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CBSE Class 12 Biology Board Paper 2026 (57/3/1) with Solutions

PREVIOUS YEAR PAPER · CLASS XII · BIOLOGY (044) · BOARD EXAM 2026 · Q.P. CODE 57/3/1

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 – Sections A, B, C, D and E.
3. Section A – questions number 1 to 16 are Multiple Choice Type Questions. Each question carries 1 mark.
4. Section B – questions number 17 to 21 are Very Short Answer Type Questions. Each question carries 2 marks.
5. Section C – questions number 22 to 28 are Short Answer Type Questions. Each question carries 3 marks.
6. Section D – questions number 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 – questions number 31 to 33 are Long Answer Type Questions. Each question carries 5 marks.
8. There is no overall choice. However, an internal choice has been provided in Sections B, D and E of the question paper. A candidate has to write answer for 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 57/3/1). 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 57/3/1, 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. Foetal ejection reflex in human female triggers the release of which hormone ? 1

(A) Oxytocin from foetal pituitary gland
(B) hCG from placenta
(C) Progesterone from corpus luteum
(D) Oxytocin from maternal pituitary gland

2. Which of the following is ***not*** a functional unit of an ecosystem ? 1

(A) Energy flow
(B) Decomposition
(C) Stratification
(D) Productivity

3. Match Column I with Column II and select the correct option : 1

Column I	**Column II**
a. Primers	i. β-galactosidase
b. Insertional inactivation	ii. To separate and purify products
c. Bioreactor	iii. Chemically synthesized oligonucleotides
d. Downstream processing	iv. Large scale production of specific product of activity of microbes

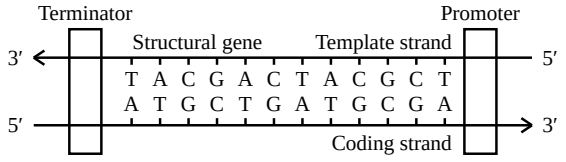
(A) a-iii, b-i, c-iv, d-ii
(B) a-iii, b-i, c-ii, d-iv
(C) a-i, b-iii, c-iv, d-ii
(D) a-i, b-iv, c-ii, d-iii

4. Golden rice is a promising transgenic crop. When released for cultivation, it will help in : 1

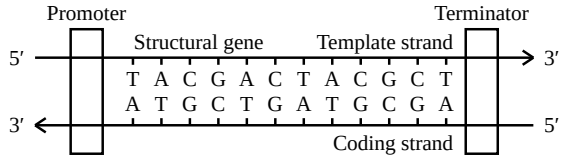
(A) Producing petrol-like fuel
(B) Reduction of Vitamin A deficiency in humans
(C) Pest resistance
(D) Herbicide tolerance

5. Four different transcription units are shown below. Choose the option with the correct image. 1

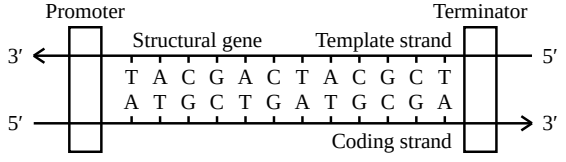
(A)



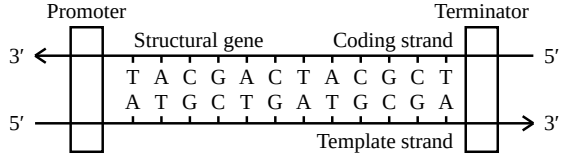
(B)



(C)



(D)



6. Appearance of antibiotic-resistant bacteria is an example of evolution due to : 1

(A) Adaptive radiation
(B) Divergent evolution
(C) Artificial selection
(D) Anthropogenic action

7. Identify the statements that correctly describe Darwin's Theory of Evolution. 1

(i) Overproduction of organisms leads to competition.
(ii) Variation is inherited and causes evolution.
(iii) Acquired characters are inherited.
(iv) Survival depends on favourable traits.
(v) New species arise due to accumulation of favourable variations.
Choose the correct option.

