CBSE Class 12 Biology Board Paper 2026 (57/2/1) with Solutions

PREVIOUS YEAR PAPER · CLASS XII · BIOLOGY (044) · BOARD EXAM 2026 · Q.P. CODE 57/2/1

TIME ALLOWED	MAXIMUM MARKS	QUESTIONS	NAME / ROLL NO.
3 hours	70	33 (A 16 · B 5 · C 7 · D 2 · E 3)	

GENERAL INSTRUCTIONS

Read the following instructions very carefully and strictly follow them:

1. This question paper contains 33 questions. All questions are compulsory.
2. Question paper is divided into FIVE sections – Section A, B, C, D and E.
3. Section A – question numbers 1 to 16 are multiple choice type questions. Each question carries 1 mark.
4. Section B – question numbers 17 to 21 are very short answer type questions. Each question carries 2 marks.
5. Section C – question numbers 22 to 28 are short answer type questions. Each question carries 3 marks.
6. 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.
7. Section E – question numbers 31 to 33 are long answer type questions. Each question carries 5 marks.
8. There is no overall choice. However, internal choices have been provided in some questions. A student has to attempt only one of the alternatives in such questions.
9. Wherever necessary, neat and properly labelled diagrams should be drawn.
10. This is the official 2026 board paper (Q.P. Code 57/2/1). The step marks shown in the solutions are our marking scheme in the CBSE style; CBSE's own marking scheme may award steps differently.
11. The answer key and the marking scheme are at the end of this booklet. Attempt the paper in 3 hours before you look at them.

Questions: CBSE board examination 2026, Q.P. Code 57/2/1, as published by CBSE at cbse.gov.in; diagrams redrawn. Answers, step marks and worked solutions © Master Testing Agency. Free for personal practice; not for resale. Master Testing Agency is an independent test-prep publisher, not affiliated with, endorsed by or connected to the Central Board of Secondary Education (CBSE) or any other exam-conducting body.

Chapters: Full syllabus · **Topics:** Sexual Reproduction in Flowering Plants · Human Reproduction · Reproductive Health · Principles of Inheritance and Variation · Molecular Basis of Inheritance · Evolution · Human Health and Disease · Microbes in Human Welfare · Biotechnology: Principles and Processes · Biotechnology and its Applications · Organisms and Populations · Ecosystem · Biodiversity and Conservation

SECTION A

Multiple choice questions of 1 mark each (Q13–16 assertion-reason).

1. To separate repetitive DNA from bulk genomic DNA, which of the following method is used ? 1

(A) Elution
(B) Southern Blotting
(C) Polymerase Chain Reaction
(D) Density Gradient Centrifugation

2. Select the correct option : 1

(A) Tropics between 23.5° N – 23.5° S — Higher biodiversity than temperate areas
(B) Columbia — 105 bird species
(C) New York — 1400 bird species
(D) India — 2000 bird species

3. In a dihybrid cross, 2400 individuals are produced in F_2 generation. Approximately how many will be phenotypically similar to parents ? 1

(A) 2000
(B) 1500
(C) 580
(D) 450

4. What could be the reason of extinction of Abingdon Tortoise from Galapagos Islands ? 1

(A) Intraspecific Competition
(B) Predation
(C) Parasitism
(D) Interspecific Competition

5. What conclusion can be drawn if the forelimbs of an aquatic animal and a terrestrial animal have similar anatomical structure ? 1

(A) Live in same habitat
(B) Share common ancestors
(C) Forelimbs perform same functions
(D) Forelimbs are analogous

6. How many of the following features are related to Nirodh – a popular brand of condoms ? 1
(i) Prevention of sexually transmitted infections.
(ii) Phagocytosis of sperms.
(iii) Male contraceptive device.
(iv) Acts as chemical barrier.
(v) Physiological changes in cervical mucus.

