BIOLOGY

Code No. 044

SAMPLE QUESTION PAPER — SET 1 | CLASS XII

Time Allowed: 3 Hours **Maximum Marks: 70**

General Instructions:

1. All questions are compulsory.
2. This question paper has five sections and 33 questions.
3. 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.
4. There is no overall choice. However, internal choices have been provided in some questions. Attempt only one of the alternatives in such questions.
5. Wherever necessary, neat and properly labelled diagrams should be drawn.

	SECTION A *Q. No. 1 to 12 are multiple choice questions of 1 mark each. Q. No. 13 to 16 are Assertion-Reason questions.*	
1.	The male gametes in flowering plants are formed by: (A) Mitotic division of the microspore mother cell (B) Meiotic division of the generative cell (C) Mitotic division of the generative cell (D) Meiotic division of the microspore mother cell	1
2.	The endosperm formed after triple fusion in angiosperms is typically: (A) Diploid (2n) (B) Triploid (3n) (C) Haploid (n) (D) Tetraploid (4n)	1
3.	Which hormonal event triggers ovulation during the human menstrual cycle? (A) A surge in FSH alone (B) A surge in LH (C) A surge in progesterone (D) A steady rise in estrogen only	1
4.	Implantation of the blastocyst in the human uterus typically occurs around: (A) 1-2 days after fertilisation (B) 6-7 days after fertilisation (C) 14-16 days after fertilisation (D) 20-22 days after fertilisation	1
5.	The bacteriophage-based experiment that provided direct proof that DNA (and not protein) is the genetic material was performed by:	1

	(A) Griffith (B) Avery, MacLeod and McCarty (C) Hershey and Chase (D) Meselson and Stahl	
6.	Short, labelled DNA sequences used to detect a complementary target sequence in a sample are called: (A) Primers (B) Probes (C) Vectors (D) Plasmids	1
7.	According to the Hardy-Weinberg principle, which of the following would disturb genetic equilibrium in a population? (A) Random mating (B) A very large population size (C) Migration of individuals into the population (D) Absence of mutation	1
8.	A colour-blind man marries a woman who is homozygous normal for colour vision. What proportion of their sons is expected to be colour-blind? (A) 0% (B) 25% (C) 50% (D) 100%	1
9.	Identify the correct sequence of events in a person infected by the malarial parasite: (A) Merozoites → liver infection → RBC infection → gametocytes (B) Sporozoites → RBC infection → liver infection → gametocytes (C) Sporozoites → liver infection → RBC infection → gametocytes (D) Gametocytes → liver infection → RBC infection → sporozoites	1
10.	Which of the following pathogen-disease pairs is correctly matched? (A) Wuchereria – Typhoid (B) Plasmodium – Filariasis (C) Salmonella typhi – Typhoid (D) Entamoeba – Ringworm	1
11.	To isolate DNA from a bacterial cell for genetic engineering, the cell is commonly treated with: (A) Cellulase, lysozyme and chilled ethanol (B) Lysozyme, ribonuclease, protease and chilled ethanol (C) Chitinase, ribonuclease and water only	1

	(D) Protease and water only	
12.	Integrated Pest Management (IPM) primarily involves: I. Judicious use of pesticides II. Use of biocontrol agents III. Complete avoidance of any chemical intervention (A) Only I (B) Only II (C) Both I and II (D) Only III	1
13.	Questions 13 to 16 consist of an Assertion (A) and a Reason (R). Select the correct option: (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. Assertion (A): Pollen-pistil interaction allows the pistil to recognise a compatible pollen grain. Reason (R): This recognition occurs through a continuous molecular dialogue between the pollen grain and the tissues of the pistil.	1
14.	Assertion (A): Organisms well adapted to a hostile environment survive and reproduce more successfully than those that are not. Reason (R): Adaptations that improve survival and reproductive success are heritable and have an underlying genetic basis.	1
15.	Assertion (A): Cocaine use produces a temporary sense of euphoria and increased energy. Reason (R): Cocaine interferes with the transport of the neurotransmitter dopamine.	1
16.	Assertion (A): "Rosie" was the first transgenic cow to produce protein-enriched milk. Reason (R): Rosie's milk contained human alpha-lactalbumin, making it more nutritionally balanced for human infants.	1

