Competency Based Practice Questions

Biology - XII

Co-created by

Board of School Education Haryana
and
Educational Initiatives

HOW TO USE THIS BOOKLET

Dear Teachers and Students,

The **Board of School Education Haryana** is pleased to present the **Competency-Based Practice Questions** booklet. This resource has been thoughtfully designed to help you deepen your understanding of key concepts and enhance your problem-solving skills. It includes **50 exemplar questions** carefully aligned with the curriculum to familiarize students with the format of **Competency-Based Questions**. These questions are intended to support targeted practice and develop the skills necessary to confidently approach a variety of question types in assessments.

Best Ways for Teachers to Utilise This Resource

1. Integrate into Classroom Teaching

- Use these questions to demonstrate how theoretical concepts translate into practical applications.
- Encourage group discussions to explore reasoning and understanding of concepts taught.

2. Scaffold Student Learning

- Start with simpler questions and guide students through the thought process.
- Gradually introduce more complex questions to build confidence and familiarity.

3. Incorporate into Assessments

- Use these questions in classroom quizzes or homework to help students adapt to the format.
- Provide feedback that emphasises reasoning over correctness, encouraging students to refine their understanding.

4. Focus on Skill Development

- Highlight how these questions nurture understanding, analysis and critical thinking.
- Use student responses to identify and address misconceptions effectively.

Best Ways for Students and Parents to Utilise This Resource

1. Focus on Conceptual Understanding

- Approach each question as a way to understand *why* and *how* a concept works, rather than simply finding the correct answer.

2. Practice Purposefully

- Don’t rush—break down the question, identify the concept it addresses, and plan your approach before solving it.

3. Use Feedback to Improve

- Treat mistakes as learning opportunities. Review incorrect answers to understand *what went wrong* and *how to improve*.
- Revisit similar questions to build confidence and mastery over the topic.

Best Ways for Parents to Utilise This Resource

1. Encourage Critical Thinking

- Spend time discussing questions and concepts, asking “Why?” and “How?”.

2. Create a Positive Environment

- Celebrate effort and curiosity, not just grades.
- Help your child view mistakes as opportunities to learn and grow.

3.Collaborate with Teachers

- Stay informed about competency-based assessments through school communications.
- Share observations and work with teachers to address any concerns or challenges.

Final Message

These practice questions are an excellent opportunity to strengthen your conceptual understanding and boost your confidence in solving competency-based questions. For students, each question builds skills that will help you tackle similar challenges with ease. For teachers, this is a chance to mentor students in developing their thinking and problem-solving skills.

Start today—every effort you invest will prepare you not only for exams but for a lifetime of meaningful learning and success. Let’s make this journey toward competency-based education a meaningful and successful one!

Board of School Education, Haryana

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Sexual Reproduction in Flowering Plants

<table>
<tr><th>Q.No.</th><th>Question</th><th>Marks</th></tr>
<tr><td>1</td><td>In a rose plant, the embryonic sac develops from a single megasporangium through a series of cellular divisions. Only one of the four megaspores survive to develop into the embryonic sac.

Which of the following correctly represents the ploidy of synergids in the embryo sac and the type of division involved in their formation?

<table>
<tr><th>Option</th><th>ploidy</th><th>type of cell division</th></tr>
<tr><td>A</td><td>n/2</td><td>mitosis</td></tr>
<tr><td>B</td><td>n/2</td><td>meiosis</td></tr>
<tr><td>C</td><td>n</td><td>mitosis</td></tr>
<tr><td>D</td><td>n</td><td>meiosis</td></tr>
</table>

[Skill: Understanding]</td><td>1</td></tr>
<tr><td>2</td><td>In artificial hybridization experiments, bagging is a technique used to prevent pollination in which type of flowers?

[Skill: Understanding]</td><td>1</td></tr>
<tr><td>3</td><td>Which pollination mechanism—xenogamy, geitonogamy, or autogamy—has an evolutionary advantage over the others, and why? Discuss the disadvantage of the other two mechanisms in your answer.

[Skill: Understanding]</td><td>2</td></tr>
<tr><td>4</td><td>(a) Double fertilisation is an important process in flowering plants.

(i) What would happen if the synergids were non-functional? How would this affect fertilisation in flowering plants?

(ii) If the second male gamete does not fuse with the polar nuclei, how will it affect seed development? Give a reason for your answer.

(b) In some Citrus varieties, both apomixis and fertilisation can occur.

(i) In apomixis, the zygote is formed after several mitotic divisions from a diploid cell from the tissue surrounding the embryo sac. What would be the ploidy of the embryo formed? Justify.

(ii) Sometimes, fertilisation of polar nuclei and the male gamete occurs to form the endosperm which nourishes the apomictic embryo. What would be the ploidy of the endosperm? Justify.

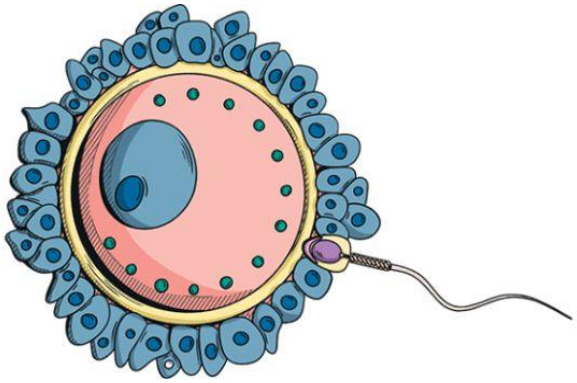
[Skill: Application]</td><td>1+1+

1.5+1.5</td></tr>
</table>

Marking Scheme

Q No.	Rubric	Marks
1	**Correct Answer:** C The synergids in the embryo sac are haploid (n) because they originate from the functional megaspore, which is haploid after meiosis. The functional megaspore undergoes three rounds of mitosis to form the mature embryo sac, which includes the synergids, antipodal cells, egg cell, and polar nuclei, all of which are known to be haploid (n).	1
	A: Students may have missed that the ploidy n/2 implies a reduction in chromosome number, which is not possible through mitosis. Mitosis maintains the existing ploidy of the cell. Synergids, just like haploid egg cells or polar nuclei, are formed from the haploid functional megaspore, so their ploidy cannot be n/2.	
	B: Students choosing this may have missed that the cells in the embryo sac are formed by mitotic divisions and not meiotic.	
	D: Students choosing this may have missed that the cells in the embryo sac are formed by mitotic divisions and not meiotic.	
2	All types of flowers. OR Both unisexual and bisexual flowers.	1
3	• Xenogamy. *[0.5 marks]* • It introduces genetic variation by transferring pollen from one plant to the stigma of a different plant. *[0.5 marks]* • Autogamy involves self-pollination within the same flower where there is no exchange of genetic material, leading to complete genetic uniformity. *[0.5 marks]* • Geitonogamy involves a pollinating agent, but it is similar to autogamy since the pollen grains come from the same plant. *[0.5 marks]* **OR** • Both autogamy and geitonogamy involve the transfer of pollen within the same parent plant leading to lesser chances to variation. *[1 mark]* *[Accept any other valid answer.]*	2
4	(a.i) 0.5 marks each for the following: • If the synergids were non-functional, the pollen tube would not be guided to the embryo sac/towards the egg. • In the absence of synergids, fertilisation may not occur.	1
	(a.ii) 0.5 marks for each of the following: • The primary endosperm nucleus (PEN) will not develop. • Without endosperm, the seed will lack the required nutrients, resulting in poor or no seed development.	1
	(b.i) • 2n/diploid *[0.5 marks]* • Since the embryo is formed after mitotic divisions of a diploid cell, the chromosome number would not reduce. *[1 mark]*	1.5
	(b.ii) • 3n/triploid *[0.5 marks]* • Endosperm formation by fertilisation involves fusion of the two polar nuclei (each haploid, n) with one haploid male gamete (n). *[1 mark]*	1.5

