BIOLOGY – CODE NO. 044
SAMPLE QUESTION PAPER*
CLASS – XII (2026-27)

Maximum Marks: 70 **Time: 3 hours**

General Instructions:

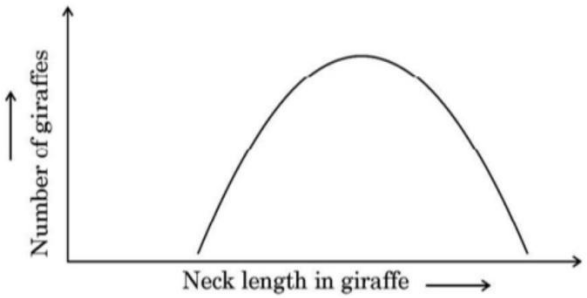
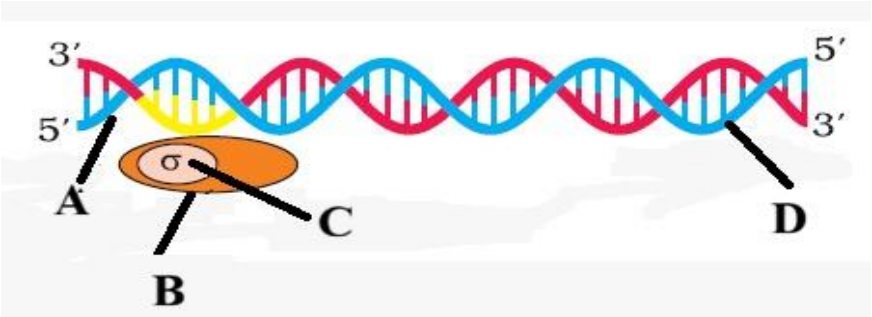
(i) All questions are compulsory.
(ii) The question paper has five sections and 33 questions.
(iii) Section–A has 16 questions of 1 mark each; Section–B has 5 questions of 2 marks each; Section– C has 7 questions of 3 marks each; Section– D has 2 case-based questions of 4 marks each; and Section–E has 3 questions of 5 marks each.
(iv) There is no overall choice. Answer all 33 questions. However, internal choices have been provided in some questions. A student has to attempt only one of the alternatives in such questions.
(v) Wherever necessary, neat and properly labeled diagrams should be drawn.

Section – A

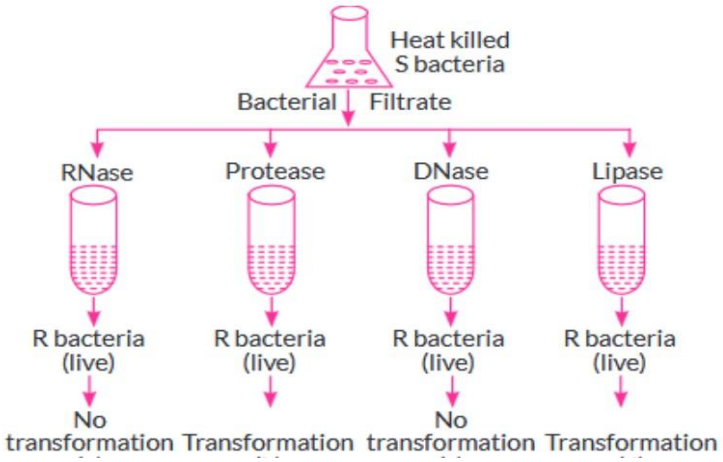
Q. Nos. 1 to 12 are multiple choice questions. Only one of the choices is correct. Select and write the correct choice as well as the answer to these questions.

Q. No.	Question	Marks
1	A researcher observes that in a particular flowering plant, the pistil matures several days before the stamens in all flowers of the plant. What is the most significant consequence of this timing difference? A. It guarantees self-pollination B. It promotes autogamy C. It ensures cross-pollination D. It leads to geitonogamy	1
2	A male patient undergoes a medical procedure where a small section of the vas deferens is cut and tied at both ends. Which of the following effects is the intended and direct result of this procedure? A. Blockage of sperm transport into the ejaculatory duct and urethra. B. Inhibition of testosterone production by the testes. C. Suppression of the formation of seminal plasma by accessory glands. D. Prevention of spermatogenesis in the seminiferous tubules.	1
3	During the early stage of human embryonic development, the blastomeres are arranged into an outer layer and an inner group of cells known as the Inner Cell Mass (ICM). What is the fundamental significance of the outer layer, the trophoblast? A. It is responsible for forming the primary germ layers (ectoderm, mesoderm, endoderm).	1