SECTION B *Section B consists of 5 questions of 2 marks each.*		
17.	A. During emasculation for artificial hybridisation, why must the anthers be removed from a bisexual flower before the pollen matures, and what is done afterward to prevent unwanted pollination? **OR** B. Why is manual emasculation and hand-pollination relatively straightforward in a large, bisexual flower such as brinjal, but difficult in a small, wind-pollinated flower such as wheat?	2
18.	How does the operator region regulate the transcription of the structural genes of the lac operon in E.	2

	coli, both in the absence and in the presence of lactose?	
19.	The table below shows a hypothetical differential leucocyte count of a patient: Cell type: Neutrophils — Observed: 68% — Reference range: 55-70% Cell type: Lymphocytes — Observed: 15% — Reference range: 20-40% Cell type: Eosinophils — Observed: 6% — Reference range: 1-4% Cell type: Monocytes — Observed: 3% — Reference range: 1-8% Cell type: Basophils — Observed: 0.5% — Reference range: 0.5-1% A. Based on these values, is the patient more likely fighting a bacterial or a parasitic infection? Justify your answer. B. Name the leucocyte type with the lowest normal reference range and state its primary role in immunity.	2
20.	A. A student claims that a person preparing idli or dosa batter at home is unknowingly using biotechnology. Do you agree with this claim? Justify your answer. **OR** B. Why is the 'insertional inactivation' method of selecting recombinants generally preferred over relying solely on antibiotic-resistance markers?	2
21.	A. (i) Pyramid I (of numbers) for a grassland: a few large trees support a very large number of insects, which in turn support a moderate number of insectivorous birds. Pyramid II (of numbers) for a pond: a very large number of phytoplankton support a large number of zooplankton, which support a moderate number of small fish, which support a few large fish. Compare the shapes of these two pyramids and explain why Pyramid I is inverted at its base. (ii) Construct an ideal pyramid of energy if 500,000 joules of sunlight energy are captured by producers, assuming the standard 10% transfer efficiency at each subsequent trophic level (show at least 4 trophic levels).	2

SECTION C *Section C consists of 7 questions of 3 marks each.*		
22.	Suggest a suitable contraceptive method for each of the following cases, with justification: (i) Anjali wants a highly effective, reversible method that does not need daily attention and can be removed by a doctor whenever she wishes to conceive. (ii) Ramesh and his wife have completed their family and want a permanent contraceptive method for the male partner. (iii) Sunita wants a method that will also protect her against sexually transmitted infections.	3
23.	With reference to events in a human female from ovulation to implantation, answer the following: (i) What is the ploidy of the secondary oocyte released at ovulation, and how does this change upon fertilisation? (ii) What would happen if the blastocyst fails to attach properly to the endometrium? (iii) If a zygote splits into two separate groups of cells early in cleavage, resulting in twins, will the genomes of the two resulting individuals be identical? Justify your answer.	3

24.	In pea plants, tall stem (T) is dominant over dwarf (t), and round seed (R) is dominant over wrinkled seed (r); the two genes assort independently. If two plants heterozygous for both traits (TtRr × TtRr) are crossed, find the probability of obtaining offspring that are dwarf with wrinkled seeds. Show your working using a Punnett square.	3
25.	Several unrelated groups of organisms — cactus (a plant), whale (a mammal), shark (a fish) and ichthyosaur (an extinct reptile) — have each independently evolved a streamlined, tapering body form suited to movement through their respective environments. A. Name and briefly explain the evolutionary phenomenon illustrated here. B. Distinguish this phenomenon from adaptive radiation, giving a brief example of the latter.	3
26.	During the secondary treatment of sewage at a treatment plant, the Biological Oxygen Demand (BOD) of the effluent is significantly reduced before it is discharged. Describe the sequence of processes involved in achieving this reduction.	3
27.	Expand the term ELISA. Explain the underlying principle on which this test works, and mention two different kinds of infections that can be detected using it.	3
28.	The age pyramids of a country are broad-based for the year 1970, bell-shaped for 2020, and projected to be urn-shaped for 2070. A. Comment on the growth status of the population in each of these three years, based on the shape described. B. What can you infer about the likely future population trend of this country from the 2070 projection?	3

