 recognised biodiversity hotspots. Notably, India is home to four of these hotspots: the Western Ghats, Indo-Burma region, the Himalayas and Sundaland.

SECTION - B

20. Events that lead to biogas production from waste water with reduced BOD are:

- (i) Once the BOD of wastewater is significantly reduced, the effluent is passed into a settling tank for sedimentation.
- (ii) From the settling tank, the major part of sedimented material called activated sludge (bacterial flocs) is pumped into large tanks called anaerobic sludge digester and a small part is pumped back into the aeration tank to serve as inoculum.
- (iii) In these tanks, the sludge is anaerobically digested by bacteria and fungi, biogas is produced which is a mixture of methane, hydrogen sulphide and CO_2 . The biogas can be used as a source of energy as it is inflammable. 2

SECTION - C

23. (a) The milk produced during the initial few days of lactation is called colostrum which contains several antibodies essential to develop resistance for the new-born babies. Breast-feeding during the initial period of infant growth is recommended by doctors for bringing up a healthy baby. 1

- (b) Vaccine is an antigen protein of pathogens or inactivated or weakened pathogens or their toxin. When introduced into the body, vaccines stimulate the immune system to produce an immune response, including the production of antibodies and memory cells.

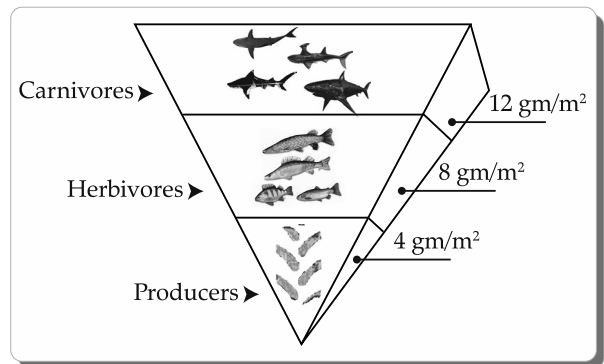
Principle: During the primary response, the immune system generates antibodies specific to the antigen present in the vaccine. Additionally, memory cells are produced, which are specialised immune cells that "remember" the pathogen's antigen. If the individual is exposed to the same pathogen in the future, these memory cells quickly recognise the antigen and initiate a rapid and robust immune response, known as the secondary response. This secondary response is more rapid and effective compared to the primary response, providing long-lasting immunity against the pathogen. 2

25. Plant breeders are interested in artificial hybridisation programmes because it allows them to introduce desirable traits from different plant varieties or species into a single plant, creating new cultivars with improved characteristics such as higher yield, disease resistance, pest resistance, better taste or adaptability to specific environmental conditions. In this method, desired pollen grains are used for pollination. This is achieved by emasculation and

bagging techniques.

- **Emasculation:** Emasculation is the process of removal of anthers (using forceps) from the bisexual flower bud without affecting the female reproductive part, i.e., pistil.
- **Bagging:** Emasculated flowers are then covered with a suitable bag (made up of butter paper) to prevent contamination of its stigma with unwanted pollen. This is called bagging.
 - When the stigma of the bagged flower attains receptivity, mature pollen grains collected from anthers of the male parent are dusted on the stigma. Then the flowers are rebagged and allowed to develop the fruits.
- If the female parent is unisexual, then there is no need for emasculation. In this case, the female flower buds are directly bagged before the flowers open. When the stigma becomes receptive, suitable pollens are dusted onto it so as to allow germination. 3

27. (a) Pyramid of biomass in sea

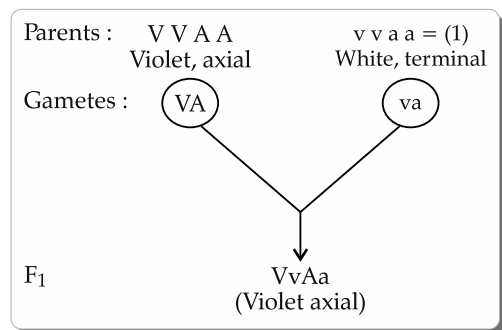


A pyramid of biomass is a graphical representation of the total amount of living matter present at each trophic level of an ecosystem. Pyramid of biomass in sea is generally inverted because the biomass of fishes far exceeds that of phytoplankton. 2

- (b) The pyramid of energy is always upright because energy decreases as it moves through trophic levels in an ecosystem due to the second law of thermodynamics, which states that energy is lost as heat during each transfer. 1

SECTION - E

33. (a) Cross between pea plants bearing violet coloured axial flowers and white coloured terminal flowers:



	VA	vA	Va	va
VA	VVAA Violet axial	VvAA Violet axial	VVaa Violet axial	VvAa Violet axial
vA	VvAA Violet axial	vvAA White Axial	VvAa Violet axial	vvAA White Axial
Va	VVaa Violet axial	VvAa Violet axial	VVaa Violet terminal	Vvaa Violet terminal
va	VvAa White Axial	vvAa White Axial	Vvaa Violet terminal	vvaa White terminal

Phenotypes – violet axial : violet axial : violet terminal : White terminal
 Phenotype ratio– 9 : 3 : 3 : 1 = 16

4

Law of Independent Assortment: When two pairs of traits are combined in a hybrid segregation of one pair of characters is independent of the other pair of characters. 1

OR

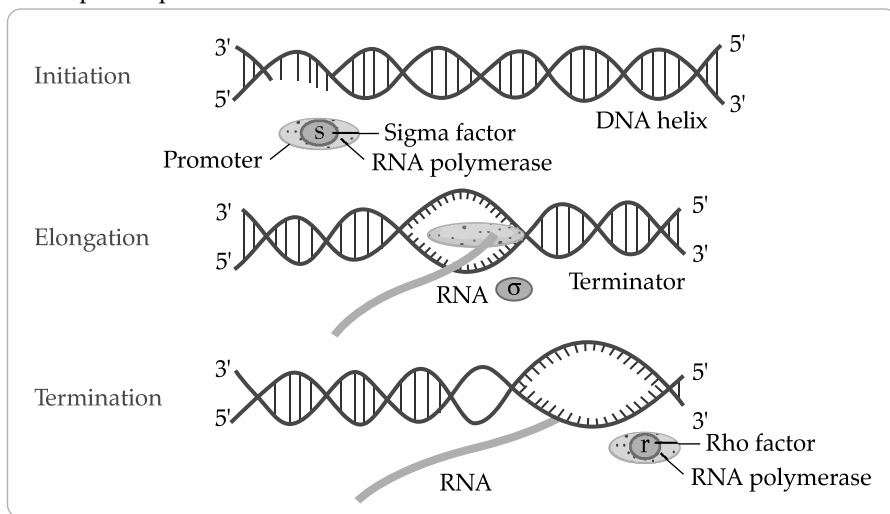
(b) The process by which the DNA message is copied into a strand of mRNA is called transcription. The process of transcription is completed in three steps:

- (i) **Initiation:** Here, the enzyme **RNA polymerase** binds at the promoter site of DNA and initiates the process of transcription. It causes the local unwinding of the DNA double helix. An **initiation factor** (σ) present in RNA polymerase initiates the RNA synthesis.
- (ii) **Elongation:** The RNA chain is synthesised in the 5'–3' direction.
- RNA polymerase unzips the DNA double helix and forms an open loop.