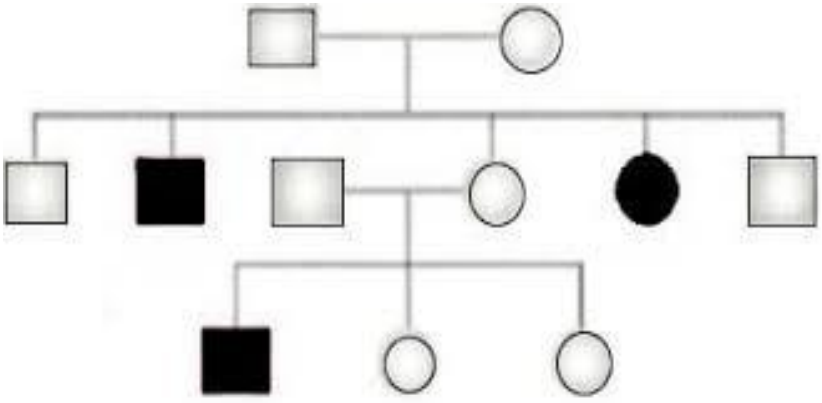
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	B. It provides essential nutrients to developing embryo and helps in its implantation. C. It secretes colostrum which contains antibodies. D. It gives rise to all the organs of the future embryo (organogenesis).	
4	Select the option that gives the correct description of the process of natural selection with respect to the length of the neck of the giraffe.  A. Stabilising selection as giraffes with longer neck lengths are selected further. B. Disruptive selection as giraffes with smaller and longer neck lengths are selected. C. Directional selection as giraffes with longer neck lengths are selected. D. Stabilising selection as giraffes with medium neck lengths are selected. - - - - - - - - - - - - - - - - - - - *For Visually impaired students* Evolution of antibiotic-resistant bacterial population signifies the information that A. Acquired traits are inherited. B. Nature selects for fitness. C. Genetic variations are not a prerequisite factor for natural selection. D. The theory of spontaneous generation of life holds true.	1
5	The initiation step during the process of transcription in bacteria is shown below. Identify A, B, C and D by selecting the option:  A. A-RNA polymerase, B-Promoter, C-Sigma factor, D-DNA helix B. A-Promoter, B-Sigma factor, C-RNA polymerase, D-DNA helix C. A-Promoter, B-RNA polymerase, C-DNA helix, D-Sigma factor D. A-Promoter, B-RNA polymerase, C-Sigma factor, D-DNA helix	1

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	- - - - - - - - - - - - - - - - - - *For Visually impaired students* The promoter site and the terminator site for transcription are located at: A. 3′ (downstream) end and 5′ (upstream) end, respectively of the transcription unit B. 5′ (upstream) end and 3′ (downstream) end, respectively of the transcription unit C. the 5′ (upstream) end D. the 3′ (downstream) end	
6	Given below is the illustration of the different steps of experiments conducted by MacLeod, McCarty and Avery to find the chemical nature of the 'transforming principle' as DNA. Select the option that **incorrectly** depicts the step of the experiment.  A B C D - - - - - - - - - - - - - - - - - - *For Visually impaired students* In the Griffith experiment, which of the following, when injected into mice, did not cause pneumonia? A. Heat-killed S strain only B. Live R strain only C. Both (A) and (B) D. Live S strain only	1
7	A scientist was culturing *E.coli* in a $^{15}NH_4Cl$ medium initially, then he shifted *E.coli* to a $^{14}NH_4Cl$ medium. The DNA was extracted from *E.coli* after 60 minutes of transfer to $^{14}NH_4Cl$ Medium and performed density gradient centrifugation to check the isotope distribution in newly replicated DNA. What will be the densities of DNA molecules formed? A. 25% hybrid and 75% light B. 50% hybrid and 50% light C. 75% hybrid and 25% light D. 85% hybrid and 15% light	1

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8	Study the given pedigree and identify the disease represented  A. Myotonic Dystrophy B. Sickle cell anaemia C. Haemophilia D. Colour blindness - - - - - - - - - - - - - - - - - - - *For Visually impaired students* If a genetic disease is transferred from a phenotypically normal but carrier female to only some of the male progeny the disease is: A. Autosomal dominant B. Autosomal recessive C. Sex-linked dominant D. Sex-linked recessive	1
9	A patient with fever, chest pain, cough and breathing difficulty undergoes a chest X-ray. The film shows patchy opacities and reduced clarity of lung fields. Which observation best supports pneumonia? A. Enlarged heart size B. Inflammation or fluid buildup in the lungs C. Fractured ribs D. Air pockets in the lungs	1
10	A stretch of an euchromatin has 200 nucleosomes, how many base pairs (bp) will be there in the stretch and what would be the length of the typical euchromatin? A. 20,000 bp and $13{,}000 \times 10^{-9}$ m B. 10,000 bp and $10{,}000 \times 10^{-9}$ m C. 40,000 bp and $13{,}600 \times 10^{-9}$ m D. 40,000 bp and $13{,}900 \times 10^{-9}$ m	1
11	A biotechnology company grew Streptomyces in a fermenter to produce an antibiotic. It was observed that Day 7 onwards, the actual yield drops sharply, even though nutrient level, temperature, and aeration remain	1