SECTION D *Section D consists of 2 case-based questions of 4 marks each.*		
29.	Given below is information about seed/fruit formation in four plant species: P: Embryos develop directly from the diploid nucellar tissue surrounding the embryo sac, without fertilisation. Q: The ovary wall develops into the fruit only after fertilisation and seed formation. R: The ovary enlarges into a fruit even though fertilisation has not taken place, and the fruit remains seedless. S: The thalamus, rather than the ovary, forms the major edible part of the fruit after fertilisation. A. In species Q, how many embryo sacs are typically present in a single ovule before maturity, and how many egg cells does each embryo sac contain, assuming standard monosporic development? [1] B. (i) Which species shows polyembryony? Will the resulting embryos be genetically identical to one another? Justify. [1] (ii) What is the ploidy of the embryonic cells formed in this case? [1] C. Which of these species/fruits is best described as parthenocarpic? Give a reason. [1] **OR** D. Which of the fruits, Q or R, is a 'false fruit'? Give a reason. [1]	4
30.	A research team studying newborn calves observes that antibodies derived from the mother's	4

	colostrum are high immediately after birth but decline steadily over the first two weeks, while antibodies produced by the calf's own immune system are low at birth but rise steadily from about day 10 onward and remain elevated thereafter. A. What is the fundamental difference between the two types of immunity described here? [1] B. If a vaccine is administered to the calf on day 3, what kind of immune response would you expect it to trigger, and why might its effectiveness be limited at this early stage? [2] C. What trend does the colostrum-derived immunity show over time, and why? [1] **OR** D. Why does the calf's own antibody-mediated immunity take time to rise after birth? [1]	

SECTION E *Section E consists of 3 questions of 5 marks each.*		
31.	A. Given a hypothetical DNA template strand: 3'-TACGGATCCGTA-5', construct the complete mRNA transcript that would be synthesised from it, clearly indicating the 5' and 3' ends. Also explain two ways in which transcription in eukaryotic cells is more complex than in prokaryotic cells, with reference to the processing of precursor mRNA (hnRNA). **OR** B. Explain the process of aminoacylation of tRNA and its role in translation. How do ribosomes function as the site of protein synthesis in a cell?	5
32.	A. (i) Name one bacterial and one viral agent used as tools in recombinant DNA technology, and briefly explain the role of each. [2] (ii) List the broad categories of enzymes essential for constructing recombinant DNA. [1] (iii) A cotton farmer wants to protect his crop from bollworm (a lepidopteran pest) without using chemical pesticides or microbial sprays. Suggest a genetic-engineering-based alternative and briefly explain how the introduced gene would control the pest. [2] **OR** B. EcoRI is a restriction enzyme that recognises the sequence 5'-GAATTC-3' and cuts between G and A. (i) Write the complementary strand and confirm that this sequence forms a palindrome. [2] (ii) Describe how EcoRI generates sticky ends when it cuts this sequence on both strands. [1] (iii) If a plasmid carries this restriction site within a gene conferring ampicillin resistance, explain how successful insertion of foreign DNA at this site would affect the transformant's response to ampicillin. [2]	5
33.	A. Justify each of the following statements about competition among species in nature, with a suitable example for each: (i) Competition can occur even between distantly related species. (ii) Competition does not always depend on a limiting resource. (iii) Competitive exclusion is observed in natural populations. (iv) Species facing competition may evolve mechanisms to coexist rather than exclude one another. **OR**	5

	B. (i) Using a simple grassland food chain, explain how it illustrates the First Law of Thermodynamics. (ii) The table below shows the number of amphibian species recorded in different regions: Ecuador: 350 species — Peru: 320 species — Costa Rica: 180 species — Germany: 22 species — Canada: 45 species Identify the common geographical factor shared by the regions with higher amphibian diversity, and suggest two reasons for this pattern.	