Human Reproduction

Q.No.	Question	Marks
5	The question below consists of two statements, Assertion (A) and Reason (R). Assertion (A): The placenta acts as an endocrine gland during pregnancy. Reason (R): Hormones secreted by the placenta ensure the maintenance of the uterine lining and regulate fetal growth. Answer the question by 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. ***[Skill: Mechanical]***	1
6	State whether the following statements are true or false and give a reason to support your answer. (a) The follicle stimulating hormone is found only in females as it is required to trigger ovulation. (b) Primary spermatocytes have a chromosome number of 23 as they are formed by mitosis from spermatogonia. ***[Skill: Understanding]***	1+1
7	(a) "Division in oogenesis occurs in different stages of a female's lifetime." Is this statement correct? Justify your answer. (b) What happens to the polar bodies formed in the process and why? ***[Skill: Understanding]***	2+1
8	The image below shows a key stage in human reproduction.  (a) Where does this stage occur (exact location) in the human body? (b) Explain the role of the hormone that peaks after this stage (in case it is a success). (c) What is the effect of the success and failure of the stage shown above on the menstrual cycle? ***[Skill: Understanding]***	1+1+2

Marking Scheme

Q No.	Rubric	Marks
5	**Correct Answer:** A The placenta secretes hormones like human chorionic gonadotropin (hCG), progesterone, and estrogen which are essential for maintaining the uterine lining and supporting fetal growth. Since these hormones directly support the uterine lining and fetal development, R is the correct explanation for A.	1
	B: Students choosing this may have missed that the reason directly justifies why the placenta is called an endocrine gland, as its hormone production aligns with its endocrine function.	
	C: Students choosing this may have missed that the hormones secreted by the placenta (e.g., hCG and progesterone) ensure uterine lining maintenance and fetal growth regulation.	
	D: Students choosing this may have missed that the placenta does act as an endocrine gland during pregnancy as it secretes hormones to maintain the pregnancy.	
6	(a) False. *[0.5 marks]* FSH is present in males as well where it stimulates the Sertoli cells, in the testes, thereby supporting spermatogenesis. *[0.5 marks]* (b) False. *[0.5 marks]* Primary spermatocytes have 46 chromosomes as they are formed by mitotic division of spermatogonia which have 46 chromosomes. *[0.5 marks]*	2
7	(a) 0.5 marks for each of the following: • Yes, the statement is correct. • It begins during fetal development, but the primary oocytes are arrested at meiosis I until puberty. • After puberty, one oocyte resumes meiosis each menstrual cycle and completes the first meiotic division, producing a secondary oocyte and a polar body. The secondary oocyte begins meiosis II but halts (at metaphase II). • After fertilisation the second meiotic division is completed, forming the ovum and another polar body.	2
	(b) 0.5 marks for each of the following: • They degenerate. • Polar bodies are by-products of unequal cytoplasmic division and do not have cytoplasm to survive.	1
8	(a) This stage occurs in the ampullary region *[0.5 marks]* of the fallopian tube *[0.5 marks]* in the female reproductive system.	1
	(b) Progesterone plays a crucial role in maintaining the uterine lining and preventing menstruation, thus supporting the early stages of pregnancy. *[Accept any other valid answer.]*	1

	(c) 1 mark each for the following: • After the successful completion of fertilisation, a zygote is formed and the menstrual cycle is temporarily suspended to support pregnancy. • If fertilisation does not occur, the corpus luteum degenerates and progesterone levels drop, leading to the uterine lining shedding or menstruation.	2

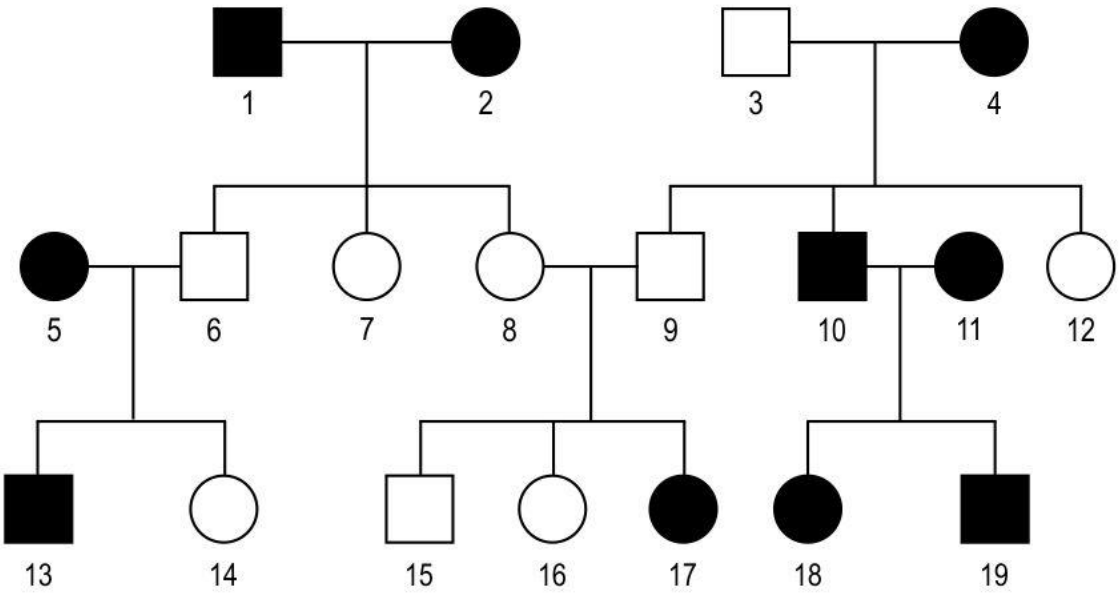
Reproductive Health

Q.No.	Question	Marks
9	Which of the following statements is correct regarding mortality rates (MR)? (A) A high MR in infants reflects poor healthcare and inadequate prenatal care. (B) A high MR for mothers indicates better maternal healthcare and lower risk during childbirth. (C) A low MR for mothers indicates a lack of access to skilled birth attendants and essential prenatal care. (D) A low MR in infants is solely due to advancements in neonatal care and is not influenced by maternal health. ***[Skill: Understanding]***	1
10	If a female undergoes tubectomy, the process of _____ is interrupted. ***[Skill: Mechanical]***	1
11	A couple is considering birth control methods and wants to avoid hormonal side effects. They also want this method to provide protection against sexually transmitted infections (STIs). Which birth control method can be recommended to this couple, and why? ***[Skill: Understanding]***	2
12	A couple has been trying to conceive for the past three years without success. After a detailed medical examination, the woman is diagnosed with blocked fallopian tubes, while the man has a normal sperm count but reduced motility. A friend of the couple suggests the couple should undergo IUI or ZIFT. (a) Is the advice of the friend correct? Justify your answer. (b) Suggest another method of assisted reproductive technology (ART) that would be most suitable for this couple. Justify. (c) State any one disadvantage of using the ART method identified. ***[Skill: Application]***	2.5+1.5 +1