- One of the strands, called sense strand, acts as template for mRNA synthesis.
- The enzyme, RNA polymerase, utilises **ribonucleoside triphosphates** (ATP, GTP, UTP and CTP) as substrate and polymerises them to form mRNA following the rule of complementarity.
- This process of opening of helix and elongation of polynucleotide chain continues until the enzyme reaches the terminator gene.

(iii) **Termination:**

- RNA polymerase recognises the **terminator gene** by a termination-factor called **rho** (ρ) factor.
- After RNA polymerase reaches the terminator region, the newly synthesised mRNA transcript along with enzyme is released.
- The proceeded mRNA leaves the nucleus and enters the cytoplasm.

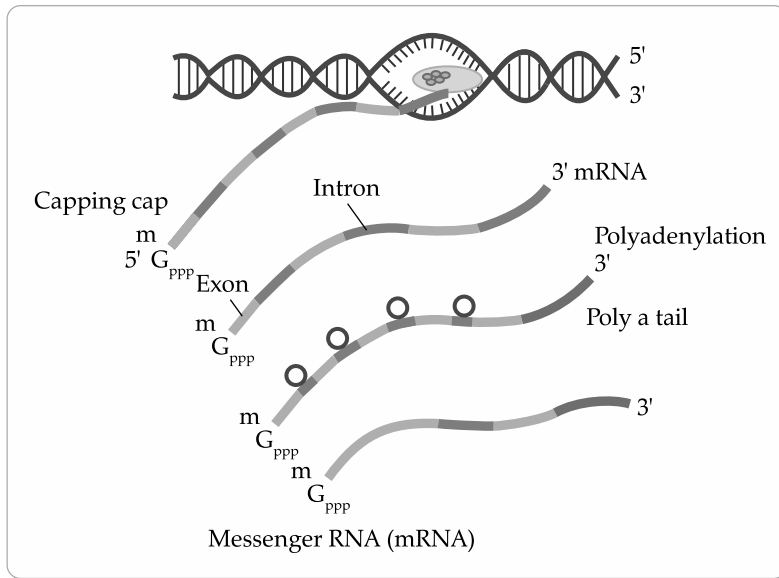


3

In eukaryotes, there are two additional complexities:

- (i) **There are three RNA polymerases:** RNA polymerase I, which transcribes rRNAs (28S, 18S and 5.8S), RNA polymerase II, which transcribes the heterogeneous nuclear RNA (hnRNA) and RNA polymerase III, which transcribes tRNA, 5S rRNA and snRNAs (small nuclear RNAs).

- (ii) **Post transcriptional processing (occurs inside the nucleus):** Eukaryotic pre-mRNA undergoes post transcriptional processing, which includes capping, splicing and polyadenylation, before it is transported out of the nucleus. These modifications stabilise the mRNA molecule, facilitate its export to the cytoplasm and regulate gene expression. 2



Outside Delhi Set-1

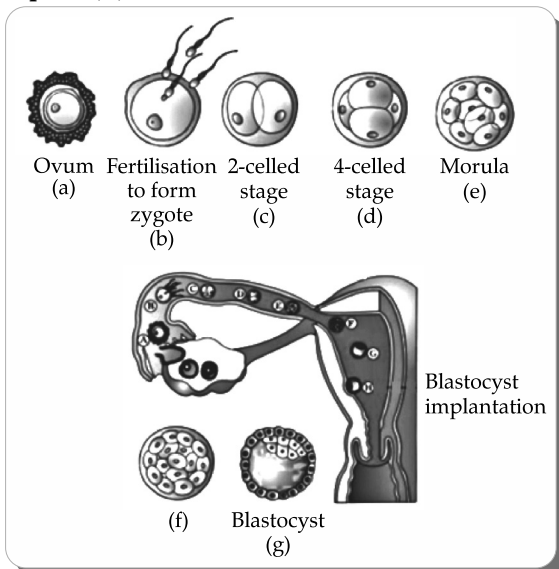
57/4/1

SECTION - A

1. Option (A) is correct.

Explanation: Antipodal cells are indeed typically haploid (n). The zygote is diploid ($2n$) resulting from the fusion of haploid egg and sperm cells. The endosperm is triploid ($3n$), formed by the fusion of a haploid sperm cell with two haploid polar nuclei in the central cell.

2. Option (C) is correct.



Explanation: The ovum, also known as the egg cell, is spherical with nucleus located at the centre. It is surrounded by a layer of cells called the follicle within the ovary. In the diagram figure (a) is the morula.

The embryo with 8 to 16 blastomeres is called a morula. In the diagram figure (e) is the morula.

The morula continues to divide and transforms into blastocyst as it moves further into the uterus. In the

blastocyst the blastomeres are arranged into an outer layer called trophoblast and an inner group of cells attached to trophoblast called the inner cell mass. In the diagram figure (g) is the morula.

3. Option (C) is correct.

(i) Prevent sperm reaching cervix – Condom

Explanation: Condoms physically block sperm from entering the cervix.

(ii) Prevent implantation – Copper-T

Explanation: Copper-T is an intrauterine device (IUD) that releases copper ions, which are toxic to sperm, preventing fertilisation. It can also prevent implantation of a fertilised egg in the uterus.

(iii) Inhibits ovulation – The pill

Explanation: Birth control pills contain hormones that prevent ovulation, the release of an egg from the ovary.

(iv) Semen contains no sperm – Vasectomy

Explanation: Vasectomy is a surgical procedure that blocks the vas deferens, the tubes that carry sperm from the testicles to the urethra, thus preventing sperm from being ejaculated with semen.

