

Ei



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# Competency Focused Practice Questions

Biology (Volume 2) | Grade 12



Co-created by  
CBSE Centre for Excellence in Assessment  
and  
Educational Initiatives

## PREFACE

Assessments are an important tool that help gauge learning. They provide valuable feedback about the effectiveness of instructional methods; about what students have actually understood and also provide actionable insights. The National Education Policy, 2020 has outlined the importance of competency-based assessments in classrooms as a means to reform curriculum and pedagogical methodologies. The policy emphasizes on the development of higher order skills such as analysis, critical thinking and problem solving through classroom instructions and aligned assessments.

Central Board of Secondary Education (CBSE) has been collaborating with Educational Initiatives (Ei) in the area of assessment. Through resources like the [Essential Concepts document](#) and [A- Question-A-Day \(AQAD\)](#), high quality questions and concepts critical to learning have been shared with schools and teachers.

Continuing with the vision to ensure that every student is learning with understanding, Question Booklets have been created for subjects for Grade 10th and 12th. These booklets contain competency-based items, designed specifically to test conceptual understanding and application of concepts.

### ***Process of creating competency-based items***

All items in these booklets are aligned to the NCERT curriculum and have been created keeping in mind the learning outcomes that are important for students to understand and master. Items are a mix of Free Response Questions (FRQs) and Multiple-Choice Questions (MCQs). In case of MCQs, the options (correct answer and distractors) are specifically created to test for understanding and capturing specific errors/misconceptions that students may harbour. Each incorrect option can thereby inform teachers on specific gaps that may exist in student learning. In case of subjective questions, each question also has a detailed scoring rubric to guide evaluation of students' responses.

Each item has been reviewed by experts, to check for appropriateness of the item, validity of the item, conceptual correctness, language accuracy and other nuances.

### ***How can these item booklets be used?***

There are 123 questions in this booklet.

The purpose of these item booklets is to provide samples of high-quality competency-based items to teachers. The items can be used to–

- get an understanding of what good competency-based questions could look like
- give exposure to students to competency-based items
- assist in classroom teaching and learning
- get inspiration to create more such competency-based items

Students can also use this document to understand different kinds of questions and practice specific concepts and competencies. There will be further additions in the future to provide competency focused questions on all chapters.

The item booklets are aligned with the 2022-23 curriculum. However, a few questions from topic which got rationalized in 2023-24 syllabus are also there in the booklet which may be used as a reference for teachers and students.

*Please write back to us to give your feedback.*

**Team CBSE**

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## 1. BIODIVERSITY AND CONSERVATION

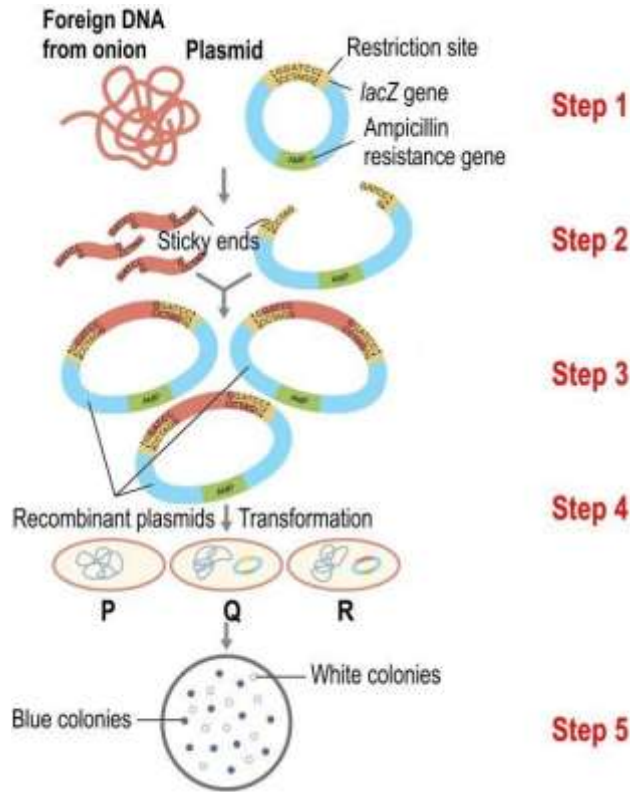
Q. No	Question	Marks
<b>Multiple Choice Question</b>		
Q.1	<p>Genetic diversity refers to the diversity in genetic makeup of organisms that are capable of interbreeding.</p> <p>What component of an ecosystem does genetic diversity DIRECTLY impact?</p> <p>A. ecosystem diversity B. species diversity C. species richness D. ecological niche</p>	1
Q.2	<p>Dr. Kirti has a patient who is diagnosed with an HIV infection. She has to test for HIV infection in the partner of the patient who has no symptoms of the infection. Which of these methods can be used to diagnose the infection in the partner?</p> <p>P) Urine analysis Q) Electroporation R) Polymerase Chain Reaction (PCR) S) Enzyme Linked Immuno-Sorbent Assay (ELISA)</p> <p>A. only S B. both Q and R C. both R and S D. all - P, R and S</p>	1

## Answer Key & Marking Scheme

Q. No	Answers	Marks
Q.1	B. species diversity	1
Q.2	C. both R and S	1

## 2. BIOTECHNOLOGY AND ITS APPLICATIONS

Q. No	Question	Marks
<b>Multiple Choice Questions</b>		
Q.3	<p>There are two statements given below marked as Assertion (A) and Reason (R). Read the statements and choose the correct option.</p> <p>Assertion: RNA interference (RNAi) is used to protect plants against nematode infestation.</p> <p>Reason: RNAi method involves silencing of a specific mRNA by a complementary dsRNA molecule that binds to and prevents translation of the mRNA.</p> <p>A. A is true but R is false.            B. A is false but R is true.            C. Both A and R are true and R is the correct explanation of A.            D. Both A and R are true and R is not the correct explanation of A.</p>	1
Q.4	<p>Given below are steps involved in the gene therapy of a patient with adenosine deaminase (ADA) deficiency.</p> <p>P) Lymphocytes are grown in a culture outside the human body.            Q) Lymphocytes are altered with a functional ADA cDNA.            R) Lymphocytes are collected from the blood of the patients.            S) The genetically modified lymphocytes are infused back into the patient.</p> <p>Which of the following show the correct order in which these steps must occur?</p> <p>A. Q → P → R → S            B. R → S → Q → P            C. R → P → Q → S            D. S → R → P → Q</p>	1
	<p>Given below is an image of the process involved in recombinant DNA technology.</p> <p>LacZ is a gene that codes of β-galactosidase. When plated on an appropriate medium, cells that produce β-galactosidase form blue colonies whereas those that do not produce it form white colonies.</p>	



Answer the Questions from Q5-Q8

Q.5 Which of the following chemicals will be involved in a step that would come before step 1?

1

lysozyme, ethanol, ribonuclease, cellulase, protease

- A. only lysozyme and ethanol
- B. only cellulase, lysozyme and ethanol
- C. only lysozyme, ribonuclease, protease, and ethanol
- D. all - lysozyme, ethanol, ribonuclease, cellulase, protease

Q.6 Which of the following will help one detect cells containing the recombinant DNA?