(A) (i), (ii), (iv)
(B) (i) and (iii)
(C) (i), (ii), (v)
(D) (ii) and (iv)

7. A bacterium having radioactive thymidine in its DNA is allowed to multiply in a medium having non-radioactive thymidine for two generations. What percentage of bacteria will have radioactive thymidine in its DNA ? 1

(A) 100
(B) 50
(C) 75
(D) 25

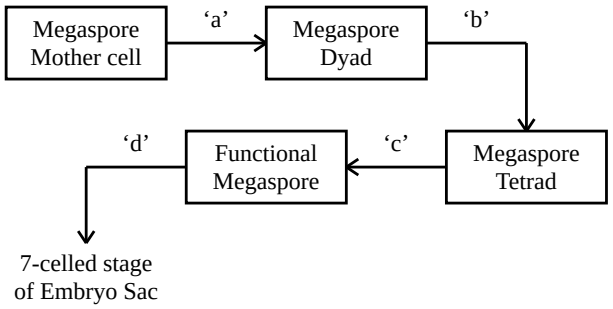
8. What is the role of histamine released by mast cells ? 1

(A) Lowers blood pressure
(B) Causes allergic symptoms
(C) Stimulates antibody formation
(D) Destroys pathogens

9. Which of the following is used to visualize DNA bands under UV light after gel electrophoresis ? 1

(A) Acetocarmine
(B) Safranine
(C) Ethidium Bromide
(D) Potassium Iodide

10. Given below are stages of embryo sac formation from megaspore mother cell. Identify the correct option for the cell division marked a, b, c and d. 1

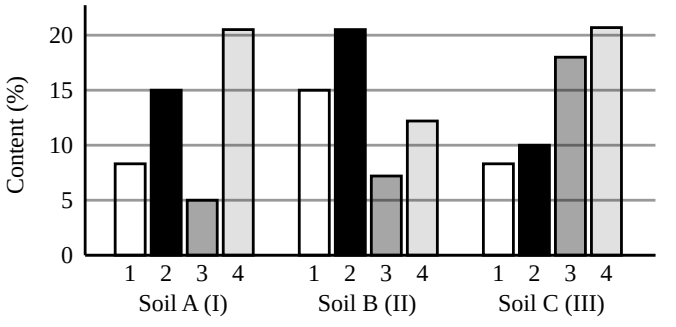


(A) a – Meiosis-I, b – No division, c – Mitosis, d – Meiosis-II
(B) a – Meiosis-I, b – Meiosis-II, c – No division, d - Mitosis
(C) a – Mitosis, b – Meiosis-I, c – Meiosis-II, d – No division
(D) a – No division, b – Mitosis, c – Meiosis-I, d – Meiosis-II

11. Genetically modified tobacco plants were produced using Agrobacterium vectors. Which property of Agrobacterium helps in carrying nematode specific genes into the host plant ? 1

(A) Infectious for monocot plant ; has Ti plasmid
(B) Infectious for dicot plant ; has Ti plasmid
(C) Infectious for plants and animals ; has Ti plasmids
(D) Infectious for monocot and dicot plants ; has cry gene

12. Observe the contents 1, 2, 3 and 4 of soil samples I, II and III shown in the graph. If the temperature and moisture of all soil samples are identical, which soil sample(s) will show faster decomposition ? 1



1 = lignin content, 2 = chitin, 3 = nitrogen content, 4 = sugar content

(A) Soil Sample I
(B) Soil Sample II
(C) Soil Sample III
(D) Both Soil Samples II and III

13. **Assertion (A) :** Apomixis leads to production of genetically identical off-springs. 1
Reason (R) : Apomixis involves fertilization between two genetically similar plants.

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

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation for Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

14. **Assertion (A) :** Microbes are used for commercial production of alcohol and beverages. 1
Reason (R) : Yeast converts glucose into ethanol and carbon dioxide during fermentation.

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

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation for Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

15. **Assertion (A) :** IUCN Red List helps in identifying and protecting endangered species worldwide. 1
Reason (R) : The list includes the species facing risk of extinction.

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

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation for Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

16. **Assertion (A) :** DNA Ligase is used to join DNA fragments. 1
Reason (R) : It catalyses the formation of glycosidic bonds between nucleotides.

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

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation for Assertion (A).

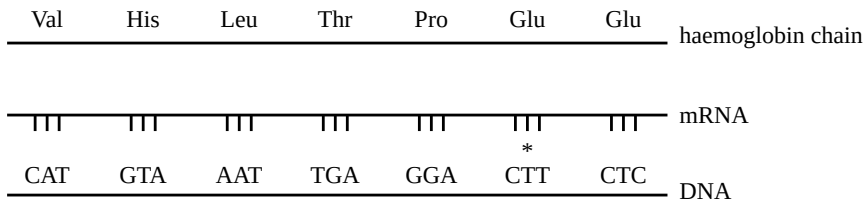
(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

SECTION B

Very short answer questions of 2 marks each.