4. Option (C) is correct.

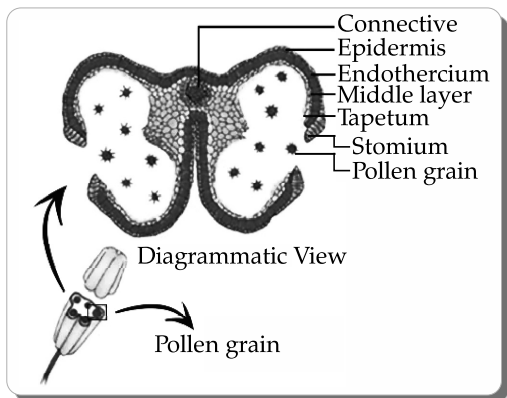
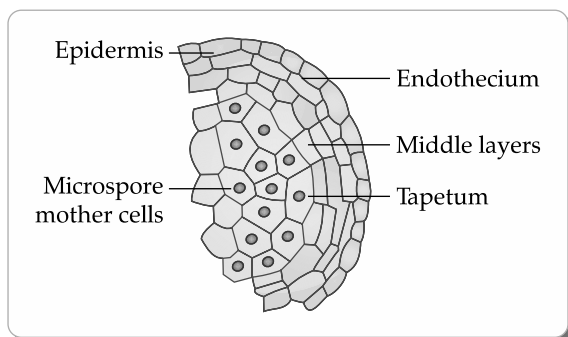
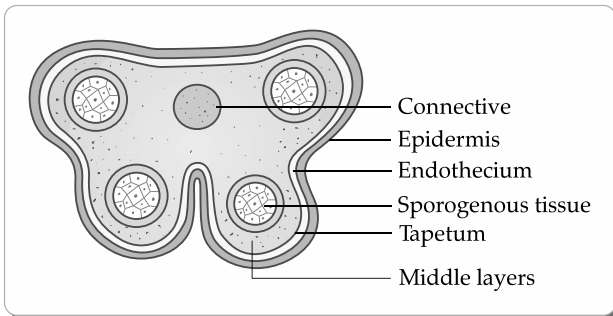
Explanation: Autosomal recessive inheritance: Disorders stem from gene mutations on non-sex chromosomes. In an autosomal recessive inheritance pattern, both parents of an affected individual are usually unaffected carriers of the gene. Therefore, as multiple siblings in a family are affected and their parents are unaffected carriers, it is suggestive of autosomal recessive inheritance.

5. Option (A) is correct.

Explanation: Chromosome 1 was the final human chromosome to undergo full sequencing, reaching

completion in May 2006. This milestone marked the conclusion of sequencing efforts for all 24 human chromosomes, including the 22 autosomes and the sex chromosomes, X and Y.

6. **Option (A) is correct.**



Explanation: The middle parenchymatous tissue that joins two anther lobes together is termed as connective tissue. Thus part (A) is the connective.

The outermost layer is known as the epidermis and inner to the epidermis is the layer of endothecium. Thus, part (B) is the endothecium.

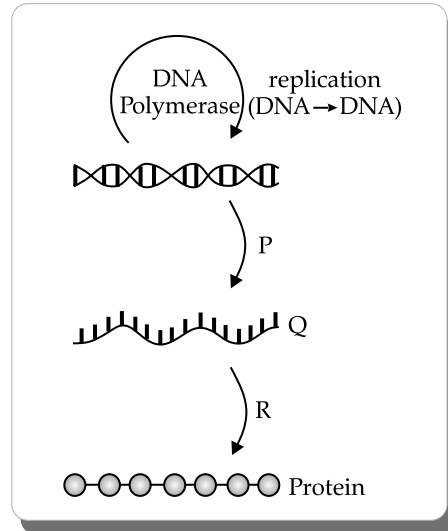
Inner to the tapetum is the microspore mother cells which give rise to pollen grains through meiotic division. Thus parts labelled as (C) is the pollen grain.

7. **Option (A) is correct.**

Explanation: Turner's syndrome is an example of aneuploidy. It is a genetic condition that occurs when a female has only one X chromosome instead of the usual two (45 with X0). This type of genetic abnormality is known as monosomy, which is a form of aneuploidy where there is an abnormal number of chromosomes in a cell.

8. **Option (D) is correct.**

Explanation: DNA (deoxyribonucleic acid) contains the genetic information for an organism and is located in the cell's nucleus. The information stored in DNA is transcribed into messenger RNA (mRNA) through a process called transcription.



mRNA carries the genetic code from the DNA in the nucleus to the ribosomes in the cytoplasm of the cell. At the ribosomes, the genetic code is translated into a specific sequence of amino acids to form a protein. This process is called translation. Thus, (P) is transcription; (Q) is mRNA and (R) is protein.

9. **Option (D) is correct.**

Explanation: The mutation theory in favour of organic evolution was proposed by Hugo de Vries, a Dutch botanist, in the late 19th and early 20th centuries. He suggested that sudden and significant variations, known as mutations, could be the driving force behind evolutionary change.

10. **Option (A) is correct.**

Explanation:

- (i) Removal of oil stains: Lipase (enzyme) is involved in the removal of oil stains.
- (ii) Removal of clots from blood vessels: Streptokinase (enzyme) is used for the removal of clots from blood vessels.
- (iii) Lowering of blood cholesterol: Statin (drug) is used for lowering blood cholesterol levels.
- (iv) Immunosuppressive agent: Cyclosporin A (drug) is an immunosuppressive agent.

11. **Option (D) is correct.**

Explanation: The term "molecular scissors" typically refers to enzymes known as restriction enzymes or restriction endonucleases. These enzymes are proteins that can recognise specific DNA sequences and cut the DNA at or near those sequences.

12. **Option (B) is correct.**

Explanation: The ELISA technique relies on antigen-antibody interactions. It involves immobilising an antigen, adding an enzyme-linked antibody and detecting the reaction through a colour change. This

allows for the detection and quantification of specific antigens or antibodies in a sample.

13. Option (A) is correct.

Assertion (A) and the Reason (R) both describe aspects of the mutualistic relationship between figs and fig wasps. The statement in the assertion is generally true. Each fig species usually has a specific species of wasp that is the primary pollinator. The reason provided in (R) explains the mechanism of this mutualistic relationship, as the wasp pollinates the fig inflorescence while searching for suitable egg-laying sites. Therefore, assertion (A) is supported by reason (R) and both are correct.

14. Option (C) is correct.

Assertion (A) is correct. Plasmids are indeed autonomously replicating circular DNA molecules that are separate from the chromosomal DNA. They can replicate independently within a host cell. However, the reason (R) is incorrect. Plasmids are not typically present in eukaryotic cells. They are more commonly found in prokaryotic cells, such as bacteria.

15. Option (A) is correct.

Assertion (A) is correct. Patents are indeed granted by government agencies to inventors or assignees who have created a new and useful invention.

Reason (R) is also correct. One of the primary purposes of patents is to provide the patent holder with the exclusive right to prevent others from commercially using, making, selling, or distributing their patented invention without their permission for a specified period of time.

Therefore, both assertion (A) and reason (R) are correct and reason (R) provides a valid explanation for assertion (A).

16. Option (C) is correct.

Inverted biomass pyramids can occur in certain aquatic ecosystems due to factors such as rapid growth rates of primary producers, efficient energy transfer between trophic levels and large numbers of small organisms supporting fewer large predators. However, the reason (R) stating that more energy is required by organisms at higher trophic levels is not the primary cause of inverted biomass pyramids.