1

Option	Ampicillin in medium	colour of colonies formed
A	present	blue colonies
B	absent	blue colonies
C	present	white colonies
D	absent	white colonies

- A. A
- B. B
- C. C
- D. D

Q.7 At which step will DNA ligase be required?

1

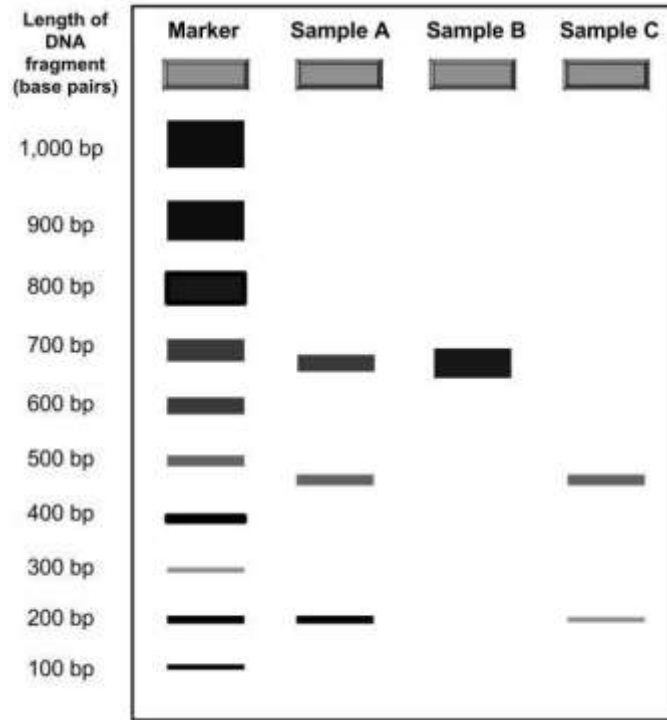
- A. step 2

	<p>B. step 3  C. step 4  D. (DNA ligase is not required in this process)</p>	
Q.8	<p>What would be the colour of the colonies formed by variant P?</p> <p>A. only blue colonies  B. only white colonies  C. a mix of blue and white colonies  D. (They will not form any colonies.)</p>	1
Q.9	<p>Polymerase chain reaction (PCR) mimics which of the following natural processes?</p> <p>A. ligation  B. translation  C. replication  D. transformation</p>	1
Q.10	<p>Which of the following correctly states the purpose of steam in a bio-processor?</p> <p>A. helps organisms grow faster  B. adds to the water content  C. maintains sterility  D. (Steam is not required in a bio-processing unit.)</p>	1
Q.11	<p>Similar to sexual reproduction, rDNA technology contributes to _____.</p> <p>P) genetic mutation  Q) faster replication  R) genetic variation  S) DNA ligation</p> <p>A. only R  B. only P and R  C. only P, Q and R  D. all - P, Q, R and S</p>	1
Q.12	<p>In which of the following natural processes is recombinant DNA made?</p> <p>A. prophase in mitosis  B. prophase 1 in meiosis  C. prophase 2 in meiosis  D. (Recombinant DNA cannot be made naturally).</p>	1
Q.13	<p>Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R).</p>	1



	<p>Assertion (A): Sexual reproduction is similar to rDNA technology because it results in variations.</p> <p>Reason (R): Variation is impossible through asexual reproduction.</p> <p>Which of the following is correct?</p> <p>A. Both A and R are true, and R is the correct explanation for A.  B. Both A and R are true, but R is not the correct explanation for A.  C. A is true, but R is false.  D. A is false, but R is true.</p>	
Q.14	<p>Two statements are given - one labelled Assertion (A) and the other labelled Reason (R).</p> <p>Assertion (A): Gene therapy is a method of treating a disorder but cannot cure it.</p> <p>Reason (R): In gene therapy, cells are drawn from a patient and the functional gene is introduced into these cells and transferred back to the patient.</p> <p>Which of the following is correct?</p> <p>A. Both A and R are true, and R is the correct explanation for A.  B. Both A and R are true, but R is not the correct explanation for A.  C. A is true, but R is false.  D. A is false, but R is true.</p>	1
Q.15	<p>Given below are two statements about polymerase chain reactions.</p> <p>P) It mimics DNA replication that happens in a cell.</p> <p>Q) It cannot be used to amplify RNA molecules.</p> <p>Which of these is/are TRUE?</p> <p>A. only P  B. only Q  C. both P and Q  D. neither P nor Q</p>	1
<b>Free Response Question/ Subjective Question</b>		
Q.16	<p>X is the first restriction enzyme isolated from strain H of <i>Bacillus amyloliquefaciens</i>. This enzyme cuts between two guanine bases of the following palindromic sequence:</p> <p>5'-G G A T C C-3'  3'-C C T A G G-5'</p> <p>(a) Name the restriction enzyme X. Explain how you arrived at this name.</p> <p>(b) Draw the DNA fragments produced due to the action of enzyme X on the palindromic sequence shown above.</p>	3