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MARKING SCHEME — SET 1 | CLASS XII

SECTION A		
1.	The generative cell divides mitotically to produce two male gametes. Answer: (C)	1
2.	Triple fusion (one male gamete + two polar nuclei) produces the triploid (3n) primary endosperm nucleus. Answer: (B)	1
3.	A sudden LH surge (the 'LH surge') triggers rupture of the Graafian follicle and ovulation. Answer: (B)	1
4.	Implantation typically occurs about 6-7 days after fertilisation. Answer: (B)	1
5.	Hershey and Chase used bacteriophages labelled with radioactive P and S to show DNA (not protein) enters the bacterial cell and directs progeny formation. Answer: (C)	1
6.	A probe is a labelled single-stranded DNA/RNA sequence used to detect a complementary sequence by hybridisation. Answer: (B)	1
7.	Migration (gene flow) introduces new alleles into a population and disturbs genetic equilibrium; random mating, large population size, and absence of mutation are all conditions required to maintain equilibrium. Answer: (C)	1
8.	Colour blindness is X-linked recessive. Sons receive their Y chromosome from the father and X chromosome from the mother. Since the mother is homozygous normal (X^N X^N), all sons receive a normal X and will have normal vision. Answer: (A) 0%	1
9.	Sporozoites (injected by the mosquito) first infect the liver, then infect RBCs (causing symptoms), and gametocytes are formed in RBCs to be taken up by a new mosquito. Answer: (C)	1
10.	Salmonella typhi causes typhoid. Wuchereria causes filariasis (not typhoid); Plasmodium causes malaria (not filariasis); Entamoeba causes amoebiasis (not ringworm). Answer: (C)	1
11.	Bacterial cells are treated with lysozyme (to digest the cell wall), ribonuclease and protease (to remove RNA and protein), followed by chilled ethanol (to precipitate the DNA). Answer: (B)	1
12.	IPM combines judicious pesticide use with biocontrol agents, rather than either extreme alone. Answer: (C) Both I and II	1
13.	Both statements are true, and R correctly explains the molecular basis of pollen-pistil recognition described in A. Answer: (a)	1
14.	Both statements are true, and R correctly explains why adaptation improves survival: because it is heritable. Answer: (a)	1
15.	Both statements are true, and R correctly explains the mechanism behind cocaine's euphoric effect. Answer: (a)	1