SECTION – B

17. If the egg remains unfertilised after ovulation, usually around the 14th day of the menstrual cycle, the uterine lining is shed as menses during menstruation, occurring approximately every 28 days. However, if fertilisation occurs, the uterine lining thickens to support the developing embryo. In the provided diagram, the uterine wall thickness of woman Y begins to decrease after the 14th day, indicating that the egg has not been fertilised. Conversely, the uterine wall thickness of woman X starts to increase, indicating that the egg has been fertilised and she has conceived.

18. (a) Intensely lactating mothers often do not conceive due to lactational amenorrhoea, where breastfeeding suppresses ovulation. These

mothers have elevated levels of prolactin, the hormone responsible for milk production. High levels of prolactin can inhibit ovulation and make it difficult for a woman to conceive.

(b) Governments impose strict conditions for Medical Termination of Pregnancy (MTP) to address ethical, public health, legal and safety concerns, ensuring proper regulation and safeguarding women's reproductive rights.

19. (a) Insulin was initially extracted from the pancreas of animals, such as pigs and cattle. However, it's no longer in use due to allergic reactions, variability in potency, supply constraints, purification challenges and the advent of synthetic human insulin through biotechnology, offering improved safety and consistency.

(b) Insulin synthesised in the human body undergoes processing within pancreatic cells, converting proinsulin to mature insulin. In contrast, insulin produced by companies like Eli Lilly is synthesised in its mature form using biotechnology, eliminating the need for additional processing.

20. (a)

Aspect	Grazing Food Chain	Detritus Food Chain
Primary Producers	Green plants and algae	Decomposers and detritivores
Primary Consumers	Herbivores (e.g., animals feeding directly on plants)	Detritivores (e.g., organisms feeding on dead organic matter)
Energy Source	Freshly synthesised organic matter (e.g., plants)	Dead organic matter (e.g., leaf litter, decaying organisms)
Energy Transfer	Through consumption and digestion	Through decomposition and microbial breakdown
Trophic Levels	Typically involves multiple trophic levels (e.g., plants, herbivores, carnivores)	May involve fewer trophic levels (e.g., detritivores and decomposers)
Examples	Grassland ecosystem, forest ecosystem	Decomposer-dominated ecosystems (e.g., soil ecosystems)

OR

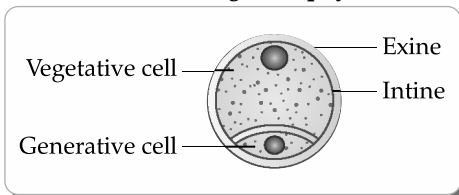
(b) Brood parasitism is a reproductive strategy observed in some bird species where a bird, known as the brood parasite, lays its eggs in the nest of another bird species, known as the host. The host bird then incubates and raises the eggs as if they were its own, often at the expense of its own offspring. A suitable example of brood parasitism is the behaviour of the common cuckoo. Female cuckoos lay their eggs in the nests of other bird species, such as crow. The cuckoo eggs closely mimic the appearance of the host's eggs,

reducing the likelihood of the host detecting the intrusion. During the course of evolution, the eggs of the parasitic bird have evolved to resemble the host's egg in size and colour to reduce the chances of the host bird detecting the foreign eggs and ejecting them from the nest.

21. (a) Biodiversity hotspots, despite covering less than 2% of Earth's land area, harbour a disproportionately high number of species. Strict protection of these areas helps conserve unique and threatened species, mitigating the ongoing loss of biodiversity and reducing the rate of extinctions by safeguarding critical habitats and ecosystems.
- (b) Two biodiversity hotspots in India are:
1. **Western Ghats:** Spanning across the states of Maharashtra, Karnataka, Kerala, Tamil Nadu and Goa, the Western Ghats are recognised for their rich biodiversity and high levels of endemism.
 2. **Indo-Burma Region:** Encompassing parts of northeastern India, as well as Myanmar, Thailand, Laos, Vietnam and southern China, the Indo-Burma Region is renowned for its diverse ecosystems and unique species.

SECTION – C

22. Sectional view of male gametophyte



Functions:

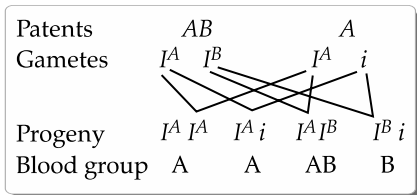
Exine: A durable outer layer of pollen grains, resistant to extreme conditions like high temperatures, strong acids and alkalis. It shields the pollen and ensures its protection during pollination.

Intine: A delicate inner layer composed of cellulose and pectin, forming a thin, continuous covering. The intine facilitates the growth of a pollen tube, essential for fertilisation.

Vegetative cell: A larger pollen grain component containing ample food reserves necessary for pollen germination and tube formation during fertilisation.

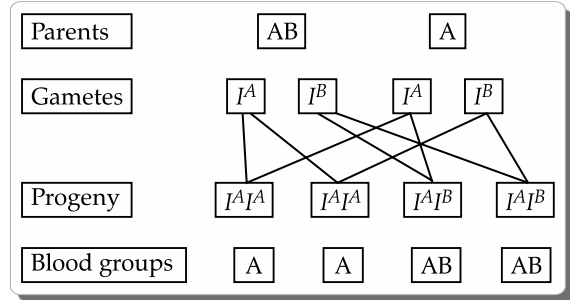
Generative cell: The pollen grain component that undergoes mitotic division to produce two male gametes, crucial for fertilisation to occur.

23. (a)



From the above cross, it is clear that the occurrence of B blood group progeny indicates that man is heterozygous for the allele A. If the man is homozygous for the allele A, the progeny will have

either an A or AB type blood group.

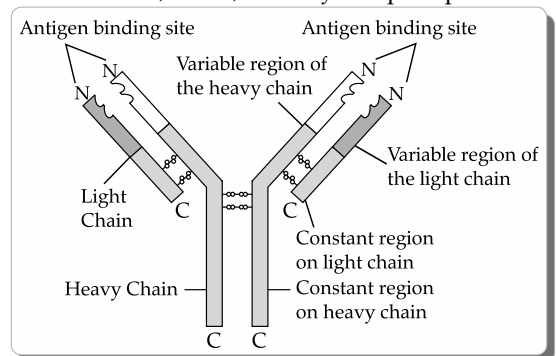


- (b) The ABO blood group system classifies human blood based on the inherited properties of red blood cells (erythrocytes), determined by the presence or absence of antigens A and B on their surface. Individuals may have type A, type B, type O, or type AB blood, depending on the combination of antigens present.

24. (a) The skull of a baby chimpanzee (B) exhibits similarities to an adult human skull (A) rather than an adult chimpanzee skull (C) due to its incomplete development. Certain features present in the baby chimpanzee skull resemble those found in adult human skulls, as both species share some common anatomical characteristics during early stages of development. This resemblance is attributed to the retention of certain primitive traits in the baby chimpanzee skull, reflecting evolutionary relationships between humans and chimpanzees.
- (b) (i) The ape-like primate that existed 1.5 million years ago is likely *Australopithecus*, specifically *Australopithecus afarensis*, which included the famous specimen "Lucy".
- (ii) The more man-like primate that existed 1.5 million years ago could be *Homo erectus*, an early human species known for its upright posture and advanced tool-making abilities.