(A) (i), (ii), (iv) and (v) are correct
(B) (ii), (iii) and (iv) are correct
(C) All are correct
(D) Only (i) and (iv) are correct

8. Which of the following is ***not*** a symptom of Ascariasis ? 1

(A) Intestinal blockage
(B) Muscular pain and fever
(C) Anaemia
(D) Skin ulcers

9. Every trophic level has a certain mass of living material at a particular time. What is it called ? 1

(A) Standing crop
(B) Primary productivity
(C) Standing state
(D) Ecological efficiency

10. The smallest part of DNA molecule that can be changed by point mutation is : 1

(A) Oligonucleotide
(B) Codon
(C) Gene
(D) Nucleotide

11. Some statements regarding drugs and alcohol are given below : 1

(i) Adolescents are more vulnerable to peer pressure.
(ii) Drug addiction leads to increased tolerance level of the receptors present in our body.
(iii) Alcohol affects the central nervous system.
(iv) Excessive use of drugs helps to increase energy.
(v) Anabolic steroids decrease aggressiveness.
Choose the option with correct statement(s).

(A) Statements (i), (iv) and (v) are correct
(B) Statements (i), (ii) and (iii) are correct
(C) Only statements (i) and (v) are correct
(D) Only statement (iii) is correct

12. Select the correct option for the pair of plants pollinated by water. 1

(A) *Vallisneria* and *Hydrilla*
(B) *Zostera* and Water lily
(C) Water lily and *Parthenium*
(D) Water hyacinth and Water lily

13. **Assertion (A) :** Activated sludge contains large population of bacteria. 1

Reason (R) : These bacteria help in anaerobic digestion of human waste in biogas plant.

(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) :** Ecosystems require a constant supply of energy to synthesize the molecules they require. 1

Reason (R) : This is to counteract the universal tendency towards increasing disorderliness as per Second Law of Thermodynamics.

(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) :** DNA cannot pass through cell membrane of a bacterial cell. 1

Reason (R) : DNA is a hydrophilic molecule.

(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) :** Repetitive sequences are stretches of DNA sequences that are thought to have no direct coding functions. 1

Reason (R) : They shed light on chromosome structure, dynamics and evolution.

(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) A person complains of persistent itching in the groin region and scalp. The person also shows dry and scaly lesions on skin, nails, etc. 2

(i) Identify the disease.

(ii) Name its two causative agents.

(iii) Mention its mode of transmission.

OR

(b) A girl develops sneezing, watery eyes and difficulty in breathing every time she visits a flower garden.

(i) Identify the condition.

(ii) Name the immune component responsible for this condition.

(iii) Name the chemical released.

(iv) State one medicine used to treat such a condition.

18. (a) (i) Mention any two characteristics of Neanderthal man that lived near East and Central Asia. 2

(ii) Identify the following hominids with respect to human evolution :

(I) Brain capacity 900 cc, probably ate meat.

(II) First human-like with brain capacity 650 – 800 cc.

OR

(b) The allele for brown eyes (B) is dominant over blue eyes (b). In a population, 36% of individuals have blue eyes. Assuming Hardy-Weinberg equilibrium, calculate :

(i) Frequency of allele B

(ii) Percentage of heterozygous individuals

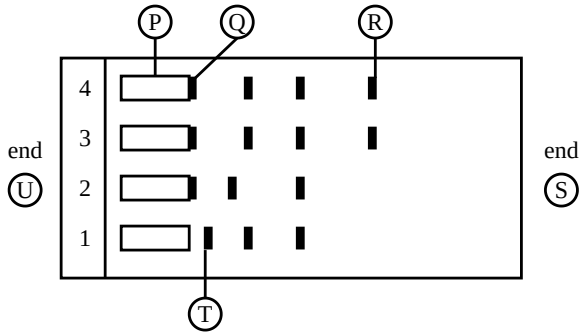
(iii) Percentage of individuals that are homozygous dominant (Working to be shown)

19. What did Henking observe in his experiments on insects that led to the discovery of sex chromosome ? How did his observation contribute to our understanding of sex determination ? 2

20. (a) (i) Given below is the schematic representation of the process of electrophoresis. Identify the alphabets representing the : 2

(I) Anode end, and

(II) Lightest/Smallest DNA in matrix.