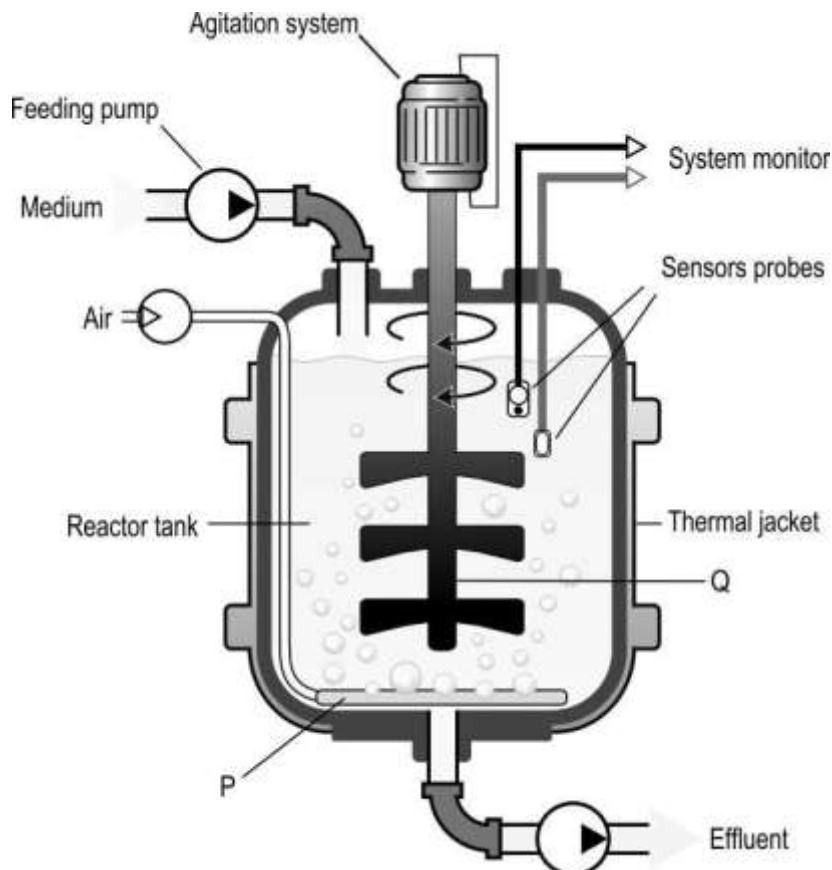
Q.17	<p>In 1997, an American company obtained patent rights on Basmati rice, allowing them to market a 'new' strain of Basmati rice in the United States and overseas. This 'new' Basmati strain was really derived from Indian farmer's varieties.</p> <p>(a) What is this unauthorised act called? Define it.</p> <p>(b) State TWO ways in which Indian farmers are set to lose due to this unauthorised act.</p> <p>(c) State TWO measures that different countries are taking to prevent such unauthorised exploitation of their bio-resources.</p>	3															
Q.18	<p>(a) What are transgenic animals?</p> <p>(b) To produce transgenic animals, the gene of interest is introduced into embryonic stem cells. These stem cells are undifferentiated and the preferred target in the process of developing any transgenic animal. Give a reason why.</p>	2															
Q.19	<p>CRISPR is a gene editing technique for which the developers won the Nobel Prize. Indian scientists are in the process of developing resilient and high-yield varieties of rice using this technology and providing these to Indian farmers by 2024, once approved.</p> <p>(a) Which organisation would be responsible for approving such varieties?</p> <p>(b) What is the purpose of establishing the organisation identified in (a)?</p>	2															
Q.20	<p>Kavya and David needed to cut out a 200 base-pair (bp) long DNA fragment from a 650 bp long vector. Enzyme A cuts at 350 bp and at 550 bp whereas enzyme B does not cut the vector. They followed the given steps to do this:</p> <table border="1" data-bbox="272 1330 1313 1536"> <thead> <tr> <th data-bbox="272 1330 368 1368">Step</th> <th data-bbox="368 1330 842 1368">David</th> <th data-bbox="842 1330 1313 1368">Kavya</th> </tr> </thead> <tbody> <tr> <td data-bbox="272 1368 368 1411">1</td> <td data-bbox="368 1368 842 1411">Take 3 micrograms of the vector</td> <td data-bbox="842 1368 1313 1411">Take 3 micrograms of the vector</td> </tr> <tr> <td data-bbox="272 1411 368 1453">2</td> <td data-bbox="368 1411 842 1453">Add 2 microlitres of enzyme A</td> <td data-bbox="842 1411 1313 1453">Add 2 microlitres of enzyme B</td> </tr> <tr> <td data-bbox="272 1453 368 1496">3</td> <td data-bbox="368 1453 842 1496">Incubate at 37°C for 2 hours</td> <td data-bbox="842 1453 1313 1496">Incubate at 37°C for 2 hours</td> </tr> <tr> <td data-bbox="272 1496 368 1536">4</td> <td data-bbox="368 1496 842 1536">Run the sample on an agarose gel</td> <td data-bbox="842 1496 1313 1536">Run the sample on an agarose gel</td> </tr> </tbody> </table> <p data-bbox="272 1559 1313 1601">Given below is an image of the gel that was run with the samples.</p>	Step	David	Kavya	1	Take 3 micrograms of the vector	Take 3 micrograms of the vector	2	Add 2 microlitres of enzyme A	Add 2 microlitres of enzyme B	3	Incubate at 37°C for 2 hours	Incubate at 37°C for 2 hours	4	Run the sample on an agarose gel	Run the sample on an agarose gel	3
Step	David	Kavya															
1	Take 3 micrograms of the vector	Take 3 micrograms of the vector															
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3	Incubate at 37°C for 2 hours	Incubate at 37°C for 2 hours															
4	Run the sample on an agarose gel	Run the sample on an agarose gel															



- (a) What is the purpose of the marker?
- (b) Which of these shows the samples run by David and Kavya? Justify your answer.

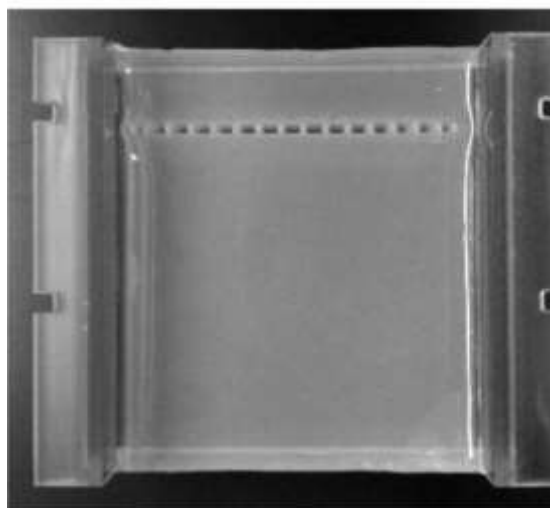
Q.21 Given below is a diagram of a bio-reactor with some of its parts labelled P and Q.

3



	<p>(a) Which type of organisms can MOST likely be used if part P is not made a part of the bio-reactor? Why?</p> <p>(b) Identify the name and purpose of part Q.</p> <p>(c) How does the thermal jacket help in the process?</p>	
Q.22	<p>(a) Give a reason why, although a toxin, Bt toxins are deadly for insects but not for plants producing them.</p> <p>(b) Describe the steps in which Bt toxins act on insects.</p>	3
Q.23	<p>Plants of a region in India are constantly infested by the corn borer.</p> <p>(a) What components are required in a recombinant plasmid that can produce modified plants which are resistant to the corn borer? State the purpose of each component.</p> <p>(b) Give an example of a plasmid that can be used for (a).</p>	2
Q.24	<p>Identify if the following statement is true or false.</p> <p>Between formation of the dsRNA and silencing of mRNA, the dsRNA needs to undergo an additional step.</p> <p>Justify if true, and rewrite the correct statement, if false.</p>	2
Q.25	<p>Hormones are broadly categorised as steroid hormones and protein hormones. Patients with type 2 diabetes, generally, have to take insulin externally. Researchers across the world believe that if insulin can be given orally it would be ideal as it would closely mimic the movement of natural insulin. Yet, injectable insulin is commonly prescribed by doctors.</p> <p>What type of a hormone is insulin and why can't it be administered orally?</p>	2
Q.26	<p>(a) What causes adenosine deaminase (ADA) deficiency?</p> <p>(b) What are the THREE methods that are currently used for the treatment of ADA?</p> <p>(c) What is the problem with the methods described in (b)? How can this problem be overcome?</p>	3
Q.27	<p>Give a reason why:</p> <p>(a) Transgenic animals are used for the production of biological components of medicines over synthetic industrial production.</p> <p>(b) In the process of testing for effects of chemicals, transgenic animals are used rather than non-transgenic ones.</p>	2
Q.28	<p>Naturally growing potatoes show bruises (black discolouration) when they get damaged. Bruising occurs when the tissue is crushed and cells rupture, releasing enzymes that produce a black discolouration. A gene has been</p>	5