Marking Scheme

Q No.	Rubric	Marks
9	**Correct Answer:** A High infant mortality rate typically reflects poor healthcare for infants, inadequate prenatal care, and high birth complications.	1
	B: Students choosing this may have missed that a high MMR reflects poor maternal healthcare, not better care.	
	C: Students choosing this may have missed that a low MR in mothers indicates improvements in access to skilled birth attendants, not a lack of them.	
	D: Students choosing this may have missed that a low MR for infants can be influenced by both neonatal care and improvements in maternal health.	
10	fertilisation	1
11	1 mark for each of the following: • The recommended birth control method for the couple is the use of condoms. • Condoms are non-hormonal and provide dual benefits: they prevent pregnancy and offer protection against sexually transmitted infections (STIs).	2
12	(a) • No, the advice is not correct *[0.5 marks]* • IUI: This method is unsuitable for the couple because the woman has blocked fallopian tubes and IUI relies on the natural process of fertilization in the fallopian tubes, which cannot occur if the tubes are blocked. *[1 mark]* • ZIFT: Zygote Intra-Fallopian Transfer (ZIFT) involves fertilizing the egg outside the body and transferring the zygote into the fallopian tube which won't be possible since both tubes are blocked. *[1 mark]*	2.5
	(b) • IVF (In Vitro Fertilization) is the most suitable option. *[0.5 marks]* • It bypasses the fallopian tubes entirely by fertilising the egg outside the body and transferring the embryo directly into the uterus. This method addresses both the blocked tubes and slightly reduced sperm motility. *[1 mark]*	1.5
	(c) 1 mark for any one disadvantage as follows: • The high financial cost can make this treatment inaccessible to many couples. • It may involve emotional stress and physical discomfort for the woman undergoing hormonal treatments and procedures. *[Accept any other valid answer.]*	1

Principles of Inheritance and Variation

Q.No.	Question	Marks
13	A pea plant with purple flowers (dominant trait) is crossed with a plant having white flowers (recessive trait). The offspring show a 1:1 ratio of purple to white flowers. Based on this, what is the genotype of the purple-flowered plant likely to be? (A) only homozygous (B) only heterozygous (C) either homozygous or heterozygous (D) (Cannot be determined.) ***[Skill: Understanding]***	1
14	(a) State ONE way in which sex determination in humans different from sex determination in birds. (b) Why are genes present on two different chromosomes not inherited together? ***[Skill: Mechanical]***	1+1
15	Shown below is the pedigree of a family. The dark coloured circles/squares indicate those individuals are suffering from a disease caused by a single trait.  From the pedigree, identify whether the trait causing the disease is: (a) autosomal or X-linked (b) dominant or recessive Justify your answers. ***[Skill: Application]***	1.5+ 1.5

16	A child with blood group O is born to parents with blood groups A and B. Based on this information, (a) Determine the possible genotypes of the parents. (b) What other blood groups could their future children inherit, and in what ratio? Draw a Punnett square to support your answer. ***[Skill: Understanding]***	1+3