(ii) What is Agarose gel and why is it used in this process ?

OR

(b) After performing gel electrophoresis, a student observes that DNA fragments are not visible.

(i) Suggest a reason for this and explain how fragments can be made visible.

(ii) Also explain how a specific DNA fragment can be collected from the gel for further use.

21. GEAC is a regulatory body under the Ministry of Environment, Forest and Climate Change in India. 2

(a) Write the full form of GEAC.

(b) Mention two of its important functions related to biotechnology.

SECTION C

Short answer questions of 3 marks each.

22. Answer the following questions : 3

(a) Explain the different ways by which apomictic seeds can be developed.

(b) Mention one advantage of apomictic seeds for farmers.

23. (a) What is meant by translation in protein synthesis ? 3

(b) Explain charging of tRNA (aminoacylation of tRNA) and mention its importance in the process of translation.

24. (a) What is the carrying capacity of a species in a habitat ? 3

(b) Explain the growth curve that takes this capacity into account.

25. *In vitro* fertilization (IVF) is a popular method these days that is helping childless couples to bear a child. 3

(a) Write the different steps that are carried out in this technique.

(b) Would you consider gamete intra fallopian transfer as a type of IVF ? Justify your answer.

26. Draw a neat diagram of a maize grain showing the internal structure and label any five parts. 3

27. Cow dung and water are mixed and fed into a biogas plant to allow digestion of biowastes. The person performing this process says that there is no need to provide an inoculum. 3

(a) Do you agree with him ? Justify your answer.

(b) What happens to the biowaste inside the digester ?

(c) Name the useful by-products obtained from this process and mention how they are used.

28. (a) Describe the experiment conducted by T.H. Morgan on *Drosophila melanogaster* involving eye colour and body colour. 3

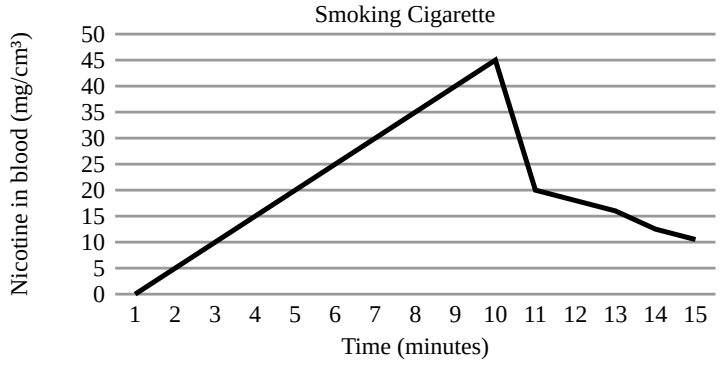
(b) How did the results deviate from Mendelian inheritance pattern ?

(c) Explain the two genetic terms used by Morgan for his observations.

SECTION D

Case-based questions of 4 marks each.

29. The data below shows the concentration of nicotine smoked by a smoker taking 10 puffs/minute.



(a) With reference to the above graph, explain the concentration of nicotine in the blood at 10 minutes. [1]

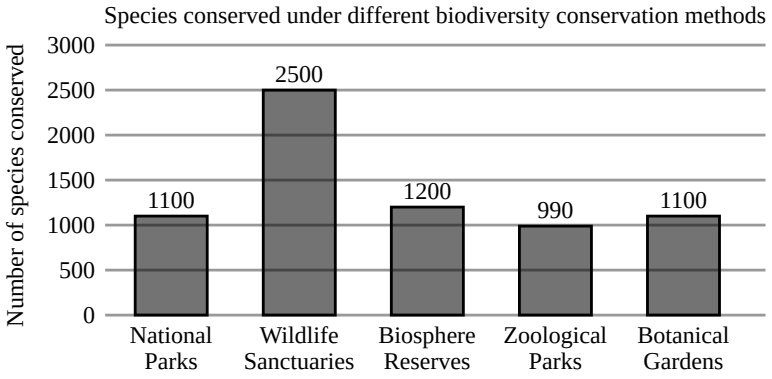
OR

(a) How will this affect the concentration of carbon monoxide and haem-bound oxygen at 10 minutes ? [1]