17. (a) The diagram below shows the sequence of amino acids in part of haemoglobin molecule. 2



Key : Val = valine, His = histidine, Leu = leucine,
Thr = threonine, Pro = proline, Glu = glutamic acid

(i) If the base T^* is substituted with A, in 'CT^*T' of DNA strand how would it affect the haemoglobin chain ?

(ii) Name the condition and the effects associated with the above substitution.

OR

(b) DNA is considered a more stable genetic material than RNA. Justify this statement with suitable reasons.

18. How do scientists use microinjection and gene gun in biotechnology ? 2

19. After significant reduction of BOD during secondary treatment of sewage, what further processes are carried out ? Mention any one important outcome of these processes. 2

20. (a) In some cases, measuring population density by counting individuals may not be feasible. Mention two other parameters that can be used and justify their use with suitable examples. 2

OR

(b) What factors contribute to the Amazonian rain forests in South America being the most biodiverse regions on Earth ?

21. (a) (i) Name the organ that forms a connection between foetus and the uterus of a pregnant human female. 2

(ii) How does it support both nutrition and hormonal regulation ?

OR

(b) Give reasons for :

(i) All copulations do not lead to pregnancy.

(ii) Meiosis I in spermatogenesis and oogenesis are markedly different.

SECTION C

Short answer questions of 3 marks each.

22. There are limitations of traditional breeding techniques that led to promotion of micro-propagation ? 3

(a) Mention two advantages of micropropagation.

(b) Give two examples where it is commercially adopted.

23. (a) Give the scientific name of the organism used by Morgan to study sex-linked traits. 3

(b) Write any four reasons why this organism made it an ideal experimental model.

24. Draw a neat diagram of enlarged view of one microsporangium of a Young anther of an angiosperm. Label the different layers of the wall and write the functions of the outermost and innermost layer. 3

25. Study the diagram given below (the drawing is given here as its labels) : 3

Part of the diagram	**Label**
A syringe needle passed through the abdominal and uterine wall into the amniotic cavity	Withdraw fluid
Labelled in the uterus	Placenta, Amniotic cavity, Uterine wall
The fluid is spun in a tube	Centrifuge: Fluid composition (above), Cells (below)
The cells are grown in a dish	Cells culture

(a) Name and explain the procedure shown in the diagram. Mention one of its advantage and one disadvantage.
(b) How is 'Saheli' different from other oral pills in terms of its composition and advantage ?

26. S.L. Miller conducted an experiment in 1953 to simulate the conditions of early earth in a laboratory setup. 3
Answer the following questions based on the experiment :
(a) What was the aim of his experiment ?
(b) Name the gases used and the source of energy.

27. (a) What is a genetic code ? 3
(b) Why did scientists feel the need to propose a genetic code ?
(c) Genetic code is said to be 'Universal'. Why ?

28. (a) A person inhales dust and pathogens but does not always fall sick. Explain how the body protects against such infections. 3
(b) Name and describe any two barriers involved in this protection.

SECTION D

Case-based questions of 4 marks each.

29. Gene manipulation is a fast emerging science. It started with the development of recombinant DNA molecules. This technology which mostly involves cutting and pasting of desired DNA fragments is based on two most important discoveries in bacteria – presence of plasmid and restriction endonucleases. The science of r-DNA technology took birth when Cohen and Boyer (1973) were able to produce a piece of gene containing foreign DNA introduced into plasmid of E.coli.

(a) Name one core technique of biotechnology that alters the genetic material. [1]

(b) What is a plasmid ? Mention its importance in biotechnology. [2]

(c) Which gene was isolated by Cohen and Boyer and from which bacteria ? [1]

OR

(c) How is the action of exonuclease different from that of endonuclease ? [1]

30. Below is shown a pond that represents a self-sustaining natural ecosystem with both biotic and abiotic components interacting in a balanced food web. (The drawing is given here as its labels.)