	unchanged. Also, Microscopy revealed new colonies of bacteria which were not present in the original culture. So the fermenter was stopped. What measures should be taken to prevent the fall in yield in future fermentations? A. Increasing temperature only at the end of fermentation to kill contaminants. B. Adding antibiotics to the culture so unwanted microbes cannot grow. C. Ensuring sterile handling, sterilised equipment, and aseptic transfer before and during fermentation. D. Using a genetically modified strain designed to grow faster than contaminants.	
12	A rice farmer's field, which typically thrives in waterlogged conditions and requires soil rich in nutrients like phosphorus, is experiencing a severe drought this year. The crop is also susceptible to root infestation by pathogens. Which of the following techniques is best to address all these issues? A. Adding nitrogen-fixing bacteria to the soil B. Applying chemical fertilizers C. Adding spores of *Glomus* to the soil D. Flooding the field artificially to mimic normal conditions	1

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 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): Spermatogenesis is an ongoing process throughout the reproductive life of a human male, while oogenesis is a discontinuous process. **Reason** (R): Oogenesis begins during the embryonic stage, gets arrested at prophase-I, resumes after puberty, and is arrested again at metaphase-II.	1
14	**Assertion** (A)**:** There is no variation in the percentage recombination due to loosely or tightly linked genes. **Reason** (R): Linked genes result in occurrence of higher proportion of parental gene combinations.	1
15	**Assertion** (A)**:** The primary goal of sewage treatment is to eliminate all organic matter from the effluent. **Reason** (R)**:** High BOD indicates a low level of organic matter in the water, which can lead to increased oxygen consumption by microorganisms, potentially harming aquatic life.	1
16	**Assertion** (A)**:** Tissue culture is used when traditional breeding technique is insufficient to keep pace with the demand of crop improvement.	1

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	Reason (R)**:** Totipotency is the ability of a single plant cell or explant to regenerate into a whole plant under sterile conditions in nutrient media.	
	Section - B	
17	***Attempt either option A or B.*** A. Geitonogamy can be compared with cross-pollination as well as self-pollination. Comment. **OR** B. Mohit wants to produce hybrid seeds in a plant in his field in which male and female flowers mature at the same time and are close together. Suggest one strategy to promote only desired cross pollination and justify your answer.	2
18	The movement of landmasses over geological time changed the distribution and evolution of animals. Explain this idea using two examples from different regions of the world.	2
19	The following is a realistic example dataset and not a real world patient dataset: **Sample ID** | **Tumor size (mm^3)** | **Glucose level mM/litre** | **Oxygen level (mmHg)** | **Neighboring cell's viability/ vitality (%)** 1 | 150 | 2.0 | 15 | 60 2 | 50 | 4.5 | 30 | 85 3 | 200 | 1.3 | 10 | 50 4 | 100 | 3.0 | 20 | 70 5 | 250 | 0.9 | 7 | 40 A. Interpret the relationship between tumor size and glucose level. B. Evaluate the data to determine how tumor progression may affect the viability/vitality of neighboring cells. Provide a brief explanation.	2
20	***Attempt either option A or B.*** A. The table below shows hypothetical data comparing α-lactalbumin concentration in three types of milk, including that of Rosie, a transgenic cow designed to express human milk proteins. **Source of Milk** | **α-lactalbumin Content approximately (g/L)** Normal cow's milk | 0.1 Rosie cow's milk | 2.4 Human milk | 3.5	2

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I. Based on the data, infer which milk would provide the least efficient infant nutrition and justify your answer.

II. If further genetic modification increases α-lactalbumin levels in Rosie to 3.5 g/L, predict one ethical concern that might arise from such a development.

OR

B. A farmer replaces the GM crop with a conventional variety. Predict any two challenges she/he may face. Support your answer with two reasons.