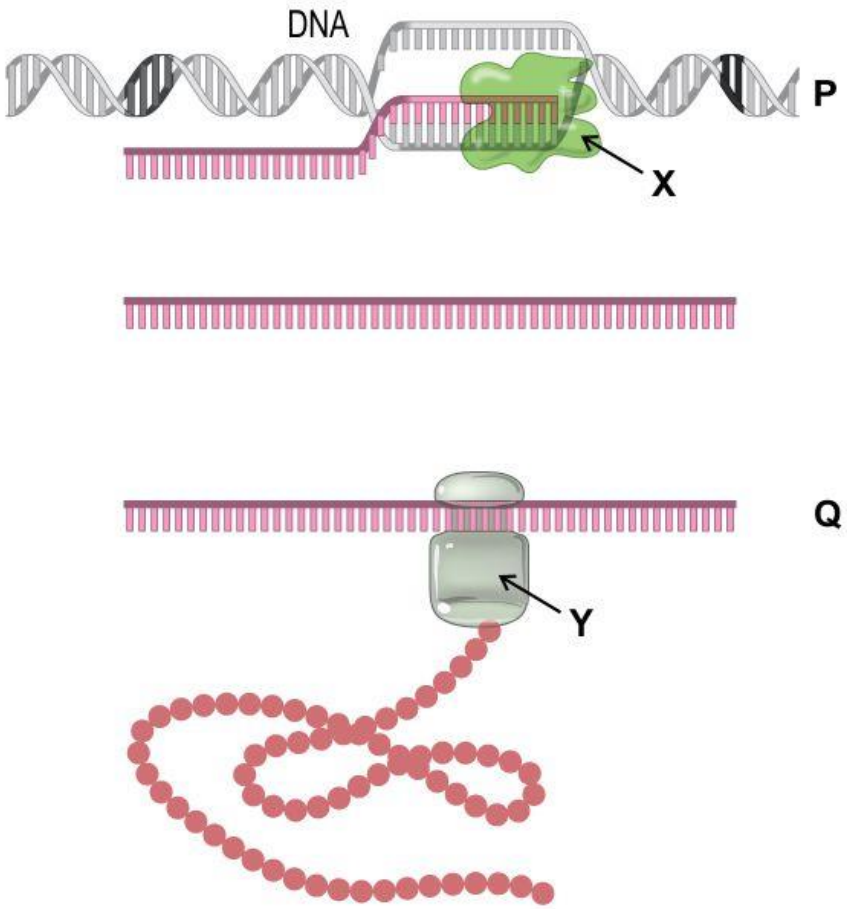
Marking Scheme

Q No.	Rubric	Marks
13	**Correct Answer:** B A test cross involves crossing an individual showing the dominant phenotype with a homozygous recessive individual. If the dominant individual is heterozygous, the offspring will exhibit a 1:1 phenotypic ratio (50% dominant trait, 50% recessive trait). In this case, the 1:1 ratio of purple to white flowers confirms that the purple-flowered plant has the genotype Pp.	1
	A: Students choosing this may have missed that if the purple-flowered plant were homozygous dominant, all offspring would inherit at least one dominant allele, leading to 100% purple flowers. A 1:1 ratio of purple to white flowers cannot occur because the recessive phenotype would not appear in the offspring.	
	C: Students choosing this may have missed that if the purple-flowered plant were homozygous dominant, all offspring would inherit at least one dominant allele, leading to 100% purple flowers. A 1:1 ratio of purple to white flowers cannot occur because the recessive phenotype would not appear in the offspring.	
	D: Students choosing this may have missed that the genotype can be determined because the phenotypic ratio of the offspring is provided. A 1:1 ratio of purple to white flowers in a test cross is a clear indicator of a heterozygous genotype for the dominant parent.	
14	(a) In humans, the male is heterogametic determines the sex of the offspring, as the father can contribute either an X or a Y chromosome whereas in birds, the female, being heterogametic, determines the sex of the offspring, as the mother can contribute either a Z or a W chromosome.	1
	(b) Genes located on two different chromosomes are not linked because they assort independently during meiosis and so they cannot be inherited together.	1
15	(a) • Autosomal *[0.5 marks]* • Reason: The trait appears almost equally in both males and females, as seen from the distribution of affected individuals. OR If it was X-linked, individual 4 (the mother) would surely transfer the trait to individual 9 (her son) which is not the case. *[1 mark]* (b) • Recessive *[0.5 marks]* • Reason: For unaffected parents (such as 8 and 9) to produce an affected offspring (17), the trait must be recessive, as both parents can carry the recessive allele without showing symptoms. *[1 mark]*	3
16	(a) The parent with blood group A must have the genotype I^Ai (heterozygous), and the parent with blood group B must have the genotype I^Bi (heterozygous). *[No marks to be awarded if either one is incorrect.]*	1

	(b) 1 mark for the correct Punnett square, 1 mark for the correct blood groups of offspring and 1 mark for the correct phenotypic ratio. **Punnett Square Analysis:** I^B | i I^A | I^AI^B (AB) | I^Ai (A) i | I^Bi (B) | ii (O) **Other possible genotypes:** 1. I^AI^B (AB) 2. I^Ai (A) 3. I^Bi (B) **Phenotypic Ratio:** 1 AB : 1 A : 1 B	3

Molecular Basis of Inheritance

Q.No.	Question	Marks
17	If a DNA molecule with the sequence 5'-ATGCCGTA-3' undergoes transcription, what will be the sequence of the synthesized mRNA? (A) 3'-UACGGCAU-5' (B) 5'-UACGGCAU-3' (C) 5'-AUGCCGUA-3' (D) 3'-AUGCCGUA-5' ***[Skill: Understanding]***	1
18	The question below consists of two statements, Assertion (A) and Reason (R). Assertion (A): The lac operon is fully activated when glucose levels are high. Reason (R): The presence of lactose inactivates the repressor, allowing the transcription of the lac operon genes. Answer the question by 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. ***[Skill: Understanding]***	1
19	Identify the characteristic of the genetic code that prevents the identification of the mRNA sequence from its protein sequence. ***[Skill: Understanding]***	1
20	A single strand of double-stranded DNA has 1200 bases. Strand 1 consists of 20% adenine (A) and 10% cytosine (C), while strand 2 consists of 50% cytosine (C). How many thymine (T) nucleotides will be present in the double-stranded DNA molecule? Show your calculation. ***[Skill: Application]***	3

21	Study the diagram given below and answer the following questions:  (a) Identify the processes P and Q? (b) Write the role of X and Y in the process shown in the image. (c) How are the two processes identified in (a) regulated? (d) Justify why this regulation is required. ***[Skill: Mechanical]***	1+1+ 2+1

Marking Scheme

Q No.	Rubric	Marks
17	**Correct Answer:** C The complementary base-pairing rules (A pairs with U, G pairs with C) produce the sequence AUGCCGUA. Since the coding strand sequence is provided, so the mRNA strand is written as 5'-AUGCCGUA-3'.	1
	A: Students choosing this may have missed that the mRNA is synthesised in the 5' to 3' direction which means the template strand is 3’ to 5’.	
	B: Students choosing this may have missed that even though the direction is correct, the mRNA synthesised won’t be complementary to the sequence provided as the coding strand sequence is provided.	
	D: Students choosing this may have understood that the sequence will be the same (with a change of T to U) as the coding strand (provided) but may have missed the direction in which synthesis will occur.	
18	**Correct Answer:** D The assertion is incorrect. The operon is not fully active in the presence of glucose, but in the presence of lactose. The reason is correct because lactose inactivates the repressor and allows transcription.	1
	A: Students choosing this may have missed that the assertion is incorrect. Even though the reason is correct, it doesn't explain the assertion because the assertion itself is wrong.	
	B: Students choosing this may have missed that the assertion is incorrect. The reason is correct.	
	C: Students choosing this may have missed that the assertion is incorrect. The assertion that the lac operon is activated when glucose levels are high is not correct. It is active only when glucose levels are low and lactose is available.	
19	Degeneracy	1
20	• Strand 1 consists of 20% adenine (A), so strand 2 must have 20% thymine (T) because A pairs with T. *[0.5 marks]* • Strand 1 also has 10% cytosine (C), so strand 2 must have 10% guanine (G) because C pairs with G. *[0.5 marks]* • Strand 2 consists of 50% cytosine (C), so strand 1 must have 50% guanine (G) because C pairs with G. *[0.5 marks]* • Since, strand 1 has 20% adenine (A), 10% cytosine (C) and 50% guanine (G), it will have 20% thymine (T). *[0.5 marks]* Thus, the total percentage of thymine in the double-stranded DNA molecule is: 20%+20%=40% Since the total number of bases is 1200: 40%×1200=480 thymine nucleotides, So, the double-stranded DNA molecule contains 480 thymine nucleotides. *[1 mark]* *[Accept any other valid way of arriving at the correct answer.]*	3

21	(a) 0.5 marks for each of the following: Process P: transcription Process Q: translation	1
	(b) 0.5 marks for each of the following: X: RNA polymerase synthesises the mRNA from the DNA template during transcription. Y: Ribosome facilitates the assembly of amino acids into a polypeptide chain using the mRNA template during translation.	1
	(c) 1 mark for each of the following: • Transcription regulation involves controlling the binding of RNA polymerase to the DNA template through promoters, terminators, transcription factors, enhancers, and repressors, determining when and how much mRNA is produced. • Translation regulation controls the initiation, elongation, or stability of mRNA, often influenced by regulatory proteins or ribosome availability, to modulate protein synthesis. *[Accept any other valid answer.]*	2
	(d) Since the processes are energetically expensive, regulation prevents wastage of energy and resources. *[Accept any other valid answer.]*	1