Part of the drawing of the pond	**Label**
The sun above the pond, its rays reaching the water	(not labelled)
Small animals in the water	Primary Consumers
At the bottom of the pond	Decomposers
Material in the water and bottom mud	Inorganic or Organic components

Based on the diagram, answer the questions :

(a) Mention two abiotic components of a pond ecosystem. [1]

(b) Differentiate between the roles of producers and decomposers in such an ecosystem. [2]

(c) Draw a simple food chain operating in such an ecosystem and label each trophic level. [1]

OR

(c) Why is transfer of energy not 100% efficient between trophic levels ? [1]

SECTION E

Long answer questions of 5 marks each.

31. (a) (i) Explain the role of stigma in pollen pistil interaction. 5

(ii) Describe the post pollination events leading to double fertilization in angiosperms starting with 2-celled pollen grain.

OR

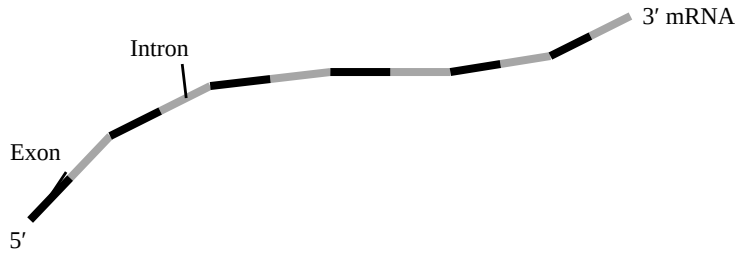
(b) (i) Explain menstrual phase in the menstrual cycle of human female.

(ii) Why is follicular phase also called proliferative phase ?

(iii) Explain the events that occur in Graafian follicle at the time of ovulation and thereafter.

(iv) Draw a Graafian follicle and label – Antrum and secondary oocyte.

32. (a) Observe the segment of mRNA given below and answers the questions given below : 5



Dark segments: exons. Light segments: introns.

(i) Explain and illustrate the steps involved to make fully processed hn RNA.

(ii) Gene encoding RNA polymerase I and RNA polymerase III have been affected by mutation. Explain its impact on the synthesis of polypeptide giving reasons.

OR

(b) In a particular cattle, the coat colour red and white are controlled by single pair of alleles. A calf that receives allele for red coat from mother and allele for white coat from father shows equal number of red and white hairs on its coat.

(i) Is this an example of Co-dominance or incomplete dominance. Give a reason for your answer.

(ii) With the help of a genetic cross upto F_2 generation, explain what will be the consequent phenotype of calf when

(1) Red is dominant over white,

(2) Red is incompletely dominant.

33. (a) A 30 year old man was admitted to a hospital with recurrent infections, weight loss, prolonged fever. His blood report showed a decline in count of T-Lymphocytes thus affecting immune system. 5

(i) Identify the disease and its causative agent.

(ii) How did the pathogen affect the immune system once it entered the body ? Explain.

(iii) Mention two major modes of its transmission.

OR

(b) (i) Why are microbes considered effective biocontrol agents in sustainable agriculture ?

(ii) Explain the role of the following as biocontrol agents naming the pests or diseases they help to control :

(1) A Bacterium

(2) A Fungus

(3) Virus

END OF THE QUESTION PAPER

ANSWER KEY — SECTION A

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
(D)	(A)	(B)	(D)	(B)	(B)	(B)	(B)	(C)	(B)	(B)	(C)	(C)	(A)	(A)	(C)

MARKING SCHEME AND WORKED SOLUTIONS

Marks for each step are shown in brackets, as in the CBSE marking scheme. Any correct alternative method earns full marks.

Q1. Answer (D). Repetitive (satellite) DNA forms a separate small peak from the bulk DNA in density gradient centrifugation, because its base composition gives it a different density.

Q2. Answer (A). Species diversity is highest in the tropics (latitudinal gradient). The NCERT figures are Colombia about 1400 bird species, New York 105 and India more than 1200, so (B), (C) and (D) are wrongly matched.

Q3. Answer (B). F_2 ratio 9 : 3 : 3 : 1. The parental types (e.g. round-yellow and wrinkled-green) are 9 + 1 = 10 of 16: 2400 × 10/16 = 1500.

Q4. Answer (D). Goats introduced on the island ate the same plants; the tortoise became extinct within a decade from competition with them (NCERT).

Q5. Answer (B). Similar anatomy with different functions (whale flipper, cheetah forelimb) shows homology: divergent evolution from a common ancestor.