21 ***Attempt either option A or B.*** 2

A. The table below is a hypothetical data on Seasonal Temperatures seen over two different zones

Region	Temp. in Spring (^oC)	Temp. in Summer (^oC)	Temp. in Autumn (^oC)	Temp. in Winter (^oC)	Primary Productivity (GPP) (g/m^2/ year)	Respiration (R) (g/m^2/year)
Region X	27	28	27	26	3500	1300
Region Y	12	20	14	4	2000	800

I. Justify which region will have greater species diversity based on the given data?

II. Calculate the net primary productivity (NPP) of the region mentioned in (I) and give its significance?

OR

B. Following is a hypothetical data on Plant Pollinator interaction

Plant	Main Pollinator	Seed set (%) with pollinator	Seed set (%) without pollinator
P1	H1 (Bee)	80	40
P2	H2 (Butterfly)	75	45
P3	H3 (Moth)	85	35

I. From the data above, justify which plant shows the highest dependence on its main pollinator?

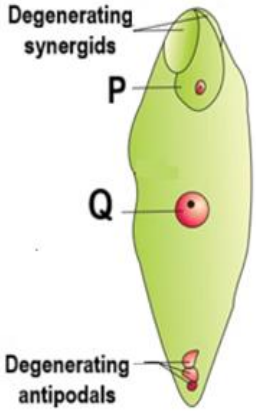
II. What kind of ecological interaction is shown in the table above? Define it in one sentence.

Section - C

22 A couple, A and B, visit a fertility clinic. Examination reveals that female A has a blockage in her fallopian tubes, but her ovaries can produce viable ova. Male B produces sperm with a very low sperm count, making natural fertilization unlikely. 3

Which two different Assisted Reproductive Technologies (ARTs) would a doctor

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	most likely recommend for this couple to increase their chances of conceiving? Justify your selection by briefly stating the principle behind each chosen technique concerning the couple's specific issues.	
23	In the post-fertilization embryo sac shown in figure, structure 'P' results from the fusion of one male gamete with the egg cell, and structure 'Q' results from the fusion of the other male gamete with the polar nuclei.  Figure: Fertilised embryo sac in a flowering plant A. Identify structure 'P' and structure 'Q' and state their ploidy. B. Evaluate the following statement: "The division of 'P' always precedes the division of 'Q'." Justify your evaluation based on the nutritional requirements for seed development. C. Which characteristic feature of endosperm helps in its nutritive role? - - - - - - - - - - - - - - - - - - - *For Visually impaired students* A. Which two products are formed after double fertilization in the embryo sac of a flowering plant? B. State the ploidy of these two structures. C. Which of these two structures develops first during embryonic development? State its significance.	3
24	In mice, the traits for running ability and hair colour assort independently. Running (R) is dominant over walking in circles (r). Black hair (B) is dominant over brown hair (b). A heterozygous running, brown-haired female mouse was artificially inseminated using sperm from a heterozygous running, heterozygous black male. A. Write the genotypes of both parents and draw a Punnett square showing all possible offspring combinations. (1) B. Using the Punnett square, state the phenotypic ratio for: Running–Black, Running–Brown, Walking–Black, Walking–Brown. (1) C. If 64 offspring were produced, calculate how many would be expected to show the Running–Black phenotype. (1)	3

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25	How can a single gene defect caused by the mutation result in Phenylketonuria (PKU)? Explain the molecular mechanism underlying pleiotropy.	3
26	Drug-use disorders often begin with occasional consumption but may progress into a compulsive state. Analyse how addiction differs from dependence in both origin and consequence, and justify why long-term drug intake forces the user to increase dose over time.	3
27	Pathogens are often considered harmful, yet they have been adapted as powerful tools in genetic engineering. Explain how pathogens have been modified into useful vectors. Describe the role of a similarly modified plant vector and animal vector.	3
28	The nematode *Myrmeconema neotropicum* lives inside the abdomen of certain tropical ants (*Cephalotes atratus*). Inside the ant's body, the nematode develops slowly without killing it. Once mature, it changes the color of the ant's abdomen to bright red, making it resemble a berry. Birds, mistaking it for a fruit, eat the ant. The nematode's eggs survive in the bird's digestive system and pass out in droppings, which other ants contact while foraging, starting the cycle again. A. Why would harming the ant too early be disadvantageous for the nematode? (1) B. How is natural selection playing a vital role in maintaining this interaction? (1) C. What kind of ecological interaction is seen between nematode and ant? Define it in one sentence. (1)	3
	Section - D	
29	Madhuri, a 17-year-old girl, has been experiencing irregular periods for the past one year. Sometimes, her cycles are as short as 20 days and sometimes as long as 45 days. She occasionally has very heavy bleeding that lasts over a week, causing fatigue and weakness. A doctor reviews her menstrual diary and explains that these changes can be linked to hormonal fluctuations in the hypothalamic-pituitary-ovarian (HPO) axis. He shows Madhuri the lack of a clear ovulation peak and low progesterone levels in her recent cycles. A. Madhuri experiences heavy bleeding lasting over a week causing fatigue. What possible complication could arise from this condition? (1) B. Examine how the absence of a distinct LH (luteinizing hormone) surge in the menstrual cycle might explain both the irregularity and heaviness of Madhuri's periods. (2) *Attempt either subpart C or D.* C. Madhuri's cycles vary between 20 and 45 days. What might this irregularity indicate about her ovarian function? (1)	4