25. (a) (i) **Cannabinoids**

- (ii) Cannabinoid drugs are consumed through various methods including smoking, vapourisation, ingestion (edibles), sublingual administration (under the tongue) and topical application (creams or patches).
- (iii) The human body organ affected by the consumption of cannabinoid drugs is the brain, primarily due to the interaction of cannabinoids with cannabinoid receptors in the central nervous system, leading to alterations in cognitive function, mood, memory and perception.



OR

- (b) Antibodies, also known as immunoglobulins (Ig), are Y-shaped proteins produced by white blood cells called B cells. They are primarily composed of proteins known as polypeptides, with additional components such as glycans and disulfide bonds contributing to their structure.
26. (a) **Flocs:** In sewage treatment, flocs are clusters of suspended particles that form when coagulants are added to wastewater. These coagulants neutralise the negative charge of colloidal particles, allowing them to clump together. Flocs help in the removal of suspended solids, organic matter and other contaminants from wastewater through a process called flocculation. The formation of larger flocs facilitates their settling during sedimentation, aiding in the separation of solids from the liquid phase.
- (b) **Anaerobic Sludge Digester:** Anaerobic sludge digestion is a biological process used in sewage treatment to break down organic solids in sludge, producing biogas and stabilising the sludge for further disposal. In the anaerobic digester, bacteria, which grow anaerobically, digest the bacteria and the fungi in the sludge. During this digestion, bacteria produce a mixture of gases such as methane, hydrogen sulphide and carbon dioxide. These gases form biogas and can be used as source of energy
27. (a) A: Denaturation
D: Extension
- (b) B represents primer
- (c) C is Taq polymerase. Taq polymerase is a thermostable DNA polymerase I named after the thermophilic eubacterial microorganism *Thermus aquaticus*.
- (d)
1. Firstly, PCR is employed for pathogen detection, enabling rapid and sensitive identification of viruses, bacteria, fungi and parasites in clinical samples. This aids in the timely diagnosis of infectious diseases such as COVID-19, HIV and tuberculosis.
 2. Secondly, PCR is utilised in genetic testing, facilitating the detection of genetic mutations associated with inherited disorders or predisposition to diseases like cancer. This allows for early intervention and personalised treatment strategies.
 3. Thirdly, PCR serves in forensic analysis, amplifying trace amounts of DNA from crime scenes to establish identities or familial relationships crucial for legal investigations.
28. (a) Transgenic animals play a pivotal role in the production of biological products by serving as bioreactors. Genetically modified to express specific proteins or enzymes, they can synthesise valuable pharmaceuticals, such as insulin or growth hormones, in their milk, blood, or tissues. This method offers a cost-effective and scalable means of generating complex proteins

for medical use.

- (b) Many transgenic animals are designed to increase our understanding of how genes contribute to the development of disease. These are specially made to serve as models for human diseases so that investigation of new treatments for diseases is made possible.
- (c) Transgenic animals are utilised in chemical safety testing to assess the potential toxicity of substances. This is known as toxicity/safety testing. Transgenic animals are made that carry genes which make them more sensitive to toxic substances than non-transgenic animals. They are then exposed to the toxic substances and the effects studied. Toxicity testing in such animals will allow us to obtain results in less time.

SECTION - D

29. (a) A: Exponential growth
B: Logistic growth
- (b) Dotted line represents carrying capacity.
Importance of carrying capacity: Carrying capacity denotes an ecosystem's ability to sustainably support a specific population size. Understanding it helps maintain ecological balance, prevent resource depletion and guide responsible management of natural environments.

OR

- (b) The difference between exponential (A) and logistic (B) growth curves lies in resource availability. Exponential growth occurs when resources are abundant and unrestricted, allowing a population to grow continuously at an increasing rate. It follows a J-shaped curve, where the population size doubles over fixed intervals.
- In contrast, logistic growth occurs when a population encounters resource limitations. Initially, the population grows exponentially, but as resources become scarce, growth slows and eventually levels off at the carrying capacity of the environment. This results in an S-shaped curve. Therefore, while exponential growth reflects ideal conditions with unlimited resources, logistic growth represents the more realistic scenario where resource constraints influence population dynamics.
- (c) (i) In environments with unlimited resources, populations grow exponentially or geometrically. However, no population can sustain exponential growth indefinitely; resource limitations eventually constrain growth. Logistic growth, depicted by a sigmoid curve, is a more realistic model, reflecting this natural constraint.
- (ii) In present times, the logistic growth curve is more relevant to the human population in our country. While human populations have experienced exponential growth in the past, resource constraints such as land, water and energy availability are increasingly becoming limiting factors. Consequently, population

growth is now more likely to follow a logistic pattern as these constraints exert pressure, leading to a more stabilised growth trajectory.

30. (a) The RNA product transcribed from the DNA that subsequently translates into a polypeptide of 400 amino acids is called messenger RNA (mRNA). The enzyme responsible for transcribing mRNA from DNA is RNA polymerase.
- (b) The process the mRNA molecule undergoes to be able to translate a polypeptide of 400 amino acids is called translation. Translation occurs in the cytoplasm of eukaryotic cells. During translation, the mRNA molecule is read by ribosomes, which assemble amino acids into a polypeptide chain according to the codons (three-nucleotide sequences) on the mRNA molecule. Transfer RNA (tRNA) molecules bring the corresponding amino acids to the ribosome, where they are added to the growing polypeptide chain.
- (c) In prokaryotes, such as bacteria, there is typically only one type of RNA polymerase involved in the transcription of DNA. In contrast, eukaryotes have multiple RNA polymerases. In humans, for example, there are three main types of RNA polymerases: RNA polymerase I, II and III, each responsible for transcribing different types of RNA molecules.

OR

- (c) In prokaryotic cells, transcription occurs in the cytoplasm since there is no distinct nucleus. The DNA is present in the cytoplasm and RNA polymerase binds directly to the DNA to initiate transcription.

In contrast, in eukaryotic cells, transcription primarily occurs within the nucleus.

SECTION – E

31. (a) (i) The process depicted in the diagram that results in the development of spermatozoa is called spermatogenesis. Spermatogenesis is the process by which spermatogonia in the seminiferous tubules of the testes undergo mitosis, followed by meiosis, to produce haploid sperm cells or spermatozoa. These spermatozoa eventually mature and are released into the seminiferous tubules for transport through the male reproductive system.
- (ii) In the diagram, the cell where a cluster of spermatozoa is attached is likely a Sertoli cell. Sertoli cells are supportive cells found within the seminiferous tubules of the testes. They provide physical and nutritional support to developing sperm cells during spermatogenesis. Additionally, Sertoli cells help regulate the process of spermatogenesis by producing various growth factors and hormones.