(b) How does cigarette smoking result in high blood pressure and increase in heart rate ? [1]

(c) To which class of compounds does nicotine belong ? Name one other drug from the same class. [2]

30. India is one of the megadiverse countries housing around 8·1 per cent of global species diversity, although its land area is only 2·4 per cent of the world's land area. Many of the species are highly threatened due to human activities like deforestation, mining and habitat fragmentation. Laws like Wildlife (Protection) Act, 1972 were enacted by the Government of India to preserve our biological wealth. Various conservation measures are being implemented to save the threatened species.
The following bar graph shows the number of species conserved under different biodiversity conservation methods.



Study the graph and answer the questions.

(a) Which method conserves the highest number of species ? Is it *ex situ* or *in situ* conservation ? [1]

(b) Which other methods shown in the diagram are opposite to the one identified by you in question (a) ? How are these two conservation approaches different ? [2]

(c) Write two features of Biodiversity hotspots. [1]

OR

(c) To which category do sacred groves belong and how do they help in bio-conservation ? [1]

SECTION E

Long answer questions of 5 marks each.

31. (a) (i) Describe the series of experiments conducted by Frederick Griffith. Comment on the significance of the result obtained. 5

(ii) State the contribution of Avery, MacLeod and McCarty.

OR

(b) The following questions are based on haemophilia.

(i) Work out the crosses between :

(I) Normal female and Haemophilic male

(II) Carrier female and Normal male

(III) Carrier female and Haemophilic male

(ii) Write the conclusions you draw from these crosses. Comment on the type of inheritance of the disease. (Use : X – Normal, X^h – Haemophilic)

32. (a) (i) Explain any two basic principles/core techniques on which biotechnology is based. 5

(ii) Describe any three key tools used in Recombinant DNA technology.

OR

(b) “Early and accurate diagnosis of diseases is vital in medical technology.”

(i) Name the conventional methods of diagnosis and their disadvantages.

(ii) Which three diagnostic techniques have been developed through Biotechnology ? Explain how each one helps in detecting diseases.

33. (a) Oogenesis is a discontinuous process that begins before birth and is completed after puberty. 5

(i) Trace the development of a gamete mother cell till its release from the ovary during ovulation.

(ii) Name the two pituitary hormones that play an important role in the process.

OR

(b) (i) Draw a labelled two-celled structure of male gametophyte of an angiosperm.

(ii) Name the three layers that surround the cytoplasm of a male gametophyte starting from innermost to outermost layer.

(iii) Which organic material makes the outermost layer ? Mention its advantage.

(iv) Why is the outermost layer of male gametophyte not continuous ?

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)	(C)	(A)	(B)	(C)	(D)	(A)	(D)	(A)	(D)	(B)	(A)	(C)	(A)	(A)	(B)

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). Signals from the fully developed foetus and placenta (foetal ejection reflex) trigger the release of oxytocin from the mother's pituitary, causing strong uterine contractions.

Q2. Answer (C). Productivity, decomposition, energy flow and nutrient cycling are the functional aspects. Stratification (vertical layering of species) is a structural feature.

Q3. Answer (A). Primers are short chemically synthesised oligonucleotides; insertional inactivation of the β-galactosidase gene gives blue/white selection; bioreactors are for large-scale production; downstream processing separates and purifies the product.

Q4. Answer (B). Golden rice is rich in β-carotene (provitamin A), so it can reduce vitamin A deficiency.

Q5. Answer (C). The template strand runs $3' \rightarrow 5'$ and the coding strand $5' \rightarrow 3'$; the promoter lies towards the $5'$ end (upstream) of the coding strand and the terminator towards its $3'$ end. Only (C) has all of this. (A) swaps promoter and terminator, (B) gives the template strand $5' \rightarrow 3'$, and (D) swaps the names of the two strands.

Q6. Answer (D). Human use of antibiotics (anthropogenic action) selects resistant bacteria, as excess use of herbicides and pesticides selects resistant varieties.

Q7. Answer (A). Inheritance of acquired characters is Lamarck's idea, not Darwin's; the other four are parts of Darwin's theory of natural selection.