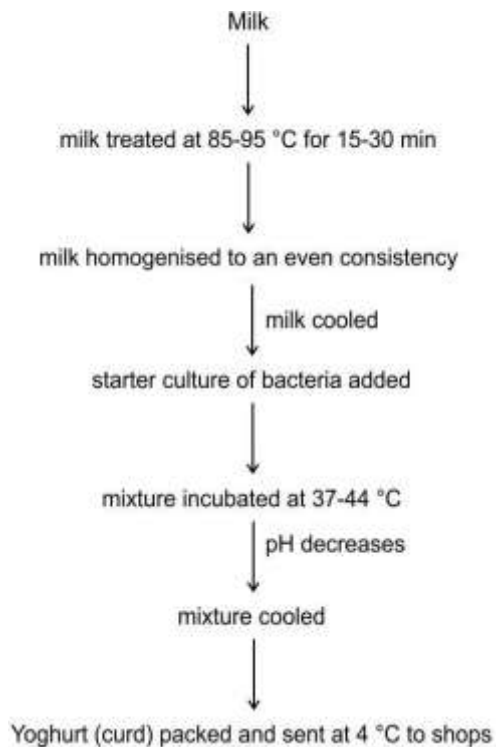
	<p>identified which codes for this enzyme. A company wants to produce potatoes that do not show these bruises.</p> <p>(a) Describe the steps in which they can produce such potatoes that do not show bruises.</p> <p>(b) What is the process called?</p>													
Q.29	<p>(a) What is a disadvantage of the traditional hybridisation procedure?</p> <p>(b) How has rDNA technology overcome the disadvantage identified in (a)?</p>	2												
Q.30	<p>Anita and Dipti followed the steps mentioned below to introduce their gene of interest into the target organism.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Step</th> <th style="width: 45%;">Anita</th> <th style="width: 45%;">Dipti</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>used a restriction enzyme to obtain gene of interest</td> <td>used a restriction enzyme to obtain gene of interest</td> </tr> <tr> <td>2</td> <td>made multiple copies of the gene of interest using PCR</td> <td>ligated the gene of interest with a cloning vector</td> </tr> <tr> <td>3</td> <td>introduced the amplified genes in the cell</td> <td>introduced the vector prepared in step 2 in the cell</td> </tr> </tbody> </table> <p>Of these, whose experiment is more likely to succeed and why?</p>	Step	Anita	Dipti	1	used a restriction enzyme to obtain gene of interest	used a restriction enzyme to obtain gene of interest	2	made multiple copies of the gene of interest using PCR	ligated the gene of interest with a cloning vector	3	introduced the amplified genes in the cell	introduced the vector prepared in step 2 in the cell	2
Step	Anita	Dipti												
1	used a restriction enzyme to obtain gene of interest	used a restriction enzyme to obtain gene of interest												
2	made multiple copies of the gene of interest using PCR	ligated the gene of interest with a cloning vector												
3	introduced the amplified genes in the cell	introduced the vector prepared in step 2 in the cell												
Q.31	<p>Golden rice is a variety of rice that has been genetically modified to produce a compound called <math>\beta</math>-carotene, which gets converted to Vitamin A when metabolised in the human body. This was done by introducing the genes coding for three enzymes - 'psy' and 'LCYB' from daffodil and 'crtI' from the soil bacterium <i>Erwinia uredovora</i>.</p> <p>(a) With the help of a diagram, describe the process by which golden rice can be made.</p> <p>(b) Name the vector used in the process.</p> <p>(c) Give a reason why the vector identified in (b) should be used.</p>	5												
Q.32	<p>Karan wanted to cut a DNA fragment which was 800 base-pairs long from a vector. He followed each step of the protocol correctly and ran the resultant sample on an agarose gel. In an earlier attempt in extracting DNA from onion cells, he had seen DNA form a thread like precipitate in ethanol. Given below is an image of the gel after he finished running his sample in it.</p>	2												



(a) Why does he not see the same thread like precipitate in the gel?

(b) How can he ensure he has obtained the desired result?

<p>Q.33</p>	<p>Papaya is a widely cultivated crop in several regions. However, its production was limited by papaya ringspot disease which is caused by the Papaya ringspot virus (PRSV). Papaya plants infected by PRSV show symptoms of yellowing, discolouration of leaves and 'ringspots' on the fruit. PRSV belongs to the genus Potyvirus which has a single-stranded RNA as its genetic material.</p> <p>(a) Explain the step-by-step process to inhibit the viral RNA from surviving in the papaya plants thus creating disease-resistance varieties of papaya.</p> <p>(b) Name the biotechnological process described in (a) and give a reason why it is the appropriate process to be used in this case.</p>	<p>5</p>
<p>Q.34</p>	<p>Growth hormone injection treatment is prescribed for children who have been diagnosed with growth hormone (GH) deficiency and other conditions causing short stature and insufficient growth. This hormone is produced by the pituitary gland in humans so the gene for this hormone was isolated from the pituitary gland and introduced into pHGH407 vectors for production. However, a problem with this was that the protein so produced was 26 amino acids longer than the active growth hormone (24 amino acids long) and so this method could not be used.</p> <p>(a) Given that the amino acid sequence of the active growth hormone was known, use a diagram to explain how human growth hormone could be produced outside the body.</p> <p>(b) The vector consists of a lac gene which codes for the enzyme <math>\beta</math>-galactosidase. Describe how this gene can help with the selection of colonies containing the transgene.</p>	<p>5</p>
<p>Q.35</p>	<p>Given below is the step-by-step process in the formation of yoghurt (curd) in a bioreactor.</p>	<p>3</p>

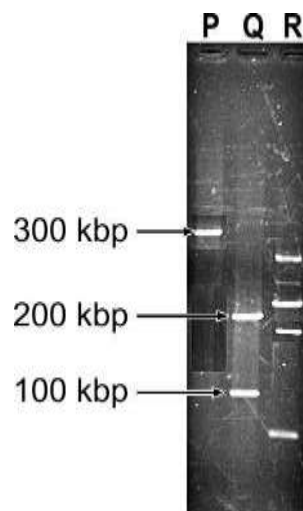


(a) Why does the pH start decreasing a while after the mixture is incubated at 37-44 °C?

(b) From the flowchart, identify two systems that the bioreactor would have. Give a reason to support your answer.

Q.36

Nidhi performed gel electrophoresis after treating one vector with restriction enzymes. She added one mixture in well Q and another mixture in well R. Given below is an image of the results.



(a) What can be concluded about the mixtures loaded in wells P and Q?

(b) What is the likely reason that the fragments in wells Q and R are different?

2

Q.37

ELISA is a test used for early detection of an infection.