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	OR D. If a doctor suspects hypothalamic-pituitary dysfunction in Madhuri, which hormone secretion pattern would you expect to be disrupted? (1)	
30	A tribal farmer is cultivating *Brassica oleracea* (cabbage) in a forest region rich in pollinators and rare butterflies. Recently, his crops have been heavily damaged by cabbage looper caterpillars. To manage the pest outbreak, he applies Nucleopolyhedrovirus (NPV). After a few weeks, the pest population decreases significantly without affecting other insects or animals in the area. A. Justify with reasons why the use of Nucleopolyhedrovirus (NPV) was a suitable choice for controlling cabbage looper caterpillars. (1) B. Suggest another IPM strategy suitable for controlling caterpillar pests, and briefly describe its mode of action. (2) *Attempt either subpart C or D.* C. Name the group of pathogens to which *Nucleopolyhedrovirus* belong. (1) **OR** D. Justify why the use of NPV is considered a biocontrol method. (1)	4
	Section - E	
31	***Attempt either option A or B.*** A. A short stretch of DNA strand that codes for a polypeptide is shown below: 3'—TACAAAAAGAAGAAAAAGAAGATT--5' Due to exposure to harmful UV radiation two different types of errors occurred during DNA replication affecting their sequences of bases in the DNA in two different cells. I. What is the term given to a segment of DNA that codes for a polypeptide? II. Which type of mutation could have occurred in each of the following due to the error during replication? a) 3'-- TACAAAAAGAAGAAAAAGAAAATT--5' b) 3'-- TACAAAAAGAAGAAAAAGAGATT--5' III. If DNA strand (a) codes for Methionine and sequences of Phenylalanine, mention the sequence of amino acids that will constitute the polypeptide chain after translation. How many amino acids will be translated from this strand? IV. If all the codons of the stretch code for Phenylalanine excluding the initiator codon which feature does it depict? **OR** B. I. If GUA is an intron how many amino acids will be translated from the mature or processed RNA. Pick out the untranslated region from the following messenger RNA and mention their location and sequence.	5

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	What is its significance? 5'ACGUCGAUGACCGUAGCGUUUGUAUCUUUAGUAGUGGUAUUA GUAGGCUAAAAA3' II. If AAA is the anticodon of phenylalanine, draw the tRNA adaptor molecule, Mention the position of amino acid Phenylalanine in the sequence of polypeptide counting the triplet codons.	
32	***Attempt either option A or B.*** A. A scientist is screening bacterial transformants engineered with DNA fragments of the β-globin gene. A radioactive DNA probe complementary to the normal β-globin sequence is used. After autoradiography: • Plates A and C show radioactive signals. • Plate B shows no radioactivity. Answer the following: I. Why does plate B fail to show radioactivity, while A and C do? (2) II. How can this experiment help in distinguishing a normal individual, a carrier, and a patient of sickle cell anaemia? (2) III. Name one other commonly used technique (apart from autoradiography) to differentiate recombinants from non-recombinants. (1) **OR** B. A student placed DNA from three different sources: bacteria, plant tissue, and fungal cells in a test tube A, B and C respectively. During the process of isolating and purifying DNA, the student added cellulase to all test tubes. I. Predict and explain in which trial(s) DNA isolation would fail, and why? Also suggest how it could be corrected. (2) II. After rectifying the mistake made in 'a', outline the steps to obtain visible spooled DNA from the sample. (2) III. Suggest one application of the spooled DNA in biotechnology. (1)	5
33	***Attempt either option A or B.*** A. A Green Valley *X*, home to rare medicinal plants and several migratory bird species, is facing multiple environmental challenges. I. A luxury brand of cosmetics with little regulation has been sourcing wild medicinal plants from the valley. II. The company has introduced an ornamental grass species from another country, which has taken over large areas of native grassland. III. There is also a reported drastic decline in the endemic trees. IV. Large scale forest fire in a part of the valley. a) From the above hypothetical case, identify and explain the four major biodiversity threats. (4) b) Suggest one in-situ conservation practice that could help protect the biodiversity of Green Valley *X*, and justify your choice. (1)	5

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	OR B. At a composting ground, after a community clean-up drive, large amounts of vegetable peels, garden leaves, and other organic waste are piled up. Over the next few weeks, the volume of the waste decreases noticeably. I. Explain the sequence of processes that could have led to this transformation, and name the major organisms involved at each step. (4) II. If a prolonged dry spell occurs during this composting period, explain how it could affect the rate of the above processes. (1)	