Q8. Answer (D). Ascariasis causes internal bleeding, muscular pain, fever, anaemia and blockage of the intestinal passage; not skin ulcers.

Q9. Answer (A). The mass of living material at a trophic level at a given time is the standing crop. (Standing state is the amount of nutrients in the soil.)

Q10. Answer (D). A point mutation changes a single base pair, i.e. one nucleotide (as in sickle-cell anaemia).

Q11. Answer (B). (i), (ii) and (iii) are true (NCERT: repeated use raises the tolerance level of receptors). Drugs do not give energy, and anabolic steroids increase aggressiveness.

Q12. Answer (A). *Vallisneria*, *Hydrilla* and *Zostera* are water-pollinated. Water hyacinth and water lily are pollinated by insects or wind; *Parthenium* is a land weed.

Q13. Answer (C). Activated sludge is made of flocs of aerobic bacteria (A true). In the anaerobic sludge digesters it is other, anaerobic bacteria that digest the bacteria and fungi of the sludge; the aerobic sludge bacteria do not carry out anaerobic digestion (R false). Answer (C).

Q14. Answer (A). NCERT: ecosystems need a constant supply of energy to make the molecules they require, to counteract the universal tendency towards increasing disorderliness. R explains A. Answer (A).

Q15. Answer (A). Being hydrophilic, DNA cannot cross the lipid cell membrane, so bacteria have to be made competent (e.g. with $CaCl_2$) to take it up. R explains A. Answer (A).

Q16. Answer (B). Both are statements from the Human Genome Project: repetitive DNA is thought to have no direct coding function, yet it sheds light on chromosome structure, dynamics and evolution. R is true but does not explain why it has no coding function. Answer (B).

Q17. (2 marks) Answer: (a) ringworm; Microsporum, Trichophyton; (b) allergy, IgE, histamine, antihistamine.
(a) (i) Ringworm. [½] (ii) Any two fungi: *Microsporum*, *Trichophyton*, *Epidermophyton*. [1] (iii) From soil, or by using the towels, clothes or comb of an infected person (heat and moisture help the fungi grow). [½]
OR (b) (i) Allergy (to pollen). [½] (ii) IgE antibodies. [½] (iii) Histamine (and serotonin) from mast cells. [½] (iv) An antihistamine (or adrenalin, or steroids). [½]

Q18. (2 marks) Answer: (a) Homo erectus; Homo habilis; (b) 0.4; 48%; 16%.
(a) (i) Brain size of about 1400 cc; they used hides to protect their bodies and buried their dead (any two). [1]
(ii) (I) *Homo erectus*. [½] (II) *Homo habilis*. [½]
OR (b) Blue-eyed people are bb: $q^2 = 0.36$, so $q = 0.6$. [½]
(i) $p = 1 - 0.6 = 0.4$. [½]
(ii) $2pq = 2 \times 0.4 \times 0.6 = 0.48$, i.e. 48%. [½]
(iii) $p^2 = 0.16$, i.e. 16% (check: 16 + 48 + 36 = 100). [½]

Q19. (2 marks) Answer: X body in half the sperms; X chromosome decides sex.
In 1891, studying spermatogenesis in an insect, Henking saw that a specific nuclear structure went into only 50% of the sperms after meiosis; the other 50% did not receive it. He called it the X body. [1]
The X body was later shown to be a chromosome, the X chromosome, a sex chromosome. It showed that sex is decided by the sperm: in such (XO type) insects, eggs fertilised by sperms with X become females and those fertilised by sperms without X become males. [1]

Q20. (2 marks) Answer: (a) S; R; sea-weed polymer acting as a sieve; (b) ethidium bromide + UV; cut out and elute.
(a) (i) (I) S: DNA is negatively charged and moves from the wells (at end U, the cathode) towards the anode. [½] (II) R: the smallest fragments move the farthest. [½]
(ii) Agarose is a natural polymer extracted from sea weeds. Its gel acts as a sieve (matrix), so the DNA fragments separate according to their size. [1]
OR (b) (i) DNA is not visible without staining. The gel is stained with ethidium bromide and exposed to UV light: the DNA shows bright orange bands. [1]
(ii) The band of the required fragment is cut out from the agarose gel and the DNA is extracted from the gel piece (elution); the purified DNA is used for constructing recombinant DNA. [1]