3

	<p>What components of a disease can be detected using ELISA?</p> <p>Describe the components that can be checked if one wants to identify whether an individual is allergic to pollen or not.</p> <p>Given below is an image of an ELISA test result with two of its cells marked P and Q. A coloured cell indicates a positive result whereas an uncoloured cell is a negative result.</p> <div data-bbox="464 506 1120 954" data-label="Image"> </div> <p>(c) The colour of P is darker than the colour of Q. What could this possibly indicate?</p>	
Q.38	<p>Explain why vectors that have restriction site/s within a marker gene are preferred, for recombinant DNA technology.</p>	2



## Answer Key & Marking Scheme

Q.No	Answers	Marks
Q.3	C. Both A and R are true and R is the correct explanation of A.	1
Q.4	C. $R \rightarrow P \rightarrow Q \rightarrow S$	1
Q.5	D. all - lysozyme, ethanol, ribonuclease, cellulase, protease	1
Q.6	C. C	1
Q.7	B. step 3	1
Q.8	D. (They will not form any colonies.)	1
Q.9	C. replication	1
Q.10	C. maintains sterility	1
Q.11	B. only P and R	1
Q.12	B. prophase 1 in meiosis	1
Q.13	C. A is true, but R is false.	1
Q.14	A. Both A and R are true, and R is the correct explanation for A.	1
Q.15	A. only P	1
Q.16	<p>(a) 0.5 marks for each of the following:</p> <ul style="list-style-type: none"> <li>- Name of the enzyme: BamHI</li> <li>- The convention used to name a restriction enzyme is the first letter comes from the genus (<i>Bacillus</i>) and next two letters from the species (<i>amyloliquefaciens</i>).</li> <li>- The fourth letter refers to the strain (strain H).</li> <li>- The roman number in the end indicating the order in which the enzyme was isolated from the strain (first enzyme).</li> </ul> <p>(b)</p> <pre style="font-family: monospace; margin-left: 40px;"> 5'-G           G A T C C-3' 3'-C C T A           G-5' </pre>	3
Q.17	(a) 0.5 marks each for the correct name and its definition:	3

	<p>- biopiracy</p> <p>- refers to the use of bio-resources by multinational companies and other organisations without proper authorisation from the countries and people concerned without compensatory payment.</p> <p>(b) 0.5 marks each for the following:</p> <p>- authorisation</p> <p>- compensation</p> <p>(c) 0.5 marks each for any two correct points such as:</p> <p>- Benefits of bio-resources should be shared between developed and developing countries.</p> <p>- Implementing laws for issues such as patent terms emergency provisions and research and development initiative.</p> <p>[Marks to be awarded for any other correct answer]</p>	
Q.18	<p>(a) Animals that have had their DNA manipulated to possess and express an extra (foreign) gene are transgenic animals.</p> <p>(b) Since embryonic stem cells are undifferentiated, they have the capability of forming all other cells of the body with their specialised functions and the inserted foreign gene.</p>	2
Q.19	<p>(a) GEAC (Genetic Engineering Approval Committee)</p> <p>OR</p> <p>GEAC (Genetic Engineering Appraisal Committee)</p> <p>[No marks to be awarded if the full form is not mentioned]</p> <p>(b) 0.5 marks each for the following:</p> <p>- Provide decisions regarding the validity of GM research.</p> <p>- Ensure the safety of introducing GM-organisms for public services</p> <p>[Accept any other valid point]</p>	2
Q.20	<p>(a) The marker acts as reference to identify the size of the fragments that are visible on the gel.</p> <p>(b) 0.5 marks each for identification and justification:</p> <p>- Sample C belonged to David.</p> <p>- David followed the procedure properly and so can see two correct bands (200 bp of the fragment and 450 bp of the remaining vector).</p> <p>- Sample B belonged to Kavya</p>	3

	- Since enzyme B does not cut the vector, it remained intact when run on the gel.	
Q.21	<p>(a) Anaerobic organisms</p> <p>Reason - since the aerator ensures supply of oxygen for aerobic organisms to respire and function, anaerobic organisms will not need this to carry out life processes.</p> <p>(b) Q - stirrer/agitator</p> <p>Purpose - The stirrer facilitates even mixing and oxygen availability throughout the bio-reactor.</p> <p>(c) to maintain temperature throughout the process</p>	3
Q.22	<p>(a) Bt toxins exist as inactive protoxins when produced by the plant and become active only when they are ingested by insects.</p> <p>(b) 0.5 marks for each of the following points:</p> <ul style="list-style-type: none"> <li>- A plant/part of plant producing bt toxins is ingested by an insect.</li> <li>- The inactive protoxin form of the bt toxin gets converted into an active form of toxin due to the alkaline pH of the gut which solubilises the crystals.</li> <li>- The activated toxin binds to the surface of midgut epithelial cells and create pores.</li> <li>- These pores cause cell swelling and lysis and eventually cause death of the insect.</li> </ul>	3
Q.23	<p>(a) 0.5 marks for each of the following components along with their purpose:</p> <ul style="list-style-type: none"> <li>- a cloning site with the cryIAb gene inserted in it to produce the toxin</li> <li>- a selectable marker such as an antibiotic resistance gene for selection of colonies with the recombinant plasmid</li> <li>- an origin of replication so that the plasmid can replicate and make copies</li> </ul> <p>[no marks to be awarded for component if purpose is not mentioned]</p> <p>(b) Ti plasmid from <i>Agrobacterium tumefaciens</i></p>	2
Q.24	<p>- True [1 mark]</p> <p>- Justification: Since dsRNA is double stranded, it cannot automatically bind to the mRNA. So the two strands must be separated so that a single stranded RNA is obtained which can bind to the single stranded mRNA, silencing it. [1 mark]</p>	2
Q.25	<p>1 mark each for the following:</p> <ul style="list-style-type: none"> <li>- Insulin is a protein hormone.</li> </ul>	2

	- If taken orally, they will get digested by pepsin and trypsin in the stomach and small intestine into their simpler forms, thereby losing their function.	
Q.26	<p>(a) ADA is caused due to the deletion of the gene coding for adenosine deaminase.</p> <p>(b) 0.5 marks each for the following methods:</p> <ul style="list-style-type: none"> <li>- bone marrow transplantation</li> <li>- enzyme replacement therapy</li> <li>- gene therapy</li> </ul> <p>(c) 0.5 marks for each of the following:</p> <p>Problem - all three methods are not completely curative.</p> <p>Way to overcome - introducing the gene coding for ADA from marrow cells into early embryonic cells could permanently cure the disorder.</p>	3
Q.27	<p>(a) 1 mark for any one correct reason such as:</p> <ul style="list-style-type: none"> <li>- Industrial production is expensive when compared to production through transgenic animals.</li> <li>- The components produced by transgenic animals have the possibility of being as close to the natural product as possible.</li> </ul> <p>(b) Transgenic animals are made that carry genes which make them more sensitive to toxic substances than non-transgenic animals allowing for results in lesser time.</p>	2
Q.28	<p>(a) 1 mark each for the following points:</p> <ul style="list-style-type: none"> <li>- Creating a Ti plasmid which have the sense and anti-sense RNA, the latter complimentary to the mRNA coding for the enzyme.</li> <li>- Introducing these plasmids into the host plant.</li> <li>- The sense and anti-sense RNA would combine to form a dsRNA</li> <li>- The two strands split and the anti-sense RNA binds to the mRNA coding for the enzyme causing the black discolouration, silencing it.</li> </ul> <p>(b) RNA interference (RNAi)</p>	5
Q.29	<p>(a) Traditional hybridisation procedures very often lead to inclusion and multiplication of undesirable genes along with the desired genes.</p> <p>(b) Using rDNA technology, only the desired gene can be introduced into an organism without introducing other undesirable gene.</p>	2
Q.30	- Dipti's experiment is more likely to succeed. [1 mark]	2