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MARKING SCHEME
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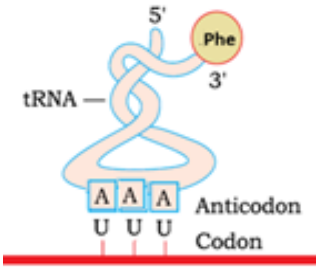
Q. No.	Answer	Marks
	Section - A	
1	C. It ensures cross-pollination	1
2	A. Blockage of sperm transport into the ejaculatory duct and urethra	1
3	B. It provides essential nutrients to developing embryo and helps in its implantation.	1
4	C. Directional selection as giraffes with longer neck lengths are selected. *For Visually impaired students* B. Nature selects for fitness.	1
5	D. A - Promoter, B - RNA polymerase, C - Sigma factor, D-DNA helix *For Visually impaired students* B. 5′ (upstream) end and 3′ (downstream) end, respectively of the transcription unit	1
6	A. No transformation *For Visually impaired students* C. Both (A) and (B)	1
7	A. 25% hybrid and 75% light	1
8	B. Sickle cell anaemia *For Visually impaired students* D. Sex-linked recessive	1
9	B. Inflammation or fluid buildup in the lungs	1
10	C. 40,000 bp and $13{,}600 \times 10^{-9}$ m	1
11	C. Ensuring sterile handling, sterilised equipment, and aseptic transfer before and during fermentation.	1
12	C. Adding spores of *Glomus* to the soil	1
13	A. Both **Assertion** (A) and **Reason** (R) are true, and **Reason** (R) is the correct explanation of **Assertion** (A).	1
14	D. A is false but R is true.	1
15	C. A is true but R is false.	1
16	B. Both A and R are true but R is not the correct explanation of A.	1

Section - B		
17	***Attempt either option A or B.*** A. Geitonogamy involves transfer of pollen grains from the anther to the stigma of another flower of the same plant. (1) Although geitonogamy is functionally cross-pollination involving pollinating agents, genetically it is similar to autogamy since the pollen grains come from the same plant. (1) **OR** B. Mohit can emasculate (remove anthers) from selected flowers before pollen release and then manually pollinate them with pollen from the chosen male parent, followed by bagging. (1) This prevents self-pollination and unwanted pollen and ensures that only the desired cross produces seeds. (1)	2
18	There were in South America mammals resembling horse, hippopotamus, bear and rabbit. Due to continental drift, when South America joined North America, these animals were overridden by North American fauna. (1) Due to continental drift, a number of Australian marsupials, each different from the other, evolved from an ancestral stock, but all within the Australian island continent. These pouched mammals of Australia survived because of lack of competition from any other mammals. (1)	2
19	A. As tumor size increases, glucose levels decrease, suggesting that larger tumors consume more glucose due to higher metabolic demand, possibly indicating a more aggressive growth pattern. (1) B. As tumor size increases, the viability of neighboring cells decreases suggesting that growing tumors create a hostile microenvironment, due to nutrient competition and less oxygen is available leading to stress or death of surrounding normal cells. /As these cells actively divide and grow they also starve the normal cells by competing for vital nutrients. (1)	2
20	***Attempt either option A or B.*** A. I. Normal cow's milk (~0.1 g/L) is least suitable. Reason: Very low α-lactalbumin compared to human milk. (1) II. (i) Going beyond morality genetical modification of organisms can have long term unpredictable results. (ii) patenting for resource (iii) loss of genetic diversity of natural cows (iv) economic exploitation Any one (1) **OR** B. (i) Increased pesticide use due to lack of pest resistance. (ii) Lower yield under abiotic stress conditions. (iii) Faster depletion of soil nutrients due to inefficient mineral usage. Any two (1+1)	2

21	***Attempt either option A or B.*** A. I. Region X will have greater species diversity/Tropical region because Temperatures are near-constant across seasons in X (27–28–27–26 °C), which supports stable conditions / higher diversity/ Higher productivity/GPP 3500/ higher NPP in X vs lower productivity in Y. (1) II. NPP of Region X = GPP − R = 3500 − 1300 = 2200 g/m²/year. Net primary productivity is the available biomass for the consumption to heterotrophs (herbiviores and decomposers) (1) **OR** B. I. P3 → drop of over 50 percentage points without main pollinator/ other plants show comparatively less drop in seed set without pollinator. (1) II. The relationship is Mutualism as both species benefit; here, plants gain pollination and pollinators obtain nectar/food. (1)	2
	Section – C	
22	ART 1: Intracytoplasmic Sperm Injection (ICSI) Justification: ICSI is required to address Male B's low sperm count. It is an advanced procedure to form the embryo in vitro, where a sperm is directly injected into the ovum. (1.5) ART 2: In vitro fertilisation followed by Intrauterine Transfer (IUT) Justification: IVF followed by IUT is required to address Female A's blocked fallopian tubes. Since the natural path for the egg is blocked, the embryo (formed via IVF/ICSI) must be transferred directly to the uterus. (1.5)	3
23	A. Structure P (Zygote) is diploid and Structure Q (Primary Endosperm Nucleus) is triploid. (1) B. The statement is False. The Primary Endosperm Nucleus (PEN/'Q') divides much earlier than zygote ('P') to form the endosperm tissue for nutrition of embryo. (1) C. The cells of endosperm tissue are filled with reserve food materials which act as the primary source of nutrition for the developing embryo. (1) - - - - - - - - - - - - - - - - - - *For Visually impaired students* A. Zygote/Embryo and Primary Endosperm Nucleus/Endosperm. (1) B. Zygote/Embryo is diploid and Primary Endosperm Nucleus/Endosperm is triploid. (1) C. The Primary Endosperm Nucleus (PEN) divides much earlier than zygote to form the endosperm tissue. The cells of endosperm tissue are filled with reserve food materials which act as the primary source of nutrition for the developing embryo. (1)	3