Evolution

Q.No.	Question	Marks
22	The presence of vestigial organs, such as the human appendix, provides evidence for: (A) convergent evolution (B) common ancestry (C) natural selection (D) co-evolution ***[Skill: Understanding]***	1
23	The process of evolution of different species in a given geographical area starting from a point and spreading to other habitats is called _____. ***[Skill: Mechanical]***	1
24	In a population of frogs living in a wetland, their skin colour ranges from bright green to dark brown. Over time, dark brown frogs have become more common because they are better camouflaged against the muddy, dark environment of the wetland floor. Green frogs, which stand out more against the dark surroundings, are more easily spotted by predators, leading to a decrease in their population. As a result, the population of frogs is now predominantly dark brown. Based on the scenario, explain which type of natural selection (stabilizing, directional, or disruptive) is occurring in this frog population. Justify your answer. ***[Skill: Application]***	2
25	In a study of two species of animals, species X and species Y, researchers find that both species have evolved to develop flippers to swim. Species X, an aquatic mammal, and species Y, an aquatic reptile, use the flippers to swim. (a) What type of evolution is seen in the case above? Justify your answer. (b) Can the flippers in these species be considered homologous or analogous? Justify your answer. (c) Can the evolution of similar traits in species X and Y above be considered an example of adaptive radiation? Justify your answer. ***[Skill: Application]***	1.5+1 +1.5

Marking Scheme

Q No.	Rubric	Marks
22	**Correct Answer:** B Vestigial organs are remnants of structures that were functional in an ancestor but have lost their original function in the current organism. This indicates evolutionary links and provides evidence of common ancestry. For example, the human appendix is thought to be a small remaining part of a larger cecum used for digesting cellulose in herbivorous ancestors.	1
	A: Students choosing this may have missed that convergent evolution refers to unrelated species evolving similar traits due to similar environmental pressures (e.g., wings of bats and birds). Vestigial organs are not related to convergent evolution.	
	C: Students choosing this may have missed that while natural selection explains survival of advantageous traits, vestigial organs represent structures that are no longer advantageous but persist due to lack of selective pressure against them.	
	D: Students choosing this may have missed that co-evolution involves the mutual evolutionary influence between two interacting species, such as bees and flowering plants. Vestigial organs are unrelated to such interactions.	
23	Adaptive radiation	1
24	• The type of natural selection occurring in the frog population is directional selection. *[1 mark]* • In directional selection, one extreme phenotype (in this case, dark brown frogs) becomes more favourable and increases in frequency, while the other extreme phenotype (bright green frogs) decreases in frequency. *[1 mark]*	2
25	(a) • Convergent evolution *[0.5 marks]* • Species X and Y, despite having different evolutionary ancestors, have developed flippers as a result of adapting to similar functional needs (swimming), indicating convergent evolution. *[1 mark]*	1.5
	(b) • The similar forelimb structure in these species can be considered analogous. *[0.5 marks]* • Though the flippers of species X and Y serve the same function of swimming, they are not inherited from a common ancestor - one is from a mammalian ancestor while another from a reptilian. *[0.5 marks]*	1
	(c) • No, the evolution of similar traits in the species above cannot be considered an example of adaptive radiation. *[0.5 marks]* • Adaptive radiation occurs when a single species diversifies into multiple species, each adapted to different ecological niches. *[0.5 marks]* • In this case, species X and Y are two separate species, living in aquatic habitats, and their similar traits have evolved independently. *[0.5 marks]*	1.5

Human Health and Disease

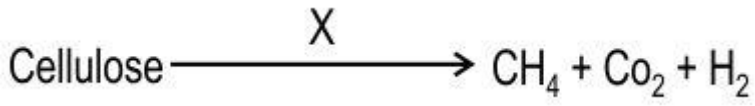
Q.No.	Question	Marks
26	Which of the following is INCORRECT regarding autoimmunity? (A) Autoimmune diseases can affect multiple organs in the body. (B) Autoimmune diseases are caused by a loss of immune tolerance. (C) Autoimmune diseases are primarily caused by external pathogens only. (D) Autoimmune diseases are due to the immune system's failure to distinguish self from non-self. ***[Skill: Understanding]***	1
27	The exaggerated response of the immune system to certain antigens present in the environment is called_____. ***[Skill: Mechanical]***	1
28	A child is diagnosed with a weakened immune system. After conducting various tests, it is found that his thymus is not functioning properly, and his lymph nodes are less effective at trapping pathogens. (a) Explain the role of the thymus in immune function and how its dysfunction could affect the child's immune response. (b) How would the malfunction of the lymph nodes impact the child's ability to defend against infections? (c) Could other lymphoid tissues, such as MALT, compensate for these deficiencies in the child's immune system? Explain. ***[Skill: Understanding]***	1+1+1
29	Consider the following scenarios and answer the question that follows: (a) A patient receives a blood transfusion from a healthy individual. (b) When pathogens such as bacteria invade the body, macrophages actively detect, engulf, and destroy these pathogens. Identify whether the type of immunity involved is (i) active or passive (ii) acquired or innate Provide a justification for your answer. ***[Skill: Understanding]***	2+2

Marking Scheme

Q No.	Rubric	Marks
26	**Correct Answer:** C Autoimmune diseases occur when the body's immune system mistakenly attacks its own cells and tissues. While infections or other environmental factors can trigger autoimmune responses, autoimmune diseases are not primarily caused by external pathogens. Instead, they are a result of the immune system malfunctioning and attacking the body itself.	1
	A: Students choosing this may have missed that this is a correct statement. Many autoimmune diseases, such as lupus or multiple sclerosis, can affect multiple organs in the body. These diseases can target various tissues and organs like the skin, joints, kidneys, and nervous system.	
	B: Students choosing this may have missed that this is a correct statement. Autoimmune diseases occur when the body's immune system loses its ability to distinguish between "self" and "non-self." This loss of immune tolerance leads to the immune system attacking the body's own cells, tissues, or organs, mistaking them for harmful pathogens.	
	D: Students choosing this may have missed that this is a correct statement. Autoimmune diseases occur when the immune system loses the ability to recognize the body's own cells (self) from foreign cells (non-self). This failure to differentiate self from non-self, results in the immune system attacking the body's own tissues.	
27	allergy	1
28	(a) 0.5 marks for each of the following: • The thymus plays a critical role in the maturation of T-lymphocytes, which are essential for adaptive immunity. • If the thymus is not functioning properly, the child's T-cells may not develop properly, leading to a weakened immune response to infections. *[Accept any other valid answer.]*	1
	(b) 0.5 marks for each of the following: • Lymph nodes are responsible for trapping pathogens and activating lymphocytes. • If the lymph nodes are less effective, the child may have difficulty mounting an immune response to pathogens, making him more susceptible to infections. *[Accept any other valid answer.]*	1
	(c) 0.5 marks for each of the following: • MALT, which is located in mucosal linings of the respiratory, digestive, and urogenital tracts, can still contribute to immune defense by activating B-cells and trapping pathogens. • Although it may partially compensate for some functions, as it occupies 50% of lymphoid tissue in the body, it cannot fully replace the roles of the thymus and lymph nodes in immune defense.	1
29	(a) 0.5 marks for each of the following: • passive • acquired • In a blood transfusion, antibodies present in the donor's blood (especially in plasma or certain blood products) are passively transferred to the recipient which can help in fighting infections.	2