16.	Both statements are true, and R correctly explains why Rosie's milk was nutritionally enriched. Answer: (a)	1

SECTION B		
17.	A. Anthers are removed before pollen matures to prevent self-pollination from the same flower (since pollen from the same or a genetically similar plant would defeat the purpose of hybridisation). After emasculation, the flower is covered with a bag (bagging) so that unwanted, unknown pollen carried by wind or insects cannot reach the stigma. [2] OR B. In brinjal, flowers are bisexual and large, making emasculation and hand-pollination physically easy to perform on individual flowers. In wheat, flowers are small, numerous and wind-pollinated, making individual emasculation impractical; pollen from pollen banks is used instead to pollinate large numbers of flowers efficiently. [2]	2
18.	In the absence of lactose, the repressor protein binds to the operator region, physically blocking RNA polymerase from transcribing the structural genes (z, y, a). In the presence of lactose, allolactose (the inducer) binds to the repressor, changing its shape so it can no longer bind the operator; RNA polymerase is then free to transcribe the structural genes. [2]	2
19.	A. The patient's lymphocyte count is below the reference range while eosinophils are elevated; this pattern (raised eosinophils, low lymphocytes) is more typically associated with a parasitic infection, since eosinophils increase specifically in response to parasitic infestations. B. Basophils have the lowest reference range; they release histamine and heparin and play a role in inflammatory responses, including allergic reactions. [2]	2
20.	A. Yes. Idli/dosa batter fermentation relies on the metabolic activity of microorganisms (yeasts and lactic acid bacteria) that produce lactic acid and CO_2, causing the batter to rise. Since this is the deliberate use of microorganisms to obtain a useful product, it qualifies as (traditional) biotechnology. [2] OR B. Antibiotic-resistance markers alone cannot distinguish recombinants from non-recombinants, since both would grow on the antibiotic used for initial selection. Insertional inactivation allows recombinants to be identified because insertion of foreign DNA inactivates one of the two resistance genes, so recombinants lose resistance to only that one antibiotic while non-recombinants remain resistant to both — making the distinction unambiguous. [2]	2
21.	A. (i) Pyramid I is upright at higher trophic levels but its base (producers) is narrower than the tier above it, making it inverted at the base; this happens because a few large trees can support a much larger number of smaller organisms like insects that feed on them, without the trees themselves being numerous. (ii) Pyramid of energy (10% transfer efficiency): Producers = 500,000 J; Primary consumers = 50,000 J; Secondary consumers = 5,000 J; Tertiary consumers = 500 J. Pyramids of energy are always upright since energy is progressively lost as heat at each transfer. [2]	2

SECTION C		
22.	(i) An IUD (Intra-Uterine Device, e.g. Cu-T) is suitable, as it is highly effective, reversible, does not need daily attention, and can be inserted or removed by a doctor as required.	3

	(ii) Vasectomy (a permanent surgical method for the male partner) is suitable, since the couple wants no more children. (iii) A barrier method such as a condom is suitable, as it is the only method listed that also protects against STIs, in addition to preventing conception. [1 each]	
23.	(i) The secondary oocyte is haploid (n). Upon fertilisation with a haploid sperm, the resulting zygote becomes diploid (2n). (ii) If the blastocyst fails to attach properly to the endometrium, implantation fails and pregnancy does not establish; the endometrial lining is subsequently shed (menstruation occurs). (iii) Yes, twins formed by the splitting of a single zygote (identical/monozygotic twins) will have identical genomes, since both groups of cells originate from mitotic division of the same fertilised egg and carry the same genetic material. [1 each]	3
24.	Cross: TtRr × TtRr. Each parent produces gametes TR, Tr, tR, tr in equal proportion (1/4 each). Probability of dwarf (tt) = 1/4. Probability of wrinkled (rr) = 1/4. Since the genes assort independently, probability of dwarf AND wrinkled (ttrr) = 1/4 × 1/4 = 1/16. (A 4×4 Punnett square confirms 1 out of 16 offspring combinations is ttrr.) [3]	3
25.	A. This is an example of convergent evolution, where unrelated groups of organisms independently evolve similar structures/body forms because they are adapting to similar environmental pressures (in this case, movement through water or a streamlined lifestyle), not because of common ancestry. B. Convergent evolution involves unrelated species evolving similar traits due to similar selection pressures in similar environments. Adaptive radiation, by contrast, involves a single ancestral species diversifying into many different forms adapted to different environments/niches, typically after colonising a new region, e.g. Darwin's finches on the Galapagos Islands evolving different beak shapes from a common ancestor. [3]	3
26.	In secondary (biological) treatment, the primary effluent is passed into large aeration tanks where it is constantly agitated and aerated. This allows aerobic microorganisms to grow vigorously, forming flocs, which consume the majority of the organic matter in the effluent, significantly lowering its BOD. The effluent is then passed to a settling tank where the microbial flocs (activated sludge) settle as sediment; most of this sludge is pumped into anaerobic sludge digesters, where anaerobic bacteria further digest it, producing biogas (methane) that can be used as fuel. [3]	3
27.	ELISA stands for Enzyme-Linked Immunosorbent Assay. It is based on the principle of antigen-antibody interaction: the presence of a pathogen (antigen) or antibodies against it in a sample is detected using an enzyme-linked antibody or antigen, which produces a measurable colour change upon reacting with a substrate. It can be used to detect infections such as HIV (by detecting antibodies produced against the virus) and to test for pregnancy (by detecting hCG) or other conditions where a specific antigen or antibody needs to be identified. [3]	3
28.	A. A broad-based pyramid (1970) indicates a rapidly growing population with a high proportion of young individuals. A bell-shaped pyramid (2020) indicates a stable, moderately growing population with balanced age distribution. An urn-shaped pyramid (projected 2070) indicates a declining population, with a greater proportion of older individuals than younger ones. B. The projected shift toward an urn-shaped pyramid suggests the country's population may shrink in the coming decades, with an ageing population and a shrinking workforce relative to dependents, unless birth rates rise or immigration compensates. [3]	3