	- Since Anita introduce her gene as it is, it did not have an origin of replication to replicate on its own and would get degenerated over time. [1 mark]	
Q.31	(a) Correct illustration of the process - drawing 3 genes of interest from 2 sources, inserting them into a plasmid cut with the same restriction enzyme, introducing the plasmid into rice embryos/cells [2 marks]  - Step by step description of the process with correct terminology [2 marks]  (b) Ti plasmid  (c) Ti plasmid can replicate well in the plant genome/Its genes can be expressed in the environment of the plant genome.	5
Q.32	(a) When DNA is extracted from several cells, it is much bigger in size than 800 base-pairs and is present in a larger volume and so can be seen with the naked eye.  [Accept any other valid answer]  (b) When stained with ethidium bromide and kept under UV light, the agarose gel should show a band of DNA corresponding to 800 base-pairs on the marker.	2
Q.33	(a) 0.5 marks each for the following:  - The viral RNA is isolated and converted to a dsDNA structure.  - The dsDNA so formed is inserted into an appropriate vector (Agrobacterium or viral vector).  - The vectors are then introduced into the host plant where it transcribes the mRNA for this gene.  - Whenever the virus infects the plant and injects its RNA into the host plant, the host plant transcribes the viral RNA.  - The mRNA produced from the vector binds to the transcribed viral RNA.  - This prevents the viral RNA from being transcribed and therefore survives in the host plant without infecting the plant.  (b) 1 mark each for the following:  - RNAi or RNA interference  - RNAi helps in in-vitro silencing of a gene/set of genes so that they lose their function.	5
Q.34	(a) 1 mark each for each of the following step explained in a diagram:  - From the amino acid sequence, the gene for growth hormone needs to be synthesized chemically.  - The gene of interest is cut using a restriction enzyme and the same restriction enzyme is used to cut the vector within the lac gene.	5

	<ul style="list-style-type: none"> <li>- The gene obtained is inserted into the vector using a ligase.</li> <li>- These are transformed into E.coli cells/host cells for production.</li> </ul> <p>(b) 0.5 marks each for the following:</p> <ul style="list-style-type: none"> <li>- In recombinants, since the lac gene is inactivated, after insertion of the gene of interest, it does not produce the <math>\beta</math>-galactosidase enzyme which results in colourless colonies when a chromogenic substrate is added.</li> <li>- In non-recombinants, since the lac gene is still active, it produced the enzyme <math>\beta</math>-galactosidase which results in blue colonies when a chromogenic substrate is added.</li> </ul>	
Q.35	<p>(a) 0.5 marks for each of the following:</p> <ul style="list-style-type: none"> <li>- As the bacteria starts to grow, it uses up the oxygen in the system.</li> <li>- After a while, the oxygen gets used up and anaerobic respiration begins which leads to the formation of lactic acid, causing a decrease in the pH.</li> </ul> <p>(b) 0.5 marks for identification and 0.5 marks for the reason for any TWO of the following:</p> <ul style="list-style-type: none"> <li>- Oxygen delivery system: After the starter culture is added, oxygen is also added which will need a delivery system.</li> <li>- Stirrer: Once oxygen is added, the system would need to be mixed thoroughly so that oxygen is available throughout the bioreactor.</li> <li>- Sterilization unit: Milk needs to be sterilised before addition of the starter culture to remove any other microorganisms already present in it.</li> </ul> <p>[Accept any other valid answer]</p>	3
Q.36	<p>(a) Well P contains the uncut vector whereas well Q contains the vector cut by a restriction enzyme.</p> <p>(b) The vector in well Q has been cut by a restriction enzyme that has two sites whereas the vector in well R has been cut either by different enzymes or by one enzyme that has more than two sites.</p>	2
Q.37	<p>Presence of antigen/antibodies to an antigen can be detected using ELISA.</p> <p>0.5 marks for each of the following:</p> <p>antigen from pollen</p> <p>IgE antibodies</p> <p>(c) P may have more antigen/antibodies as compared to Q.</p>	3
Q.38	<p>1 mark each for the following:</p> <ul style="list-style-type: none"> <li>- When a target gene gets inserted into a marker gene which has a restriction site, it inactivates the production of the marker</li> </ul>	2

	<p>- The absence of a characteristic that was coded for by the marker is useful in the detection of cells with the recombinant vectors.</p> <p>[Accept any other valid answer]</p>	
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### 3. ECOSYSTEM

Q. No	Question	Marks
<b>Free Response Question / Subjective Question</b>		
Q.39	State ONE quality that a pioneer species must have. How can the process of succession be interrupted?	2

#### Answer Key & Marking Scheme

Q. No	Answers	Marks
Q.39	(a) They should be able to derive energy and produce organic matter from inorganic and non-living substances. <i>[Accept any other valid answer]</i> (b) Succession can be interrupted in the event of disturbances such as fire that convert a seral stage to an earlier stage or even lead to the elimination of species. <i>[Accept any other valid answer]</i>	2



#### 4. ENVIRONMENTAL ISSUES

Q. No	Question	Marks
<b>Free Response Question / Subjective Question</b>		
Q.40	<p>In a research paper titled "Ecological Risk of DDT - A Case Study of Biomagnification Causing Extinction Risk of Herring Gull in Long Island" (Nakamaru <i>et al</i>, 2001), it was cited that use of DDT causes immense risks of extinction of a bird named Herring Gull. There are severe implications of this.</p> <p>(a) The Herring Gull is a top predator in the food pyramid of the area. How will its extinction impact the food chain?</p> <p>(b) State ONE reason how can bio-magnification cause extinction of birds like the Herring Gull?</p>	2
Q.41	<p>(a) Recycling of e-waste is one of the most popular methods of e-waste management in developing countries. It benefits a sizeable proportion of the population by providing employment in such countries. What can be one of the biggest disadvantages of these recycling efforts?</p> <p>(b) Incineration, as a process of e-waste management, can destroy organic constituents in e-waste. What is the main advantage of using incineration in a landfill?</p>	2
Q.42	<p>Impurities in domestic sewage account for 0.1% of the total waste water. Such impurities include:</p> <p>A: suspended solids like sand, silt and clay</p> <p>B: colloidal material like faecal matter, bacteria</p> <p>C: dissolved materials like nutrients (nitrates, ammonia, phosphate, sodium, calcium etc).</p> <p>As a project manager for treatment of domestic sewage in a town, Shivam thought of recycling of the sewage water into other processes in the area.</p> <p>(a) How can Shivam remove the suspended solids from the sewage water?</p> <p>(b) How can the colloidal impurities be used in any other process in the town?</p> <p>(c) If the domestic sewage is allowed to enter a pond or a lake without being treated,</p> <p>what can be ONE impact it has on the quality of water in the water body?</p>	3