	• It is acquired immunity as the healthy individual would have developed antibodies against certain pathogens that they were exposed to. *[Accept any other valid justification.]*	
	(b) 0.5 marks for each of the following: • active • innate • This is an active response by the body's immune system, where these cells recognize and react to pathogens, and mount a response. • This is part of the innate immunity system as these cells do not need prior exposure to the pathogen to carry out the response as it is non-specific in nature. *[Accept any other valid justification.]*	2

Microbes in Human Welfare

Q.No.	Question	Marks
30	The question below consists of two statements, Assertion (A) and Reason (R). Assertion(A): Antibiotics are chemical substances produced by some microbes that can kill or inhibit the growth of disease-causing microbes. Reason (R): Antibiotics work by stimulating the immune system to fight off infections caused by bacteria. Answer the question by 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. ***[Skill: Understanding]***	1
31	Microorganism X is used to carry out the following reaction:  Identify X. ***[Skill: Understanding]***	1
32	Sita wants to make curd at home. She boiled the milk and let it cool to room temperature. Later she kept it aside in a warm place for 6-8 hours. However, the milk did not set into curd. What did Sita miss? Justify your answer. ***[Skill: Understanding]***	2
33	A sewage treatment plant in a city is struggling with high organic waste loads, causing frequent blockages and incomplete treatment of sewage. To address the issue, the city plans to upgrade its primary and secondary treatment systems. (a) Explain how the primary treatment step reduces the load on secondary treatment. (b) What is the role of aerobic microbes in reducing the BOD of wastewater during secondary treatment? (c) Predict the impact on the environment if the effluent from the secondary treatment is released into natural water bodies without sufficient reduction in BOD. (d) Suggest any TWO improvements the city could make to prevent blockages and ensure efficient treatment. ***[Skill: Understanding]***	1+1+1 +2

Marking Scheme

Q No.	Rubric	Marks
30	**Correct Answer:** C The assertion (A) is true because antibiotics are indeed produced by some microbes and can inhibit or kill disease-causing microbes. However, the reason (R) is false because antibiotics do not stimulate the immune system directly; they act by targeting the bacteria themselves, not by boosting immune responses.	1
	A: Students choosing this may have missed that the correct mechanism of antibiotics is that they directly act on bacteria (e.g., inhibiting cell wall synthesis or protein production), and not by stimulating the immune system.	
	B: Students choosing this may have missed that the correct mechanism of antibiotics is that they directly act on bacteria (e.g., inhibiting cell wall synthesis or protein production), not by stimulating the immune system.	
	D: Students choosing this may have missed that the assertion (A) is true because antibiotics are indeed produced by some microbes and can inhibit or kill disease-causing microbes. But the reason (R) is false as the correct mechanism of antibiotics is that they directly act on bacteria (e.g., inhibiting cell wall synthesis or protein production), not by stimulating the immune system.	
31	X is Methanogen/Methanobacterium	1
32	• Sita missed adding a small amount of starter curd (which contains *Lactobacillus* bacteria). *[1 mark]* • The process of making curd requires the presence of lactic acid bacteria (LAB), such as *Lactobacillus*, that are responsible for fermenting the lactose in milk, converting it into lactic acid. *[0.5 marks]* • The lactic acid causes proteins in milk to coagulate, turning the milk into curd. *[0.5 marks]*	2
33	(a) The primary treatment removes large particles, such as debris, grit, and suspended solids, through filtration and sedimentation. This reduces the inorganic load on the secondary treatment, allowing the biological processes to function more efficiently.	1
	(b) Aerobic microbes grow in aeration tanks, forming flocs that use oxygen to metabolize and break down the organic material, reducing the BOD of the effluent.	1
	(c) If effluent with high BOD is released into natural water bodies, it can lead to oxygen depletion, harming aquatic life. OR High organic content can promote excessive microbial growth, resulting in eutrophication, algal blooms, and eventual ecosystem degradation.	1
	(d) 1 mark each for two methods suggested. • The city could install pre-treatment screens or grit removal mechanisms to prevent large debris from entering the system. • Additionally, increasing aeration efficiency in the secondary treatment tanks could enhance microbial activity and improve overall treatment efficiency. *[Accept any other valid answer.]*	2

Biotechnology: Principles and Processes

Q.No.	Question	Marks
34	The question below consists of two statements, Assertion (A) and Reason (R). Assertion (A): Restriction enzymes are essential tools in recombinant DNA technology. Reason (R): Bacteria that produce restriction enzymes use them as a defense mechanism against bacteriophage infections. Answer the question by 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. ***[Skill: Understanding]***	1
35	X was the fourth restriction enzyme to be isolated from the M strain of *Neisseria gonorrhoeae*. The name of enzyme X would be _____. ***[Skill: Understanding]***	1
36	A scientist is performing gel electrophoresis to separate DNA fragments after cutting the DNA with restriction endonucleases. The following steps were performed: 1. Agarose gel was prepared with ethidium bromide. 2. DNA fragments were loaded in the wells. 3. The gel was run for 45 minutes under an electric field. 4. After the run, the bands were observed under visible light. The scientist could not observe the bands. Where did the scientist go wrong, and what change should be made to improve the results? ***[Skill: Understanding]***	2

37	(a) A group of scientists is trying to clone a gene of interest into a plasmid vector to express the gene in *Escherichia coli*. They are using a plasmid vector, which contains two antibiotic resistance genes: one for kanamycin and one for tetracycline. The scientists insert the gene of interest at the restriction site within the tetracycline resistance gene. Some cells, however, would have the plasmid inserted without the gene of interest. After performing the transformation procedure, the scientists plate the transformed cells onto two plates - one containing only kanamycin and another containing only tetracycline. (i) On which plate will the following cells grow - cells with the plasmid containing the gene of interest, cells with the plasmid but no gene of interest, and cells without the plasmid. (ii) This plasmid has two ori sequences - one for a bacterial cell and another for a plant cell. Would this be beneficial in any situation? Justify. (b) Why is it important for a vector to have a few, preferably single, recognition sites for restriction enzymes? Explain how this feature helps in the cloning process. ***[Skill: Application]***	1.5+1.5 +2

Marking Scheme

Q No.	Rubric	Marks
34	**Correct Answer:** B Restriction enzymes are crucial in recombinant DNA technology and they are produced by bacteria that use them against bacteriophage infections. However, their use as defense mechanisms does not explain why they are important in rDNA technology.	1
	A: Students choosing this may have missed that while the assertion and reason are both true, the reason does not explain the assertion.	
	C: Students choosing this may not know that bacteria that produce restriction enzymes use them as a defense mechanism against infections. They may also be guessing.	
	D: Students choosing this may be guessing.	
35	NgoMIV	1
36	1 mark for each of the following: • The scientist went wrong in step 4, where the bands were observed under visible light. • The gel is stained with ethidium bromide and so it needs to be observed under UV light for visualising the bands.	2
37	(a.i) 0.5 marks for each of the following: • cells with the plasmid containing the gene of interest - kanamycin plate • cells with the plasmid but no gene of interest - both plates • cells without the plasmid - none of the plates	1.5
	(a.ii) • Yes *[0.5 marks]* • Having both bacterial and plant ori sequences in the plasmid makes it versatile and suitable for cloning experiments that involve both bacterial and plant cells. *[1 mark]*	1.5
	(c) 1 mark for each of the following: • Having few, preferably single, recognition sites for restriction enzymes in a vector ensures that only a single, predictable fragment of DNA is generated when the vector is cut. • This simplifies the cloning process by preventing the formation of multiple fragments, which could complicate the ligation step and lead to unwanted recombinant products.	2