SECTION D		
29.	A. In species Q (normal sexual reproduction, monosporic development), a single embryo sac develops per ovule, and it contains one egg cell (along with synergids, polar nuclei and antipodal cells). [1] B. (i) Species P shows polyembryony (embryos developing from diploid nucellar tissue without fertilisation, i.e. apomixis/adventive embryony). These embryos will be genetically identical to each other and to the maternal parent, since they arise mitotically from the same diploid maternal tissue without any fertilisation or genetic recombination. [1] (ii) The embryonic cells in this case are diploid (2n), since they originate directly from the diploid nucellar tissue rather than from a fertilised haploid gamete. [1] C. Species R is parthenocarpic, since its ovary develops into a fruit without fertilisation ever taking place, resulting in a seedless fruit. [1] OR D. Species R is a 'false fruit' (in the sense that it forms without normal fertilisation), OR if referring to Q vs R for thalamus-based development: Species S (in the original set) would be the false fruit since its edible part develops from the thalamus rather than the ovary; between Q and R specifically, Q develops from the ovary after normal fertilisation and is therefore a true fruit, while R (parthenocarpic, seedless) is best regarded as an atypical/false developmental case since it forms without fertilisation. [1]	4
30.	A. Colostrum-derived immunity is passive immunity (ready-made antibodies transferred from mother to calf), while the calf's own rising antibody levels represent active immunity (produced by the calf's own immune system after its own exposure to antigens). [1] B. The vaccine would be expected to trigger an active immune response (the calf's immune system would begin producing its own antibodies against the vaccine antigen). However, its effectiveness may be limited at day 3 because high levels of maternal (passive) antibodies still circulating in the calf's blood may neutralise the vaccine antigen before the calf's own immune system can mount a strong response, and because the calf's immune system is still immature at this early stage. [2] C. Colostrum-derived (passive) immunity shows a declining trend over time, because these antibodies are not being replenished by the calf's own immune system and are gradually broken down/cleared from circulation. [1] OR D. The calf's own antibody-mediated (active) immunity takes time to rise because it must first be exposed to antigens and then activate and expand specific B-lymphocyte populations to produce antibodies — a process that takes days rather than being immediately available at birth. [1]	4

SECTION E		
31.	A. Template strand (3'→5'): T A C G G A T C C G T A. The mRNA is synthesised complementary and antiparallel to this template, using U in place of T: mRNA (5'→3'): A U G C C U A G G C A U (Reading the template 3'→5' as TACGGATCCGTA, the complementary mRNA synthesised 5'→3' is AUGCCUAGGCAU.) Eukaryotic transcription is more complex because: (i) the primary transcript (hnRNA) must undergo splicing to remove non-coding introns and join together the coding exons before it can function as mature mRNA; (ii) the transcript also undergoes capping (addition of a modified guanosine cap at the 5' end) and tailing (addition of a poly-A tail at the 3' end), both of which protect the mRNA and	5