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A. Female mice: Heterozygous for running (Rr) and brown hair (bb), so its genotype is Rrbb. Male mice: Heterozygous for running (Rr) and heterozygous for black hair (Bb), so its genotype is RrBb.
Possible gametes
Female (Rrbb): Rb, Rb, rb, rb Male (RrBb): RB, Rb, rB, rb (1)
Punnett square
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<tr><td>rb</td><td>RrBb</td><td>Rrbb</td><td>rrBb</td><td>rrbb</td></tr>
<tr><td>rb</td><td>RrBb</td><td>Rrbb</td><td>rrBb</td><td>rrbb</td></tr>
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B. Probable phenotypes of the progeny
Running black (RRBb x 2, RrBb x 4,): 6/16
Running brown (RRbb x 2, Rrbb x 4): 6/16
Walking black (rrBb x 2,): 2/16
Walking brown (rrbb x 2): 2/16 Ratio will be 6:6:2:2 OR 3:3:1:1 (1)
C. 24 will show running black phenotype. (1)
</td>
<td>3</td>
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<tr>
<td>25</td>
<td>
The disease is caused by a single gene mutation resulting in an inborn error of metabolism where the affected individual lacks an enzyme that converts the amino acid phenylalanine into tyrosine. (1)
As a result of this phenylalanine is accumulated and converted into phenyl pyruvic acid and other derivatives. Accumulation of these in the brain results in mental retardation. (1)
In pleiotropy a single gene can exhibit multiple phenotypic expressions by affecting metabolic pathways in different ways. (1)
</td>
<td>3</td>
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<tr>
<td>26</td>
<td>
Addiction - – Psychological attachment to effects of drugs/alcohol (½) → driven by desire for euphoria/well-being even when not needed (½). (1)
Dependence – Physical tendency of the body → manifests withdrawal symptoms (anxiety, shakiness, nausea, sweating) when drug is stopped. (1)
Reason for increased intake – Repeated drug use increases tolerance level of body receptors → receptors respond only to higher doses for the same effect. (1)
</td>
<td>3</td>
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<tr>
<td>27</td>
<td>
I. Certain pathogens naturally have the ability to transfer their DNA into host cells. Scientists have modified these pathogens by removing their disease-causing genes, while retaining their ability to deliver DNA, making them useful cloning vectors. (1)
II. In animals, retroviruses have been engineered to remove cancer-causing genes, while keeping their capacity to integrate DNA into the host genome, making them effective vectors for gene delivery. (1)
</td>
<td>3</td>
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	III. In transgenic plants, nematode-specific genes were introduced via Ti plasmid of *Agrobacterium tumefactions* to produce dsRNA, which triggered RNA interference (RNAi) and silenced nematode mRNA, protecting the plant from the parasite. (1)	
28	A. If the ant dies too soon, the nematode won't complete its development and won't be transmitted to new hosts. (1) B. Natural selection favors nematodes that keep the ant alive until it can be eaten by a bird, ensuring better dispersal and survival of the nematode. The birds eat only the red-bellied ant. This ensures complete maturation of nematode and its dispersal and protects the other ants from predation. (1) C. Type: Parasitism, Definition: An interaction where one organism benefits and the other is harmed. (1)	3
Section – D		
29	A. Anaemia due to excessive blood loss. (1) B. Without a distinct LH surge, ovulation may not occur, so no corpus luteum forms to secrete progesterone. As a result, the endometrial lining grows excessively under unopposed estrogen and is then unpredictably or heavily shed, causing irregular and heavy periods. (2) *Attempt either subpart C or D.* C. It suggests lack of ovulation due to hormonal imbalance affecting ovarian function. (1) **OR** D. GnRH secretion from hypothalamus and subsequent LH/FSH secretion from pituitary would be disrupted. (1)	4
30	A. NPV is species-specific and affects only target insect pests, narrow spectrum insecticide; causes no harm to plants, pollinators, mammals, birds, fish, or non-target insects. (1) B. He could have sprayed the spores of Bacillus thuringiensis, in the gut of the larvae, the bacterial toxin is released and the larvae get killed. (2) C. Baculovirus (1) **OR** D. Because it is a biological method for controlling plant diseases and pests (using natural predators). (1)	4
Section – E		
31	***Attempt either option A or B.*** A. I. The term given to a segment of DNA that codes for a polypeptide is Cistron. (0.5) II. (a) 3'-- TACAAAAAGAAGAAAAAGAAAATT--5'—Point Mutation. (1) (b) 3'—TACAAAAAGAAGAAAAAGAAATT--5'—Deletion / Frameshift mutation. (1)	5