Q6. Answer (B). Nirodh is a male condom: a physical barrier that also protects against STIs. Phagocytosis of sperm (IUDs) and changes in cervical mucus (hormonal IUDs, pills) belong to other methods; it is not a chemical barrier.

Q7. Answer (B). Replication is semiconservative. After two generations there are 4 cells; the two old labelled strands are in 2 of them: 2/4 = 50%.

Q8. Answer (B). In allergy, mast cells release histamine and serotonin, which cause the allergic symptoms (sneezing, watery eyes, running nose).

Q9. Answer (C). DNA stained with ethidium bromide shows bright orange bands under UV light.

Q10. Answer (B). MMC → dyad by meiosis I → tetrad by meiosis II; three megaspores degenerate (no division) leaving the functional megaspore, whose nucleus divides by mitosis three times to give the 7-celled, 8-nucleate embryo sac.

Q11. Answer (B). *Agrobacterium tumefaciens* infects dicots and transfers a piece of its Ti plasmid (T-DNA) into the plant genome; this was used to introduce the nematode-specific genes (RNA interference) into tobacco.

Q12. Answer (C). Decomposition is slower when detritus is rich in lignin and chitin, and faster when it is rich in nitrogen and water-soluble sugars. Soil III has the lowest lignin and chitin together with the highest nitrogen and sugar.

Q13. Answer (C). Apomixis is the formation of seeds without fertilisation, so the offspring are clones (A true). It involves no fertilisation at all (R false). Answer (C).

Q14. Answer (A). Brewer's yeast (*Saccharomyces cerevisiae*) ferments malted cereals and fruit juices to ethanol: this is why microbes are used to make wine, beer, whisky and rum. R explains A. Answer (A).

Q15. Answer (A). The Red List records the species threatened with extinction; that is what lets them be identified and given priority for protection. R explains A. Answer (A).

Q16. Answer (C). DNA ligase joins DNA fragments (A true) by forming phosphodiester bonds; the glycosidic bond links the base to the sugar inside a nucleotide (R false). Answer (C).

Q17. (2 marks) Answer: (a) Glu → Val; sickle-cell anaemia; (b) 2′-OH in RNA, thymine, double strand.
(a) (i) The DNA shown is the template strand: CTT is read as the mRNA codon GAA (Glu). With A in place of T the triplet becomes CAT, read as GUA (Val). So the 6th amino acid, glutamic acid, is replaced by valine. [1]
(ii) Sickle-cell anaemia. The changed haemoglobin (HbS) polymerises at low oxygen tension, the red cells become elongated and sickle-shaped, carry less oxygen and break easily, causing anaemia (they can also block small vessels). [1]
OR (b) The 2′-OH group on every ribose makes RNA reactive and easily broken down (RNA is also catalytic); DNA has deoxyribose. [1] DNA is double stranded with complementary strands, and it has thymine (5-methyl uracil) in place of uracil, which adds stability; so DNA changes more slowly. [1]

Q18. (2 marks) Answer: DNA into animal nucleus; DNA-coated gold/tungsten particles into plant cells.
Microinjection: recombinant DNA is injected directly into the nucleus of an animal cell. [1]
Gene gun (biolistics): plant cells are bombarded with high-velocity micro-particles of gold or tungsten coated with DNA. [1]

Q19. (2 marks) Answer: settling, sludge to anaerobic digesters; biogas.
The effluent is passed into a settling tank, where the bacterial flocs settle as activated sludge. A small part of the sludge is pumped back to the aeration tank as inoculum; the major part goes to large anaerobic sludge digesters, where anaerobic bacteria digest the bacteria and fungi in it. The treated effluent is released into rivers and streams. [1½]
Outcome: the digestion produces biogas (methane, H_2S, CO_2), which can be used as fuel. [½]