	assist in its export and translation — none of which occur in prokaryotic transcription. [5] OR B. Aminoacylation (charging) of tRNA is the process by which a specific amino acid is attached to its corresponding tRNA molecule, catalysed by the enzyme aminoacyl-tRNA synthetase, using energy from ATP. This 'charged' tRNA then delivers its amino acid to the ribosome during translation, where the anticodon of the tRNA pairs with the corresponding codon on the mRNA, ensuring the correct amino acid is added to the growing polypeptide chain. Ribosomes act as the site of protein synthesis: the small subunit binds mRNA and helps in codon reading, while the large subunit contains the peptidyl transferase site where peptide bonds are formed between successive amino acids; the ribosome moves along the mRNA, translating each codon in sequence until a stop codon is reached. [5]	
32.	A. (i) Agrobacterium tumefaciens (bacterial) naturally transfers a portion of its Ti plasmid into plant cells, and is used as a vector to introduce foreign genes into plants. Bacteriophages/viruses such as lambda phage or engineered viral vectors are used to introduce foreign DNA into bacterial or animal cells, exploiting the virus's natural ability to inject its genetic material into a host cell. [2] (ii) Restriction enzymes (to cut DNA at specific sites) and DNA ligases (to join/seal DNA fragments together) are the essential enzyme categories needed. [1] (iii) The farmer can plant Bt cotton, a genetically modified crop carrying a gene from the bacterium Bacillus thuringiensis. This gene codes for a Bt toxin protein; when the lepidopteran pest ingests plant tissue containing this protein, it is converted in the insect's alkaline gut into its active, toxic form, which binds to the gut epithelium, causing cell lysis and killing the pest larva, without the farmer needing to apply any external pesticide. [2] OR B. (i) EcoRI site: 5'-GAATTC-3' / complementary 3'-CTTAAG-5'. Reading the complementary strand 5'→3' gives GAATTC again — identical to the original strand read 5'→3', confirming the sequence is a palindrome. [2] (ii) EcoRI cuts between the G and A on both strands (at the same relative position), leaving short single-stranded overhangs ('sticky ends') with complementary sequences (AATT overhangs) on each fragment, which can base-pair with any other DNA fragment cut by the same enzyme. [1] (iii) If foreign DNA is successfully inserted at this restriction site within the tetracycline-resistance gene (in the case of pBR322-type plasmids) or the relevant resistance gene, that gene is disrupted (insertional inactivation). The transformant would then lose resistance to the antibiotic whose gene was disrupted, while remaining resistant to the other antibiotic marker (e.g. ampicillin) — allowing recombinants to be identified by their differential growth on the two antibiotics. [2]	5
33.	A. (i) Competition is not limited to closely related species; e.g. flamingoes and fish in the same lake compete for the same zooplankton food source despite being taxonomically very distant. (ii) Competition need not depend on a limiting resource; species can compete through interference (e.g. one species directly harming or excluding another) even when resources are not scarce. (iii) Competitive exclusion (where one species drives a competitor to local extinction) is observed in nature, e.g. the near-total displacement of the native Abingdon tortoise following the introduction of goats on the Galapagos, which out-competed the tortoises for food. (iv) Competing species may evolve mechanisms of resource partitioning to coexist rather than exclude one another, e.g. different warbler species feeding in different parts of the same tree to reduce direct competition. [5, distributed across the four points] OR B. (i) A grassland food chain (grass → grasshopper → frog → snake) illustrates the First Law of Thermodynamics because energy is never created or destroyed as it passes from one trophic level to the next — it is only transformed (from light energy fixed by grass into chemical energy in tissues, and then transferred, with some lost as heat, through each subsequent consumer). (ii) All the high-diversity regions (Ecuador, Peru, Costa Rica) lie in or near the tropics, close to the equator. Two reasons for higher amphibian diversity there: tropical regions have had a longer, more	5

	stable evolutionary time (less disrupted by glaciation) allowing more speciation to accumulate; and they offer more constant, favourable environmental conditions (higher temperature, rainfall, and productivity) that support a greater diversity of niches and food resources. [5]	