Biotechnology and its Application

Q.No.	Question	Marks
38	A researcher is using a radioactive probe to detect a specific gene in a clone of cells. The probe is single-stranded DNA or RNA tagged with a radioactive molecule, which will hybridise with the complementary DNA sequence in the clone. If the target gene in a particular clone has a point mutation, what would be the likely result in the autoradiography? (A) No radioactive signal will be detected in the clone with the mutated gene or the wild-type. (B) The radioactive signal will appear in a different location on the autoradiogram for the mutated gene. (C) The radioactive signal will be weaker in the clone with the mutated gene compared to the wild-type clone. (D) The radioactive signal will be stronger in the clone with the mutated gene compared to the wild-type clone. ***[Skill: Understanding]***	1
39	A biotechnology company is working on producing disease-resistant plants. The company uses a small piece of tissue from a healthy, disease-resistant plant and grows it under sterile conditions in a nutrient medium containing sucrose, amino acids, vitamins, and plant growth regulators. Name the technique used by the company. ***[Skill: Mechanical]***	1
40	(a) Distinguish between enzyme replacement therapy and gene therapy in the context of treating genetic disorders with respect to following points: • method of treatment • duration of effect (b) Explain the approach that could potentially provide a permanent solution for treating an enzyme deficiency. ***[Skill: Understanding]***	2+1
41	(a) Which diagnostic method would be more reliable for detecting low levels of pathogen: PCR or ELISA? Justify your answer by comparing the two. (b) Justify whether the following statements are true or false: (i) RNAi works only on RNA viruses. (ii) Genetically produced human growth hormone cannot be administered orally to a patient. ***[Skill: Understanding]***	2+2

Marking Scheme

Q No.	Rubric	Marks
38	**Correct Answer:** C When a point mutation occurs in the target gene, it results in a mismatch between the probe and the mutated DNA sequence. Even a single base mismatch can reduce the stability of hybridization between the probe and the target DNA under standard conditions. This weaker binding leads to a weaker radioactive signal because fewer probes remain hybridized to the target DNA, resulting in less detectable radioactivity during autoradiography.	1
	A: Students choosing this may have missed that the wild-type gene will hybridize completely with the probe, producing a strong radioactive signal. Even for the mutated gene, hybridization can still occur (may be weakly).	
	B: Students choosing this may have missed that the mutation is a point mutation, which does not change the size or physical location of the DNA sequence. Autoradiography detects the signal at the same location as long as the probe partially or fully binds.	
	D: Students choosing this may have missed that a mutation typically causes a reduction in the hybridization efficiency of the probe, not an increase.	
39	Micropropagation/Tissue culture	1
40	(a) 1 mark for each distinguishing point • Method of Treatment: In ERT, the missing or defective enzyme is directly supplied to the patient, often via injection or infusion. On the other hand, in gene therapy, a functional copy of the defective gene is introduced into the patient's cells to restore normal function at the genetic level. • Duration of Effect: Treatment by enzyme replacement requires ongoing treatments as the effects are temporary, and the enzyme is eventually broken down by the body, whereas, treatment by gene therapy aims for a long-lasting or potentially permanent solution by modifying the patient's genetic material, leading to continuous production of the enzyme.	2
	(b) Introducing the correct gene for the enzyme at early embryonic stages could offer a permanent solution, as the correct gene would be integrated into all cells from the beginning of development, ensuring continuous production of the enzyme throughout life.	1
41	(a) • PCR is more reliable. • PCR has the ability to amplify specific DNA sequences. Even trace amounts of pathogen DNA can be detected by PCR, making it highly sensitive and capable of diagnosing infections in the early stages before symptoms appear. *[1 mark]* • ELISA detects antigens from the pathogen or antibodies produced by the host in response to infection. If the pathogen is at low levels or produces insufficient antigens, ELISA may fail to identify the infection, especially in the early stages when the immune response is minimal. *[1 mark]*	2

	(b) (i) False because RNA interference (RNAi) works by degrading specific RNA molecules, which can originate from RNA viruses as well as in the form of mRNA from DNA, preventing the translation of target proteins. *[1 mark]* (ii) True because growth hormone is a protein which, if administered orally, would be broken down by digestive enzymes in the stomach and intestines into amino acids or peptides and will not be able to function. *[1 mark]*	2

Organisms and Populations

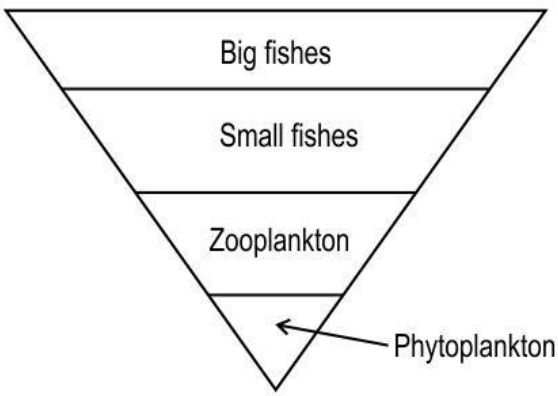
Q.No.	Question	Marks
42	Which of the following combinations of factors will most likely result in an increase in population density? (A) high natality and low mortality (B) high emigration and low natality (C) low immigration and high mortality (D) high mortality and high immigration ***[Skill: Understanding]***	1
43	Identify the type of population interaction in each scenario and justify your answer. (a) Pistol shrimps dig burrows that gobies use for shelter and breeding. Gobies have excellent eyesight which they use to spot shrimp predators and warn them in case of danger. (b) *Mycobacterium tuberculosis* bacteria cannot survive for long without a host. Its host is the human macrophage cell. (c) Cheetahs and lions hunt the same prey in the African savannah. ***[Skill: Application]***	1+1+1
44	(a) Give TWO points of difference between exponential and logistic growth patterns. (b) How would an environmental factor, such as the introduction of a predator species, affect the logistic growth of a prey population? ***[Skill: Understanding]***	2+2