## Answer Key & Marking Scheme

Q. No	Answers	Marks
Q.40	(a) 0.5 marks for each correct answer: <ul style="list-style-type: none"><li>- increase in other predators, carnivores and herbivores in the area</li><li>- imbalance in availability of food</li></ul> (b) 1 mark each for mentioning any one of the following: <ul style="list-style-type: none"><li>- decrease in fertility</li><li>- early breakage of egg shells</li><li>- thinning of eggshells</li></ul>	2
Q.41	(a) exposes workers to hazardous and toxic substances during manual participation (b) reduces volume of the waste	2
Q.42	(a) 1 mark for any correct answer such as: <ul style="list-style-type: none"><li>- sedimentation</li><li>- filtration</li></ul> (b) in agricultural fields as organic manure (c) 1 mark for mentioning any one of the following: <ul style="list-style-type: none"><li>- increase of BOD</li><li>- eutrophication</li></ul>	3

## 5. HUMAN HEALTH AND DISEASE

Q. No	Question	Marks
<b>Multiple Choice Question</b>		
Q.43	<p>In addition to being a vector, the female <i>Anopheles</i> mosquito also acts as a host for the malarial parasite - <i>Plasmodium</i>.</p> <p>Choose the option that supports the role of the female <i>Anopheles</i> mosquito as a host.</p> <p>A. Liver cells serve as the site for the multiplication of <i>Plasmodium</i>.            B. <i>Plasmodium</i> completes part of its lifecycle in the female <i>Anopheles</i>.            C. The female <i>Anopheles</i> mosquito lays eggs in stagnant pools of water.            D. The female <i>Anopheles</i> mosquito transmits <i>Plasmodium</i> to humans by biting.</p>	1
Q.44	<p>Immuno-suppressants are administered to patients post-organ transplantation and also to those suffering from auto-immune disorders.</p> <p>In which of the following ways are immuno-suppressants helpful?</p> <p>A. They trigger allergic response.            B. They eliminate unhealthy tissues.            C. They control the cell-mediated response.            D. They differentiate between self and non-self parts of the body.</p>	1
<b>Free Response Questions/Subjective Question</b>		
Q.45	<p>Drug abuse is a common problem faced by countries around the world today due to its impact on the health and well-being of an individual.</p> <p>(a) How is the cocaine consumed? What impact it has on the body?            (b) Some drugs make an individual sleepy while some other make them hyper-energetic. Using appropriate examples, explain this statement.            (c) Why does a regular drug abuser have withdrawal symptoms when consumption of the drug is suddenly stopped?</p>	5

## Answer Key & Marking Scheme

Q. No	Answers	Marks
Q.43	B.	1
Q.44	C. They control the cell-mediated response.	1
Q.45	<p>(a) 1 mark each for the following:</p> <ul style="list-style-type: none"> <li>- Cocaine is usually consumed by snorting/smoking.</li> <li>- Both these actions involve the respiratory system and so cocaine consumption can interfere with the regular functioning of the respiratory tract.</li> </ul> <p>(b) 1 marks each for naming the correct drug as an example and 0.5 marks each for the explanation:</p> <ul style="list-style-type: none"> <li>- Heroin is a drug that acts as a depressant to the functioning of the nervous system and so it slows down bodily functions and makes an individual sleepy.</li> <li>- Cocaine is a drug that stimulates the nervous system thereby making an individual feel very energetic.</li> </ul> <p><i>[Accept any other valid answer]</i></p> <p>(c) 0.5 marks each for the following:</p> <ul style="list-style-type: none"> <li>- Using drugs chronically makes the body used to functioning in the presence of the drug.</li> <li>- Sudden removal of the drug from the body leads to the body asking for the drug through improper functioning or withdrawal symptoms.</li> </ul>	5

## 6. HUMAN REPRODUCTION

Q. No	Question	Marks
<b>Free Response Question/ Subjective Question</b>		
Q.46	<p>Meiotic arrest is a phenomenon noticed during oogenesis in human females where oocytes are arrested in the primary oocyte stage.</p> <p>(a) What is the chromosomal count of these primary oocytes?</p> <p>(b) How are these primary oocytes converted to ovum?</p>	3

### Answer Key & Marking Scheme

Q. No	Answers	Marks
Q.46	<p>(a) 46</p> <p>(b) 0.5 marks for each step:</p> <ul style="list-style-type: none"><li>- each primary oocyte is converted to primary follicle</li><li>- primary follicles further develop to form secondary and tertiary follicles</li><li>- the tertiary follicles are converted to secondary oocytes</li><li>- initiated by the action of FSH at puberty</li></ul>	3

## 7. MICROBES IN HUMAN WELFARE

Q. No	Question	Marks
<b>Multiple Choice Question</b>		
Q.47	<p>A scientist measured the BOD (biochemical oxygen demand) of water from the following sources.</p> <p>kitchen tap</p> <p>sewer pipe</p> <p>Choose the correct statement.</p> <p>A. The BOD of sample P will be lesser than sample Q. B. The BOD of sample P will be greater than sample Q. C. The BOD of sample P will be equal to that of sample Q. D. The BOD of the two samples cannot be compared without additional data.</p>	1

### Answer Key & Marking Scheme

Q. No	Answers	Marks
Q.47	A. The BOD of sample P will be lesser than sample Q.	1

## 8. MOLECULAR BASIS OF INHERITANCE

Q. No	Question	Marks
<b>Multiple Choice Question</b>		
Q.48	<p>Which of the following occurs as a result of DNA replication being semi-conservative?</p> <p>A. Chromosome number becomes half in the gametes.            B. Each chromosome has half DNA and half RNA.            C. Parental characters are found in each chromosome.            D. Each new DNA strand has half the number of nucleotides compared to the parent DNA strand"</p>	1
Q.49	<p>An organism has <math>6 \times 10^9</math> bp in its DNA. Which of the following is likely to be closest in height to the length of its DNA molecule?</p> <p>- A wardrobe: 2 m            - A tall tree: 20 m            - An A4 sheet: 20 cm            - A eukaryotic nucleus: 10-10 m</p> <p>A. A wardrobe            B. A tall tree            C. An A4 sheet            D. A eukaryotic nucleus</p>	1
Q.50	<p>Which of the following is true about the structure of DNA and RNA?</p> <p>P) The nitrogenous base is devoid of an OH group in DNA.            Q) The nitrogenous base of RNA gains the OH group lost by DNA.            R) The pentose sugar in RNA combines with an extra OH group.            S) The pentose sugar in DNA loses an OH group to form deoxyribose.</p> <p>A. only P            B. only S            C. only R and S            D. only P and Q</p>	1
Q.51	<p>Keratin is a common protein found in the human body with its gene on chromosome no. 12. Centromeres are constricted regions on the chromosome that help during cell division.</p> <p>In which of the following regions will the keratin gene and centromere be found?</p>	1

Option	Keratin	Centromere
P	euchromatin	euchromatin
Q	heterochromatin	heterochromatin
R	euchromatin	heterochromatin
S	heterochromatin	euchromatin