OR

- (i) A – Chasmogamous, B – Cleistogamous
- (ii) **Comparing the two types of flowers with reference to:**

(1) Characteristic features:

- Chasmogamous flowers (type A) are typically large, showy and have open petals, making their reproductive organs easily accessible to pollinators.
- Cleistogamous flowers (type B) are often smaller, inconspicuous and remain closed, with petals tightly covering the reproductive organs.

(2) Modes of pollination:

- Chasmogamous flowers (type A) rely on cross-pollination, which is facilitated by pollinators such as insects, birds, or wind. These flowers produce abundant nectar and pollen to attract pollinators.
- Cleistogamous flowers (type B) are self-pollinating or autogamous. Because they remain closed, they are less likely to be visited by pollinators. Instead, they self-pollinate within the closed flower, ensuring reproductive success even in the absence of pollinators.

(iii) Two outbreeding devices in flowering plants:

1. Dichogamy: Temporal separation of male and female reproductive structures within a flower or between flowers on the same plant.
2. Herkogamy: Structural adaptations that physically prevent self-pollination, such as spatial separation of stigma and anthers or specialised floral structures that guide pollinators to specific reproductive organs. Plants develop these outbreeding devices to enhance genetic diversity and promote reproductive success. By promoting cross-pollination or preventing self-pollination, plants increase the chances of successful fertilisation and produce genetically varied offspring, which contributes to species survival and adaptation.

32. (a) (i) Polarity is 5' to 3'. No more amino acids will be added as UAA stop codon is present.

- (ii) The initiating codon for translation is AUG. Its complementary anticodon on the transfer RNA (tRNA) molecule is UAC. The amino acid that AUG codes for is methionine (Met).

- (iii) Charging of an adaptor molecule, which is a tRNA molecule, involves the attachment of the appropriate amino acid to its specific tRNA molecule. This process is catalysed by an enzyme called aminoacyl-tRNA synthetase.

Charging of tRNA molecules is essential for accurate and efficient protein synthesis during translation. Without charging, the tRNA molecules would not be able to deliver the correct amino acids to the ribosome, leading to errors in the formation of the polypeptide chain. Charging ensures that each tRNA molecule is correctly matched with its corresponding amino acid, thus maintaining the fidelity of protein synthesis.

OR

- (b) (i) Sickle-cell anemia is so named because of the distinctive sickle or crescent shape assumed by red blood cells in affected individuals. This abnormal shape is caused by the presence of

abnormal haemoglobin molecules within the red blood cells.

- (ii) The disease is controlled by a single pair of alleles, Hb^A and Hb^S . Out of the three possible genotypes only homozygous individuals for Hb^S ($Hb^S Hb^S$) show the diseased phenotype. Heterozygous ($Hb^A Hb^S$) individuals appear apparently unaffected but they are carrier of the disease as there is 50 per cent probability of transmission of the mutant gene to the progeny, thus exhibiting sickle-cell trait. The defect is caused by the substitution of Glutamic acid with valine at the sixth position of the beta-globin chain. This mutation causes the haemoglobin molecule to polymerise under low-oxygen conditions, leading to the deformation of red blood cells into the characteristic sickle shape. Individuals who inherit two copies of the mutant allele (homozygous for the sickle-cell gene) typically exhibit the severe form of the disease, while those who inherit one copy of the mutant allele and one normal allele (heterozygous carriers) may display some symptoms of the disorder but are generally less severely affected.
- (iii) Sickle-cell anemia is an autosomal recessive genetic disorder, meaning that individuals need to inherit two copies of the mutant allele (one from each parent) to express the disorder. Therefore, both parents must be carriers of the sickle-cell trait (heterozygous) to have a chance of having a sickle-cell anemic child.

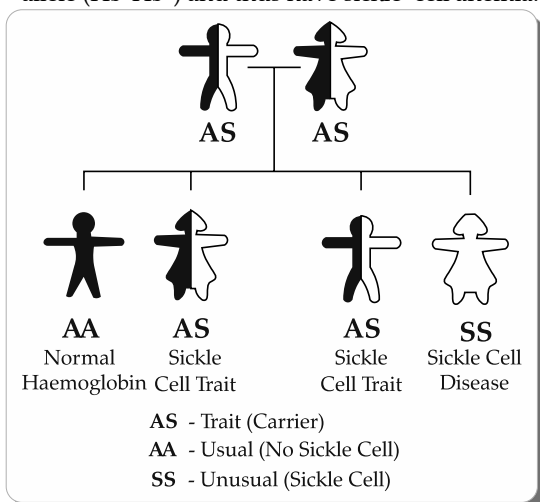
Let's denote the normal allele as H and the sickle-cell allele as S. Normal parents who are carriers of the sickle-cell trait (Heterozygous: Hb^A/S) have the following genetic makeup:

Father: $Hb^A Hb^S$ Mother: $Hb^A Hb^S$

When these parents produce offspring, there are four possible combinations of alleles in their offspring:

1. $Hb^A Hb^A$ (normal)
2. $Hb^A Hb^S$ (carrier, asymptomatic)
3. $Hb^S Hb^A$ (carrier, asymptomatic)
4. $Hb^S Hb^S$ (affected with sickle-cell anemia)

In this scenario, there is a 25% chance (1 out of 4) that the child will inherit two copies of the sickle-cell allele ($Hb^S Hb^S$) and thus have sickle-cell anemia.



33. (a) Concise life cycle of HIV leading to AIDS:

1. After getting into the body of the person, the virus enters into macrophages where RNA genome of the virus replicates to form viral DNA with the help of the enzyme reverse transcriptase.
2. This viral DNA gets incorporated into host cell's DNA and directs the infected cells to produce virus particles. The macrophages continue to produce virus and in this way acts like a HIV factory.
3. Simultaneously, HIV enters into helper T-lymphocytes (TH), replicates and produce progeny viruses. The progeny viruses released in the blood attack other helper T-lymphocytes. This is repeated leading to a progressive decrease in the number of helper T-lymphocytes in the body of the infected person.
4. During this period, the person suffers from bouts of fever, diarrhoea and weight loss. Due to decrease in the number of helper T lymphocytes, the person starts suffering from infections that could have been otherwise overcome such as those due to bacteria especially Mycobacterium, viruses, fungi and even parasites like Toxoplasma. The patient becomes so immunodeficient that he/she is unable to protect himself/herself against these infections

OR

- (b) (i) Malaria symptoms include fever, chills, headache, fatigue, muscle and joint pain, nausea, vomiting and in severe cases, anemia, respiratory distress and jaundice. These symptoms occur due to the lifecycle of Plasmodium parasites within the human body. When infected female Anopheles mosquitoes bite humans, they inject sporozoites, which travel to the liver and infect hepatocytes. After replication, they burst out as merozoites, invading red blood cells and initiating cycles of replication. The rupture of red blood cells releases merozoites, causing fever and chills. The destruction of red blood cells leads to anemia, fatigue and weakness. Additionally, the release of toxic byproducts triggers symptoms like headache, muscle pain and nausea. Severe malaria complications, such as respiratory distress and jaundice, result from widespread organ damage and immune responses to the infection.