Marking Scheme

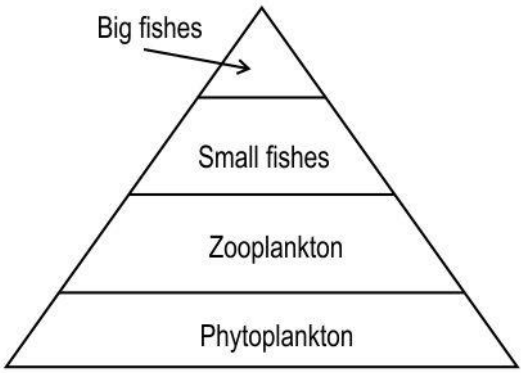
Q No.	Rubric	Marks
42	**Correct Answer:** A This combination results in an increase in population density. Natality refers to the birth rate, so high natality means more individuals are being added to the population. Low mortality means fewer individuals are dying, so the population is not decreasing. Together, these factors lead to population growth and increased density.	1
	B: Students choosing this may be guessing or may not know the meanings of the terminologies used.	
	C: Students choosing this may be guessing or may not know the meanings of the terminologies used.	
	D: Students choosing this may be guessing or may not know the meanings of the terminologies used.	
43	0.5 marks for each identification and 0.5 marks for each justification: (a) • Type of Interaction: Mutualism • The gobies are benefitted as they get shelter and food from the shrimp, whereas shrimp benefit as they receive protection from predators. (b) • Type of Interaction: Parasitic • *Mycobacterium tuberculosis* benefits by using the human body as a host to obtain nutrients and reproduce, while the human host's immune system is damaged. (c) • Type of Interaction: Competition • In this scenario, both cheetahs and lions are hunting for the same food source (prey) in the African savannah. This creates competition between the two.	3
44	(a) 1 mark each for any two differences: • In exponential growth, the population grows at a constant rate, leading to rapid increase over time, whereas, logistic growth occurs when a population's growth rate slows as it approaches the carrying capacity of its environment. • In exponential growth, the growth rate is unrestricted assuming there are unlimited resources, so no constraints limit population expansion, whereas in logistic growth, initially, the growth rate is rapid, but as resources become limited, the growth rate decreases, and the population stabilizes at the carrying capacity. • Exponential growth results in a J-shaped curve, whereas logistic growth results in an S-shaped (sigmoid) curve. *[Accept any other valid answers.]*	2

	(b) 1 mark for each of the following: • Predators decrease the number of preys, which lowers the prey population's growth rate. • The effective carrying capacity for the prey population decreases because the predator adds pressure that limits prey survival. The population may stabilize at a new, lower carrying capacity.	2

Ecosystem

Q.No.	Question	Marks
45	The question below consists of two statements, Assertion (A) and Reason (R). Assertion (A): Decomposers are a vital part of nutrient cycling in an ecosystem. Reason (R): Decomposers break down dead organic matter, releasing nutrients back into the soil for plants to use. Answer the question by 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. ***[Skill: Mechanical]***	1
46	Shown below is the pyramid of numbers in an aquatic ecosystem.  **Aquatic ecosystem** Draw the pyramid of energy for this ecosystem. Justify your answer. ***[Skill: Understanding]***	2
47	(a) Fluctuations in respiration (R) can significantly affect the relationship between GPP (Gross Primary Productivity) and NPP (Net Primary Productivity). Explain the effect of the changes in the ecosystems, given below, on the respiration rate and NPP: • in ecosystems where plants experience stress due to extreme temperatures • in dense, healthy ecosystems • in ecosystems with limited nutrients (b) Is GPP is directly proportional to NPP? Justify your answer. ***[Skill: Application]***	3+2

Marking Scheme

Q No.	Rubric	Marks
45	**Correct Answer:** A The reason (R) does explain the assertion (A) accurately. Decomposers break down dead organic matter, which directly supports why they are vital for nutrient cycling.	1
	B: Students choosing this may have missed that the reason (R) does explain the assertion (A) accurately. Decomposers break down dead organic matter, which directly supports why they are vital for nutrient cycling.	
	C: Students choosing this may have missed that the reason (R) is a correct statement. Decomposers do break down organic matter and release nutrients back into the soil for plants to use, making R true. They may also be guessing.	
	D: Students choosing this may have missed that the assertion (A) is a true statement. Decomposers are indeed vital for nutrient cycling. They may also be guessing.	
46	1 mark for drawing an upright pyramid of energy:  The pyramid of energy will always be upright *[0.5 marks]* as energy is always lost at each trophic level and lesser energy is available at higher levels. *[0.5 marks]*	2
47	(a) • In ecosystems where plants experience stress due to extreme temperatures, their respiration rates may increase as stressed plants may need more energy to maintain basic cellular functions or repair damage *[0.5 marks]*. This reduces NPP because the gap between GPP and R reduces (more energy is consumed in respiration, relative to the energy produced). *[0.5 marks]* • In dense, healthy ecosystems, the respiration rate may be high as vegetation is more. *[0.5 marks]*. This results in a higher NPP as GPP is also high due to extensive photosynthesis. *[0.5 marks]* • Ecosystems with limited nutrients may have lower GPP and respiration rate *[0.5 marks]*, leading to a significant reduction in NPP. *[0.5 marks]* *[Accept any other valid answer.]*	3
	(b) No, GPP is not directly proportional to NPP. *[0.5 marks]* GPP is the total energy fixed by plants through photosynthesis, while NPP represents the energy stored as biomass after accounting for respiration (NPP = GPP - R). *[1 mark]* Therefore, the relationship between GPP and NPP depends on the rate of respiration (R), which varies with environmental and physiological factors. *[0.5 marks]*	2

Biodiversity and Conservation

Q.No.	Question	Marks
48	In a species-area relationship graph, what does a higher Z value indicate? (A) A larger number of species in smaller areas. (B) A smaller number of species in larger areas. (C) A decrease in species diversity with increasing area. (D) A greater increase in species diversity with increasing area. ***[Skill: Mechanical]***	1
49	Species diversity _____ as we move away from the equator towards the poles. ***[Skill: Mechanical]***	1
50	The African elephant (*Loxodonta africana*) is a keystone species in the Serengeti National Park. Although the population is under threat from poaching and habitat fragmentation, there are still substantial numbers of African elephants living in their natural habitat. Which conservation technique (in-situ or ex-situ conservation techniques) would be most suitable for this scenario? Justify your answer. ***[Skill: Application]***	2

Marking Scheme

Q No.	Rubric	Marks
48	**Correct Answer:** D A higher Z value (steeper slope) in a species-area relationship graph indicates that species diversity increases at a faster rate as the area size increases.	1
	A: Students choosing this may have missed that a steeper slope (higher Z value) indicates that the number of species increases faster as the area increases. A smaller number of species would correspond to a lower slope.	
	B: Students choosing this may have missed that this is the opposite of what a steeper slope represents. A steeper slope means the rate of increase in species diversity is higher with increasing area, not lower.	
	C: Students choosing this may have missed that a steeper slope indicates greater species diversity as area increases, not a decrease.	
49	decreases	1
50	In-situ Conservation *[0.5 marks]* • In-situ conservation involves protecting the species in their natural habitat. *[0.5 marks]* • Since the African elephant is still present in significant numbers within its natural habitat, making in-situ conservation appropriate as protecting and managing their habitat, and addressing threats like poaching can help maintain the species within its natural environment. *[1 mark]*	2

Board of School Education Haryana, Bhiwani