Q21. (2 marks) Answer: Genetic Engineering Appraisal Committee.
(a) Genetic Engineering Appraisal Committee. [1]
(b) It makes decisions on the validity of GM research, and on the safety of introducing GM organisms for public services. [1]

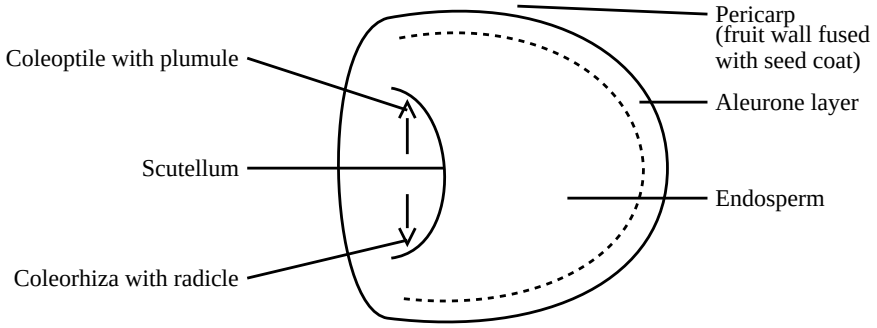
Q22. (3 marks) Answer: diploid egg without fertilisation; nucellar embryos; reuse hybrid seed.
(a) A diploid egg cell is formed without reduction division and develops into an embryo without fertilisation. [1] Or, as in many *Citrus* and mango varieties, some nucellar cells around the embryo sac divide, protrude into the embryo sac and develop into embryos. [1]
(b) Hybrid seeds have to be bought every year because the characters segregate in their progeny; if hybrids are made apomictic there is no segregation, so farmers can keep using the hybrid seeds year after year. [1]

Q23. (3 marks) Answer: polypeptide synthesis from mRNA; amino acid + ATP joined to its tRNA.
(a) The process of polymerisation of amino acids into a polypeptide; the order of amino acids is decided by the sequence of bases in the mRNA, and they are joined by peptide bonds. [1]
(b) Amino acids are activated in the presence of ATP and linked to their cognate tRNA: this is charging (aminoacylation). [1]
When two charged tRNAs are brought close enough, peptide bond formation is energetically favoured; the charged tRNA, through its anticodon, brings the right amino acid to each codon. [1]

Q24. (3 marks) Answer: maximum population a habitat supports; logistic, sigmoid curve.
(a) The largest population (K) of a species that the resources of a habitat can support; beyond it no further growth is possible. [1]
(b) Logistic (Verhulst–Pearl) growth: a lag phase, then acceleration, then deceleration as resources become limiting, and finally an asymptote when the population reaches K. N plotted against time gives a sigmoid (S-shaped) curve. $dN/dt = rN(K - N)/K$. [2]

Q25. (3 marks) Answer: fertilisation in the lab, then ZIFT/IUT; GIFT is not IVF.
(a) Ova from the wife or a donor and sperms from the husband or a donor are collected and made to form a zygote in the laboratory (test tube baby programme). [1] The zygote or early embryo, up to 8 blastomeres, is transferred into the fallopian tube (ZIFT); an embryo with more than 8 blastomeres is transferred into the uterus (IUT), where it develops further. [1]
(b) No. In GIFT an ovum from a donor is transferred into the fallopian tube of a female who cannot produce one but can provide the right environment, so fertilisation takes place inside her body (*in vivo*), not *in vitro*. It is an assisted reproductive technology, but not IVF. [1]

Q26. (3 marks) Answer: pericarp, aleurone layer, endosperm, scutellum, coleoptile, plumule, radicle, coleorhiza.
L.S. of a maize grain:



Any five correct labels, ½ mark each, and ½ mark for the diagram. [3]