(ii) In the sexual mode of reproduction in the malaria parasite's life cycle, several steps occur:

1. **Gametocyte Development:** Male and female gametocytes develop within infected red blood cells.
2. **Mosquito Ingestion:** When a mosquito feeds on a human host, it ingests the gametocytes along with the blood.
3. **Fusion and Zygote Formation:** Within the mosquito's gut, male and female gametocytes fuse to form zygotes.
4. **Sporozoite Formation:** Zygotes develop into sporozoites which are produced through

multiple divisions.

5. **Migration to Salivary Glands:** Sporozoites migrate to the mosquito's salivary glands,

ready to infect another human host during a subsequent bite, completing the sexual cycle and initiating a new infection.

Outside Delhi Set-2

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SECTION – A

9. **Option (B) is correct.**

Explanation: Homologous organs are structures in different species that have a similar underlying anatomy, suggesting common ancestry. They arise through divergent evolution, where related species diverge from a common ancestor and adapt to different environmental conditions, leading to the formation of similar structures with different functions.

11. **Option (D) is correct.**

Explanation: The human Y chromosome possesses the fewest number of genes among the chromosomes in the human genome. It contains relatively fewer genes compared to the other chromosomes, primarily because it is smaller and has undergone significant degeneration over evolutionary time.

SECTION – B

17. Artificial insemination in Assisted Reproductive Technology (ART) involves the artificial introduction of the sperm collected either from the husband or a healthy donor either into the vagina or into the uterus (IUI – intra-uterine insemination) of the female. Medically, it's advised for couples experiencing infertility either due to inability of the male partner to inseminate the female or due to very low sperm counts in the ejaculates.
18. Repeated infusions of genetically engineered lymphocytes, which express ADA enzyme in patients with ADA deficiency, help restore immune function temporarily. However, as these cells are not immortal, the patient requires periodic infusion of such genetically engineered lymphocytes. A possible permanent remedy could be possible if the gene isolate from the bone marrow cells producing ADA is introduced into cells at early embryonic stages.

SECTION – C

22. True-breeding pea plants with purple flowers (PP) crossed with true-breeding pea plants with white flowers (pp) produce F_1 progeny with all purple flowers (Pp). This is due to the dominant allele (P) for purple color masking the recessive allele (p) for white colour.
- True-breeding *Antirrhinum* plants with red flowers (RR) crossed with true-breeding *Antirrhinum* plants with white flowers (rr) produce F_1 progeny with all pink flowers (Rr). This is due to incomplete dominance, where the heterozygous condition (Rr) results in an intermediate phenotype (pink) between the two homozygous conditions (red and white). Therefore, the phenotypes of the F_1 progeny would be:
- **For garden pea plants:** All plants with purple flowers.
 - **For Antirrhinum plants:** All plants with pink flowers.
26. (a) A is vector DNA and B is foreign DNA
- (b) The specific palindromic sequence recognised by *EcoRI* is
- 5' – GAATTC – 3'

3' – CTTAAG – 5'

which results in sticky ends.

- (c) *EcoRI* creates 4 nucleotide sticky ends with 5' end overhangs of AATT. The nucleic acid recognition sequence where the enzyme cuts is $G\downarrow AATTC$, which has a palindromic complementary sequence of $CTTAA\downarrow G$.

After *EcoRI* cuts the DNA, the following events occur to form recombinant DNA:

1. **Digestion of DNA:** *EcoRI* cuts both the donor DNA (containing the desired gene or sequence) and the recipient DNA (vector) at specific recognition sites.
 2. **Mixing of Donor and Recipient DNA:** The donor DNA (containing the gene of interest) and the recipient DNA (vector) are mixed together.
 3. **Annealing of Sticky Ends:** The complementary sticky ends of the donor DNA and the recipient DNA hybridise or anneal due to base pairing. The hydrogen bonds form between the complementary sequences.
 4. **DNA Ligase Activity:** DNA ligase enzyme catalyses the formation of phosphodiester bonds between the sugar-phosphate backbones of the donor DNA and the recipient DNA. This seals the DNA strands together, creating recombinant DNA molecules.
27. (a) **Mycorrhiza:** Mycorrhizal fungi form symbiotic relationships with plant roots, enhancing nutrient uptake and water absorption. They improve soil structure and nutrient availability, promoting plant growth and health. Mycorrhizal associations act as bio-fertilisers by increasing nutrient uptake efficiency and enhancing soil fertility.
- (b) *Azotobacter* bacteria fix atmospheric nitrogen into ammonia, making it available for plant uptake. They also produce growth-promoting substances, stimulating plant growth and development. *Azotobacter* acts as a bio-fertiliser by enhancing nitrogen availability and promoting crop yields in agriculture.
- (c) *Rhizobium* bacteria form symbiotic relationships with leguminous plants, fixing atmospheric nitrogen in root nodules. This enriches the soil with nitrogen, promoting plant growth and soil fertility. *Rhizobium* acts as a bio-fertiliser by facilitating nitrogen fixation in legumes, reducing the need for synthetic nitrogen fertilisers and supporting sustainable agriculture.

SECTION – E

31. (a) (i)
- (1) **Menstruation:** During menstruation, the inner lining of the uterus, known as the endometrium, sheds off along with blood vessels and tissue debris. This process is triggered by a drop in estrogen and progesterone levels if fertilisation does not occur. Menstruation marks the beginning of the menstrual cycle and typically lasts 3–7 days.
- (2) **Follicular Phase:** The follicular phase begins on the first day of menstruation and lasts until ovulation.

During this phase, follicle-stimulating hormone (FSH) stimulates the development of ovarian follicles, each containing an immature egg (oocyte). One dominant follicle continues to grow, while others degenerate. The dominant follicle secretes estrogen, which thickens the uterine lining in preparation for potential pregnancy.

- (3) **Luteal Phase:** The luteal phase begins after ovulation and lasts until the start of menstruation. During this phase, the ruptured follicle transforms into a structure called the corpus luteum, which secretes progesterone. Progesterone maintains the thickened uterine lining and prepares it for embryo implantation. If fertilisation does not occur, the corpus luteum degenerates, leading to a drop in progesterone levels and the start of menstruation.
- (ii) A proper understanding of the menstrual cycle can indeed aid in family planning. By tracking menstrual cycles, individuals can identify fertile and infertile periods, thus helping in natural contraception or family planning. This knowledge allows couples to

time intercourse to maximise or minimise the chances of conception, depending on their reproductive goals.