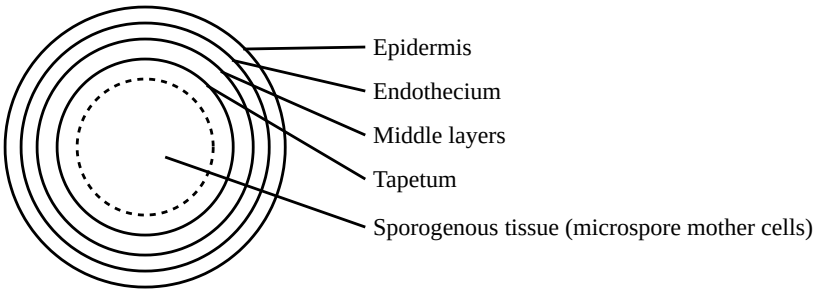
Q20. (2 marks) Answer: (a) percent cover/biomass; relative density (traps, pugmarks); (b) no glaciation, stable climate, more solar energy.
(a) Percent cover or biomass: where numbers mislead, e.g. one huge banyan tree and 200 *Parthenium* plants; biomass or cover shows the banyan's real role. [1] Relative density by indirect estimates, where counting is impossible or the animals are hidden: fish caught per trap in a lake, or pugmarks and faecal pellets for tigers in a reserve. [1]
OR (b) Being tropical, the Amazon has not suffered glaciations: it has been undisturbed for millions of years, giving long time for species diversification. [1] Its climate is less seasonal, relatively constant and predictable, which favours niche specialisation; and it receives more solar energy, so productivity is higher. [1]

Q21. (2 marks) Answer: (a) placenta; (b) timing with ovulation; unequal division in oogenesis.
(a) (i) The placenta. [½]
(ii) Through the umbilical cord it supplies oxygen and nutrients to the embryo and removes carbon dioxide and wastes. [1] It is also an endocrine tissue: it makes hCG, hPL, oestrogens and progestogens, which maintain the pregnancy. [½]
OR (b) (i) Fertilisation happens only if the ovum and sperm reach the ampullary region of the fallopian tube at the same time; copulation that does not coincide with ovulation gives no pregnancy. [1]
(ii) Meiosis I of a primary spermatocyte gives two equal secondary spermatocytes; that of a primary oocyte is unequal, giving a large secondary oocyte and a tiny first polar body. Also, oogenesis starts before birth and is arrested, while spermatogenesis is continuous from puberty. [1]

Q22. (3 marks) Answer: many identical plants fast; disease-free; tomato, banana, apple.
(a) A very large number of plants can be raised in a short time, and they are genetically identical to the parent (somaclones). Healthy, virus-free plants can be obtained from meristem culture. [2]
(b) Tomato, banana, apple (any two). [1]

Q23. (3 marks) Answer: Drosophila melanogaster.
(a) *Drosophila melanogaster* (fruit fly). [1]
(b) It grows on a simple synthetic medium in the laboratory; completes its life cycle in about two weeks; a single mating gives a large number of progeny; males and females are easily told apart; and it has many hereditary variations visible under a low-power microscope (any four). [2]

Q24. (3 marks) Answer: epidermis, endothecium, middle layers, tapetum; protection; nourishment.
Diagram (transverse section of one microsporangium, from outside to inside):



[1½: diagram with the four wall layers labelled]
Outermost layer, epidermis: protection (the outer three layers also help in dehiscence of the anther to release pollen). [½]
Innermost layer, tapetum: nourishes the developing pollen grains (its cells have dense cytoplasm and often more than one nucleus). [1]

Q25. (3 marks) Answer: amniocentesis; Saheli: non-steroidal, weekly.
(a) Amniocentesis: a little amniotic fluid is drawn from the amniotic cavity; the foetal cells in it are cultured and their chromosomes studied. [1] Advantage: detects chromosomal and genetic disorders (e.g. Down's syndrome) early. Disadvantage: it is misused to find the sex of the foetus, leading to female foeticide (so this use is banned); it also carries a small risk of miscarriage. [1]
(b) Other pills contain steroidal hormones (progestogens alone or with oestrogen) and are taken daily. Saheli (from CDRI, Lucknow) has a non-steroidal compound and is taken once a week; it has very few side effects and high contraceptive value. [1]

Q26. (3 marks) Answer: chemical origin of organic molecules; CH_4, H_2, NH_3, H_2O; electric discharge.
(a) To show that organic molecules (such as amino acids) could have formed from inorganic substances under the conditions of the early earth, supporting chemical evolution (Oparin–Haldane). [1]
(b) Gases: CH_4, H_2, NH_3 and water vapour, in a closed flask at 800 °C. [1] Energy: electric discharge (sparks), standing in for lightning. [1]