Q27. (3 marks) Answer: yes, dung has methanogens; anaerobic breakdown to CH_4; biogas and manure.
(a) Yes. Cow dung is rich in methanogens (e.g. *Methanobacterium*), which live in the rumen of cattle and come out with the dung, so the slurry already carries the inoculum. [1]
(b) In the anaerobic digester the bacteria break down the organic matter (including cellulose) and produce gases: mainly methane, with CO_2 and H_2. [1]
(c) Biogas, used as fuel for cooking and lighting; and the spent slurry, used as fertiliser (manure). [1]

Q28. (3 marks) Answer: linkage and recombination; parental types far exceed recombinants.
(a) Morgan crossed yellow-bodied, white-eyed females with brown-bodied (wild type), red-eyed males and intercrossed the F_1 progeny (a dihybrid cross with X-linked genes). [1]
(b) The F_2 ratio deviated greatly from 9 : 3 : 3 : 1: the parental combinations were far more frequent than the non-parental ones, because the two genes are on the same (X) chromosome. [1]
(c) Linkage: the physical association of genes on a chromosome. Recombination: the generation of non-parental gene combinations. (Body colour and eye colour genes were tightly linked, with only 1.3% recombination.) [1]

Q29. (4 marks) Answer: peak 45 mg/cm³ at 10 min; adrenaline; alkaloid, morphine or cocaine.
(a) It is at its peak, about 45 mg/cm³: during the 10 minutes of continuous smoking nicotine is absorbed faster than it is removed, so it builds up; after smoking stops it falls sharply. [1]
OR (a) Smoke also contains carbon monoxide, so CO in the blood is also highest at 10 minutes. CO binds haemoglobin more strongly than O_2, so the haem-bound oxygen is at its lowest, causing oxygen deficiency in the body. [1]
(b) Nicotine stimulates the adrenal glands to release adrenaline and nor-adrenaline into the blood; these raise the blood pressure and heart rate. [1]
(c) Nicotine is an alkaloid. [1] Another alkaloid drug: morphine (from the poppy) or cocaine (from the coca plant). [1]

Q30. (4 marks) Answer: wildlife sanctuaries, in situ; zoos and botanical gardens, ex situ; richness and endemism.
(a) Wildlife sanctuaries (2500 species); *in situ* conservation. [1]
(b) Zoological parks and botanical gardens: *ex situ* conservation. [1] *In situ* protects species in their natural habitat, conserving the whole ecosystem; *ex situ* takes threatened species out of their natural habitat and keeps them in special settings where they are protected and cared for. [1]
(c) Very high species richness and a high degree of endemism; and they are under threat (heavy habitat loss). [1]
OR (c) *In situ* conservation. Tracts of forest set aside for religious reasons, where all trees and wildlife are venerated and fully protected; they shelter many rare and threatened plants (e.g. Khasi and Jaintia Hills in Meghalaya, the Aravalli Hills in Rajasthan, the Western Ghats). [1]

Q31. (5 marks) Answer: (a) transformation; DNA is the genetic material; (b) X-linked recessive, criss-cross.
(a) (i) Griffith (1928) used *Streptococcus pneumoniae* and mice. S strain (smooth, with a mucous coat) injected: mice died. R strain (rough, no coat): mice lived. Heat-killed S strain: mice lived. Heat-killed S strain mixed with live R strain: mice died, and live S bacteria were recovered from them. [2]
Significance: the R strain had been transformed by a 'transforming principle' from the heat-killed S strain; some genetic material had passed from S to R (transformation), though its chemical nature was not known. [1]
(ii) Avery, MacLeod and McCarty (1933–44) purified DNA, RNA and proteins from heat-killed S cells: only DNA transformed R into S. Proteases and RNases did not stop the transformation; DNase did. So DNA is the hereditary material. [2]
OR (b) (i) (I) $XX \times X^hY \rightarrow XX^h$ (carrier daughters) and XY (normal sons). [1]
(II) $XX^h \times XY \rightarrow$ XX normal female, XX^h carrier female, XY normal male, X^hY haemophilic male, 1 : 1 : 1 : 1. [1]
(III) $XX^h \times X^hY \rightarrow XX^h$ carrier female, X^hX^h haemophilic female, XY normal male, X^hY haemophilic male, 1 : 1 : 1 : 1. [1]
(ii) Haemophilia is a sex-linked (X-linked) recessive disorder. A male needs only one X^h to be affected, a female needs two, so many more males suffer. A carrier mother passes it to half her sons; an affected father passes the allele to all his daughters (carriers) but never to his sons (criss-cross inheritance). Haemophilic females are very rare, as they need a carrier (or affected) mother and an affected father. [2]