OR

- (i) **Endosperm Development Preceding Embryo Development in Angiosperm Seeds:** Endosperm development precedes embryo development in angiosperm seeds because the endosperm provides essential nutrients and support to the developing embryo during germination and early seedling growth.
- (ii) **Role of Endosperm in Mature Albuminous Seeds:** In mature albuminous seeds, the endosperm serves as a food reserve for the developing embryo and seedling. It contains stored nutrients such as starch, proteins and lipids, which provide energy to the growing embryo during germination. The endosperm is gradually consumed by the developing embryo as it grows, ensuring the successful establishment of the seedling until it can photosynthesise and produce its own nutrients.

Outside Delhi Set-3

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SECTION - A

5. **Option (B) is correct.**

Explanation: Hugo de Vries proposed the mutation theory of organic evolution after his experiments on the evening primrose plant (*Oenothera lamarckiana*). He observed sudden and heritable changes in certain traits of this plant, which he termed "mutations."

6. **Option (C) is correct.**

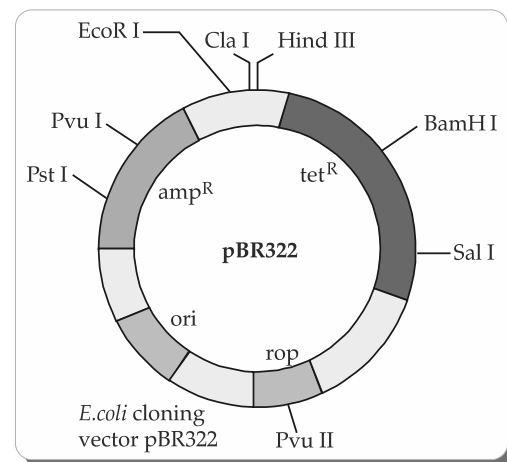
Explanation: *Lactobacillus* is used in the production of curd. *Saccharomyces cerevisiae* is used in the preparation of bread. *Aspergillus niger* is used in production of citric acid and *Acetobacter acetii* in production of acetic acid.

9. **Option (C) is correct.**

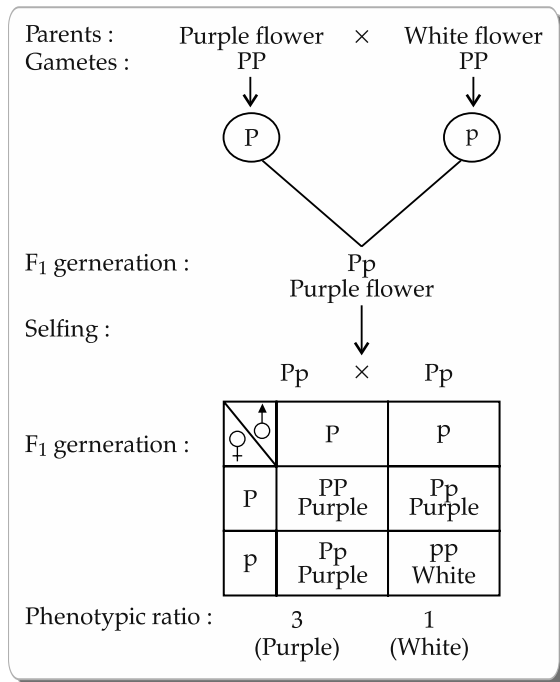
Explanation: Bacterial artificial chromosomes (BAC) and yeast artificial chromosomes (YAC) are the commonly used vectors for human genome sequencing.

17. (a) The first developed transgenic cow is named "Rosie."
- (b) Rosie was engineered to produce human alpha-lactalbumin in her milk. This protein enhances the nutritional quality of milk by increasing the levels of essential amino acids, promoting infant health and potentially providing therapeutic benefits for human consumers.
19. (a) HIV and Hepatitis-B can be transmitted to a healthy person through unprotected sexual contact with an infected individual and sharing contaminated needles or syringes during drug use.
- (b) Early detection of HIV and Hepatitis-B is essential to initiate timely treatment, prevent disease progression, reduce transmission risk to others and improve long-term health outcomes for infected individuals. Early intervention can also help prevent complications and improve quality of life.

22.



23. The use of *Agrobacterium* as a vector has helped in controlling the infestation of nematode *Meloidogyne incognita* in tobacco plants through genetic engineering. Here's the sequence of events:
- (a) Using *Agrobacterium* vectors, nematode-specific genes were introduced into the host plant.
- (b) The introduction of DNA was such that it produced both sense and anti-sense RNA in the host cells.
- This two RNA's being complementary to each other formed a double stranded (dsRNA) that initiated RNA interference RNAi and thus, silenced the specific mRNA of the nematode.
- (iii) The consequence was that the parasite could not survive in a transgenic host expressing specific interfering RNA. The transgenic plant therefore got itself protected from the parasite.
27. The gene for purple flowers is dominant over that of white flowers. So, when two pure varieties are crossed, the F_1 generation has only purple flowers and on selfing, the flowers are produced in a 3: 1 ratio.



This result is obtained due to segregation of the alleles at the time of gametogenesis. The alleles remain together in a zygote but during gamete formation, they segregate such that the gametes carry only one allele.

33. (a) (i) The objective of adopting artificial hybridisation programmes in plants is to create new plant varieties with desirable traits by selectively cross-breeding two different parent plants. This process allows plant breeders to combine desirable characteristics from different parent plants, such as disease resistance, high yield, improved quality and adaptation to specific environmental conditions. By creating hybrids, breeders aim to develop plants with superior traits that can enhance agricultural productivity, food security and economic viability. Additionally, artificial hybridisation programs can lead to

the development of plants better suited for diverse agricultural practices, such as organic farming or sustainable agriculture.

(ii)

- Select parental plants with desired traits.
- If the female parent bears bisexual flowers, anthers from the flower bud is removed using a pair of forceps before the anther dehiscence. This step is referred to as emasculation transfer pollen from male parent to female parent's stigma.
- Emasculated flowers are covered with a bag made up of butter paper to prevent contamination of its stigma with unwanted pollen. This process is called bagging.
- When the stigma of bagged flower attains receptivity, mature pollen grains collected from anthers of the desired male parent are dusted on the stigma.
- The flowers are then rebagged and the fruits allowed to develop.

OR

- (b) (i) After implantation, finger-like projections appear on the trophoblast called chorionic villi which are surrounded by the uterine tissue and maternal blood. The chorionic villi and uterine tissue become interdigitated with each other and jointly form a structural and functional unit between developing embryo (foetus) and maternal body called placenta.

(ii) **Role of placenta:**

- The placenta facilitates the supply of oxygen and nutrients to the embryo and also removal of carbon dioxide and excretory/waste materials produced by the embryo.
- The placenta is connected to the embryo through an umbilical cord which helps in the transport of substances to and from the embryo.
- Placenta also acts as an endocrine tissue and produces several hormones like human chorionic gonadotropin (hCG), human placental lactogen (hPL), estrogens, progesterone, etc.