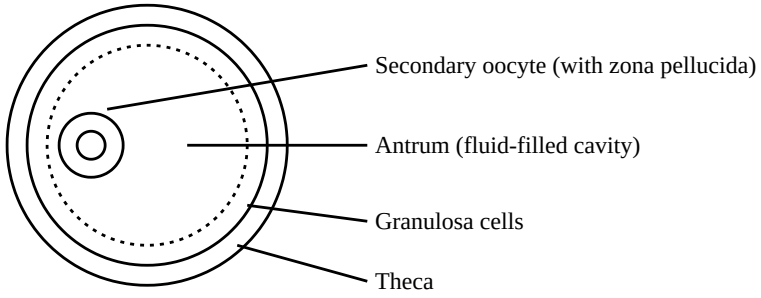
Q27. (3 marks) Answer: triplet code; 4 bases for 20 amino acids; same in all organisms.
(a) The relationship between the sequence of bases in mRNA and the sequence of amino acids in a polypeptide; each amino acid is coded by a triplet of bases (codon). [1]
(b) DNA has only 4 kinds of bases while proteins have 20 amino acids, so a code was needed to explain how 4 bases can specify 20 amino acids (Gamow: triplets give $4^3 = 64$ codons). [1]
(c) The same codon codes for the same amino acid in almost all organisms, from bacteria to humans (a few exceptions are in mitochondria and some protozoa). [1]

Q28. (3 marks) Answer: innate immunity; physical, physiological, cellular, cytokine barriers.
(a) By innate (non-specific) immunity, present from birth: barriers stop the entry of foreign agents into the body. [1]
(b) Any two: Physical barriers: the skin, and the mucus coating of the respiratory, gastro-intestinal and urogenital tracts, which traps microbes. Physiological barriers: acid in the stomach, saliva in the mouth, tears. Cellular barriers: neutrophils (PMNL), monocytes, natural killer cells and macrophages that destroy microbes. Cytokine barriers: interferons from virus-infected cells protect other cells. [2]

Q29. (4 marks) Answer: genetic engineering; vector; antibiotic resistance gene of Salmonella typhimurium.
(a) Genetic engineering (recombinant DNA technology). [1]
(b) A plasmid is an autonomously replicating, circular, extra-chromosomal DNA in bacteria. [1] It is used as a vector: the gene of interest is joined to it and carried into the host, where it is copied many times (high copy number gives many copies of the gene). [1]
(c) The antibiotic resistance gene, from a native plasmid of *Salmonella typhimurium*. [1]
OR (c) Exonucleases remove nucleotides from the ends of DNA; endonucleases cut DNA at specific positions within it. [1]

Q30. (4 marks) Answer: water, soil, minerals, sunlight; make food vs recycle nutrients; phytoplankton → zooplankton → fish.
(a) Any two: water, the soil deposit at the bottom, the dissolved inorganic and organic substances, sunlight (and temperature, pH). [1]
(b) Producers (phytoplankton, algae, floating and submerged plants) fix solar energy by photosynthesis and make the food for the whole pond. [1] Decomposers (fungi, bacteria and flagellates, plentiful at the bottom) break down dead organic matter and release minerals for reuse by the producers. [1]
(c) Phytoplankton (producer, 1st trophic level) → zooplankton (primary consumer, 2nd) → small fish (secondary consumer, 3rd) → large fish (tertiary consumer, 4th). [1]
OR (c) At each level most energy is lost as heat in respiration and other life processes, and not all the food is eaten, digested or absorbed; only about 10% passes to the next level (10 per cent law). [1]