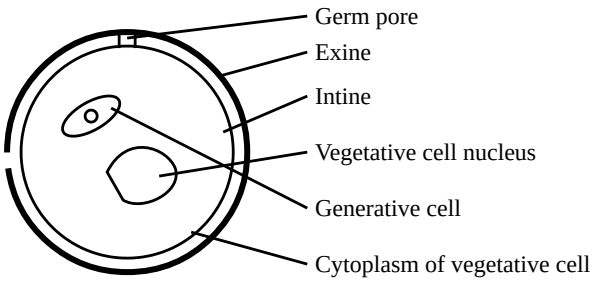
Q32. (5 marks) Answer: (a) genetic engineering, bioprocess engineering; restriction enzymes, vectors, host; (b) probes, PCR, ELISA.
(a) (i) Genetic engineering: changing the chemistry of the genetic material (DNA/RNA) and introducing it into a host organism to change its phenotype. [1] Bioprocess engineering: keeping sterile, contamination-free conditions so that only the desired microbe or cell grows in large quantities, for making products such as antibiotics, vaccines and enzymes. [1]
(ii) Restriction enzymes: 'molecular scissors' that cut DNA at specific palindromic sites (e.g. EcoRI at GAATTC), often leaving sticky ends. [1] Cloning vectors (plasmids, bacteriophages) with an origin of replication, selectable markers and cloning sites, which carry the foreign DNA into the host and multiply it. [1] A competent host (e.g. *E. coli* made competent with $CaCl_2$ and heat shock) that takes up the recombinant DNA. (Also DNA ligase, which joins the fragments.) [1]
OR (b) (i) Serum and urine analysis, and microscopy. [1] They cannot detect a disease early: the pathogen is found only when its numbers are high, after symptoms appear. [1]
(ii) Recombinant DNA technology (probes): a single-stranded DNA or RNA tagged with a radioactive molecule hybridises with its complementary DNA in a clone of cells, detected by autoradiography; a mutated gene does not show up. [1] PCR: amplifies even a very small amount of the pathogen's nucleic acid, e.g. to detect HIV in suspected AIDS patients or mutations in genes of suspected cancer patients. [1] ELISA: based on antigen–antibody interaction; detects the pathogen's antigens or the antibodies made against it. [1]

Q33. (5 marks) Answer: (a) oogonia → primary oocyte → follicles → secondary oocyte → ovulation; FSH, LH; (b) sporopollenin, germ pores.

(a) (i) Gamete mother cells (oogonia) form in the foetal ovary and multiply by mitosis. They enter prophase I of meiosis and are arrested there as primary oocytes. [1] Each primary oocyte is surrounded by a layer of granulosa cells: a primary follicle. Many degenerate between birth and puberty. At puberty, primary follicles gain more granulosa layers and a theca to become secondary follicles; a fluid-filled antrum appears, giving tertiary follicles. [1] The primary oocyte completes meiosis I by an unequal division: a large haploid secondary oocyte and a tiny first polar body. [1] The tertiary follicle becomes the mature Graafian follicle; the secondary oocyte forms the zona pellucida around it. The Graafian follicle ruptures and releases the secondary oocyte (ovum): ovulation. [1]

(ii) FSH and LH (the LH surge causes ovulation). [1]

OR (b) (i)



[1]

(ii) Plasma membrane (innermost), intine, exine (outermost). [1½]

(iii) Sporopollenin, one of the most resistant organic materials known: it withstands high temperatures and strong acids and alkalis, and no enzyme degrades it, so pollen is protected (and preserved as fossils). [1½]

(iv) The exine has apertures, the germ pores, where sporopollenin is absent; the pollen tube comes out through them when the pollen germinates. [1]

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