	III. Methionine -Phenylalanine -Phenylalanine -Phenylalanine - Phenylalanine -Phenylalanine –Phenylalanine; 7 amino acids. (2) IV. Degenerate. (0.5) **OR** B. I. AUGACC**GUA**GCGUUU**GUA**UCUUUA**GUA**GUG**GUA**UUA**GUA**GGC Nine amino acids will be translated from the mature or processed RNA. (1) 5'**ACGUCG** ---------- **UAAAAA**3' Location of the untranslated region from the above messenger RNA will be at the 5' end and 3'prime end and their sequences are 5'ACGUCG and 3' end UAAAAA. (2) They are required for efficient translation process. (0.5) II.  (1) 4th triplet codon codes for phenylalanine. (0.5)	
32	***Attempt either option A or B.*** A. I. Plate B fails to show radioactivity because the probe could not hybridise with its DNA sequence, indicating the presence of the mutated β-globin gene (sickle mutation). Plates A and C show signals since their DNA has the normal complementary sequence. (2) II. ● Normal individual: Probe binds fully → strong radioactivity observed ● Carrier (heterozygote): Both normal and mutated sequences present → partial hybridisation (mixed pattern). ● Patient (homozygous mutant): No hybridisation with the probe → no radioactivity seen. (2) III. Insertional inactivation (1) **OR** B. I. Test tube A (bacteria): DNA isolation will fail because bacteria require lysozyme, not cellulase, to digest the peptidoglycan cell wall. ● Test tube B (plant): DNA isolation will succeed because plants require cellulase to digest cellulose walls. ● Test tube C (fungus): DNA isolation will fail because fungi require chitinase to digest chitin walls. ● Correction: Use lysozyme for bacteria, cellulase for plants, and chitinase for fungi. (2)	5

II. The further steps are

- Break open cells → DNA released with RNA, proteins, polysaccharides, and lipids.
- Remove contaminants:
  - RNase digests RNA
  - Protease digests proteins
- Remove polysaccharides and lipids by specific treatments.
- Add chilled ethanol → DNA precipitates as white threads, spooled on a glass rod. (2)

III. Spooled DNA can be used in genetic engineering, PCR amplification, DNA fingerprinting, or sequencing. (1)

33 ***Attempt either option A or B.*** 5

A.

(a)

Biodiversity Threat	**Explanation of the effect it will have**
Overexploitation	Unsustainable sourcing of wild medicinal plants by the cosmetic brand threatens plant species/may lead to depletion and extinction of valuable species. (1)
Invasion by alien species	Ornamental grass from another country spreading aggressively into native grassland/outcompetes native grasses, reduces local biodiversity. (1)
Co-extinction	Disappearance of nesting tree species causing sharp decline in migratory bird population/ disrupts ecological balance, loss of niches. (1)
Habitat loss and fragmentation	Forest fires lead to habitat loss and fragmentation by destroying forest vegetation and breaking continuous habitats into smaller, isolated patches. This forces species to migrate, reduces population sizes, and alters species distribution, often resulting in local extinction and decline in biodiversity. (1)

(b) Example: Declaration of *Green Valley X* as a **protected area** (wildlife sanctuary/national park/biosphere reserve/sacred groove/hotspot). Justification: Maintains species in their natural habitat, preserves ecological interactions, and allows long-term protection of genetic, species, and ecosystem diversity. (1)

OR

B.

I.

Step / Process	**Description**
Fragmentation	Breaking down of waste into smaller particles by detritivores (e.g., earthworms, termites). (1)
Leaching	Soluble inorganic nutrients dissolve in water and percolate into the composting soil. (1)

Catabolism	Enzymatic breakdown of complex organic matter into simpler inorganic substances by bacteria/fungi. (1)
Humification & Mineralisation	Formation of humus and release of inorganic nutrients into the compost by microbes. (1)

II. A dry spell would lower moisture content, slowing microbial activity and enzymatic breakdown, thereby reducing the rate of decomposition and delaying the reduction in waste volume. (1)

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