Q31. (5 marks) Answer: (a) recognition of compatible pollen; syngamy and triple fusion; (b) LH surge, ovulation, corpus luteum.
(a) (i) The pistil, through chemical interaction between pollen and stigma, recognises pollen of the same species: it accepts compatible pollen, which germinates, and rejects incompatible pollen, stopping its germination or tube growth. [1]
(ii) Compatible pollen germinates and a pollen tube grows out through a germ pore; the cell contents move into it. [1] In 2-celled pollen the generative cell divides in the tube to form two male gametes. The tube grows through the stigma and style into the ovary, and enters the ovule through the micropyle. [1] Guided by the filiform apparatus it enters a synergid and releases the two male gametes into its cytoplasm. [1] One male gamete fuses with the egg (syngamy) giving the diploid zygote; the other fuses with the two polar nuclei in the central cell (triple fusion) giving the triploid primary endosperm nucleus. Two fusions in one embryo sac: double fertilisation. [1]
OR (b) (i) If the released ovum is not fertilised, the corpus luteum degenerates and progesterone falls; the endometrium of the uterus and its blood vessels break down and are discharged as menstrual flow, lasting 3–5 days. [1]
(ii) During this phase, as the primary follicles grow into a Graafian follicle, oestrogen from them makes the endometrium regenerate by proliferation. [1]
(iii) A mid-cycle LH surge makes the Graafian follicle rupture and release the secondary oocyte (ovulation, about day 14). [1] The remaining follicle cells form the corpus luteum, which secretes much progesterone to keep the endometrium ready for implantation; with no fertilisation it degenerates. [1]
(iv)



[1]

Q32. (5 marks) Answer: (a) splicing, capping, tailing; no rRNA/tRNA, no translation; (b) co-dominance; 3 : 1 red; 1 : 2 : 1.
(a) (i) The hnRNA (exons and introns) is processed in three steps: [3]
Splicing: the introns are removed and the exons joined together.
Capping: an unusual nucleotide, methyl guanosine triphosphate, is added to the 5′ end.
Tailing: 200–300 adenylate residues (poly-A tail) are added to the 3′ end, without a template.
Illustration: 5′ ▬exon▬ ┄intron┄ ▬exon▬ ┄intron┄ ▬exon▬ 3′ → splicing → 5′ ▬▬▬▬▬ 3′ → capping and tailing → 5′ m⁷Gppp–▬▬▬▬▬–AAAA…A 3′. The processed mRNA leaves the nucleus for translation.
(ii) RNA polymerase I makes the rRNAs (28S, 18S, 5.8S) and RNA polymerase III makes the tRNAs, 5S rRNA and snRNAs. [1] mRNA would still be made by RNA polymerase II, but without ribosomes and tRNAs (and with no snRNA for splicing) no polypeptide can be made. [1]
OR (b) (i) Co-dominance: both alleles are expressed fully in the heterozygote (separate red and white hairs, a roan coat), not blended into an intermediate colour. [1]
(ii) (1) Parents RR (red) × rr (white): F_1 all Rr, red. $F_1 \times F_1$: F_2 1 RR : 2 Rr : 1 rr, i.e. 3 red : 1 white. The calf (Rr) would be red. [2]
(2) Parents RR × rr: F_1 all Rr with an intermediate colour (a blend, light red). F_2 1 RR red : 2 Rr intermediate : 1 rr white; phenotype ratio equals genotype ratio, 1 : 2 : 1. The calf would show the intermediate colour. [2]

Q33. (5 marks) Answer: (a) AIDS, HIV; T-helper cells destroyed; sex, blood, needles, mother to child; (b) Bt, Trichoderma, baculoviruses.
(a) (i) AIDS (Acquired Immuno Deficiency Syndrome), caused by HIV, the Human Immunodeficiency Virus (a retrovirus). [2]
(ii) HIV enters macrophages; its RNA is copied into viral DNA by reverse transcriptase, which joins the host DNA, and the macrophages go on producing virus (an HIV factory). [1] The virus then enters helper T-lymphocytes (T_H), multiplies, and the new viruses attack more T_H cells; their number falls steadily, the immune response fails and the person suffers infections that would otherwise be resisted. [1]
(iii) Any two: sexual contact with an infected person; transfusion of contaminated blood or blood products; sharing infected needles; from an infected mother to her child through the placenta. [1]
OR (b) (i) They control pests and diseases without toxic chemical pesticides, so they protect the environment, are specific to their targets and fit integrated pest management. [1]
(ii) (1) *Bacillus thuringiensis* (Bt): its spores, sprayed on plants such as brassicas and fruit trees, are eaten by butterfly caterpillars; the toxin released in the gut kills the larvae. [1½] (2) *Trichoderma*: free-living fungi of the root ecosystem that control several plant pathogens. [1] (3) Baculoviruses (genus *Nucleopolyhedrovirus*): attack insects and other arthropods; they are species-specific, narrow-spectrum insecticides with no harm to plants, mammals, birds or non-target insects. [1½]

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