- A. P
- B. Q
- C. R
- D. S

Q.52	<p>In Griffith's experiment, when he injected a mixture of heat-killed S strain (virulent) and live R bacteria (non-virulent), the mice died.</p> <p>What type of colony/ies would he observe when the bacteria from the dead mice would be plated on a culture medium?</p> <ul style="list-style-type: none"> <li>A. Only rough colonies would be observed.</li> <li>B. Only smooth colonies would be observed.</li> <li>C. Both rough and smooth colonies would be seen.</li> <li>D. Each colony would have a mix of both rough and smooth textures.</li> </ul>	1
Q.53	<p>Given below are some statements about DNA replication.</p> <p>DNA replication is semiconservative.</p> <p>One of the DNA strands is replicated in a discontinuous fashion.</p> <p>Each strand of parental DNA acts as a template for the new strand.</p> <p>DNA replication shows a low level of accuracy.</p> <p>Based on the statements, pick the correct option.</p> <ul style="list-style-type: none"> <li>A. P and S are true and S is the reason for P</li> <li>B. P and Q are true and Q is the reason for P</li> <li>C. P and R are true and R is the reason for P</li> <li>D. S and Q are true and Q is the reason for S</li> </ul>	1
Q54	<p>Two statements are given below - one is an Assertion (A) and the other is a Reason (R).</p> <p>Assertion (A): DNA-dependent RNA polymerase catalyses polymerisation in the 5' to 3' direction.</p> <p>Reason (R): The strand with 5' to 3' polarity is called the coding strand.</p> <p>Which of the following is correct?</p> <ul style="list-style-type: none"> <li>A. Both A and R are true, and R is the correct explanation for A.</li> <li>B. Both A and R are true, but R is not the correct explanation for A.</li> <li>C. A is true, but R is false.</li> </ul>	1



	D. A is false, but R is true.	
Q.55	<p>Which of the following statement/s are correct example/s of the degenerate feature of the genetic code?</p> <p>UAA and UAG act as terminator codons.</p> <p>CUA codes for leucine in bacteria as well as humans.</p> <p>Valine is coded for by GUU and GUC.</p> <p>A. only Q B. only R C. only P and Q D. only P and R</p>	1
<b>Free Response Question/ Subjective Question</b>		
Q.56	<p>A DNA molecule is much longer than the length of nucleus of a cell.</p> <p>Describe the organization of DNA inside a nucleus.</p>	2
Q.57	<p>One strand of a DNA segment is made up of repeats of adenine and cytosine - 5' ACACACAC 3'</p> <p>Explain the formation of a dinucleotide (AC) and its base pair from nitrogenous bases.</p>	5
Q.58	<p>State TWO points of similarity between the process of replication and transcription in humans.</p> <p>Describe the fate of the products of replication and transcription with respect to the following:</p> <p>location of the product/s</p> <p>lifespan of the product/s</p> <p>In which phase/s of the cell cycle do these processes occur?</p>	5
Q.59	<p>Why is the enzyme ligase not required in DNA amplification using PCR?</p> <p>What will happen if DNA polymerase is used in PCR? Give a reason to support your answer.</p> <p>State one advantage of PCR over DNA replication.</p> <p>For any given sequence of nucleotides, DNA replication is faster than PCR. Justify.</p>	5
Q.60	<p>A DNA sequence consists of 35% cytosine nucleotides.</p> <p>What would be the percentage of adenine nucleotides in the same DNA sequence? Justify your answer.</p>	2

Q.61	Although DNA replication by polymerases is an energetically expensive process, it still proves to be an efficient process. Justify the statement.	3
Q.62	What are the four properties needed in a molecule to function as genetic material?  Compare these parameters between the DNA and RNA.	4
Q.63	Justify:  RNA polymerase cannot transcribe a gene by itself.  The terminator sequence can be used to define the template strand.	2
Q.64	Given below is a DNA sequence.  5' - TAACGATCGTACATGGAT - 3'  Identify the mRNA sequence that is transcribed from this DNA sequence.  Can this sequence be translated? Give a reason to support your answer.  [Note: Assume no post-transcriptional and post-translational modifications will take place.]	3
Q.65	What does a translational unit comprise?  If a codon CGA that codes for arginine is present on the mRNA after codon AUG, describe how the translation process will be done step-wise.	3
Q.66	The expressions of genes are regulated by metabolic, physiological and environmental factors/conditions.  With the help of TWO examples, justify this statement in the case of eukaryotes.	2

## Answer Key & Marking Scheme

Q. No	Answers	Marks
Q.48	C. Parental characters are found in each chromosome.	1
Q.49	A. A wardrobe	1
Q.50	B. only S	1
Q.51	C. R	1
Q.52	C. Both rough and smooth colonies would be seen.	1
Q.53	C. P and R are true and R is the reason for P	1
Q.54	B. Both A and R are true, but R is not the correct explanation for A.	1
Q.55	B. only R	1
Q.56	<p>0.5 marks each for the following:</p> <ul style="list-style-type: none"> <li>- Positively charged basic histone proteins combine to form a unit of 8 molecules called the histone cluster.</li> <li>- DNA is wrapped around the histone cluster to form a nucleosome.</li> <li>- Many such nucleosomes repeat to form a bead-in-a-string structure called the chromatin which are thread like bodies.</li> <li>- The chromatin is further packaged with the help of non-histone chromosomal proteins to fit into the nucleus.</li> </ul> <p>[Key words mandatory in the complete answer are highlighted]</p>	2
Q.57	<p>1 mark for each correct step such as:</p> <ul style="list-style-type: none"> <li>- A nitrogenous base is linked to the OH of 1' C pentose sugar through a N-glycosidic linkage to form adenosine and cytidine nucleosides.</li> <li>- Next, a phosphate group is linked to OH of 5' C of a nucleoside through a phosphoester linkage, forming adenine and cytosine nucleotides.</li> <li>- The 3'C of adenine links to the 5'C of cytosine to form a 3'-5' phosphodiester linkage to form a dinucleotide.</li> <li>- In a similar manner, a dinucleotide is formed between thymine and guanine.</li> <li>- Finally, adenine forms two hydrogen bonds with thymine and cytosine forms three hydrogen bonds with guanine to form the dinucleotide base pairs.</li> </ul>	5

<p>Q.58</p>	<p>1 mark each for the following:</p> <p>Both processes involve the copying of a DNA molecule.</p> <p>Both processes take place in the nucleus of the cell.</p> <p>[Accept any other valid answer.]</p> <p>1 mark each for the following:</p> <p>location: DNA strands formed after replication continue to stay in the nucleus whereas mRNA formed after transcription moves/is exported to the cytoplasm.</p> <p>lifespan: DNA strands formed after replication continue to remain in the nucleus as long as the cell is living whereas mRNA is degraded after translation.</p> <p>(c) 0.5 marks each for the following:</p> <p>DNA replication: S phase</p> <p>DNA transcription: throughout the cell cycle</p>	<p>5</p>
<p>Q.59</p>	<p>Since no Okazaki fragments are formed in PCR amplification, ligase is not required in the process.</p> <p>1 mark each for the following:</p> <p>In PCR, heat is used to denature/separate the dsDNA.</p> <p>DNA polymerase cannot withstand this high temperature and will denature.</p> <p>PCR can be used to amplify any sequence of nucleotides - RNA or DNA whereas DNA replication is only for DNA sequences.</p> <p>PCR can be used to amplify just one gene as well unlike DNA replication which involves duplication of the entire genome.</p> <p>[Accept any other valid answer]</p> <p>For a given sequence, DNA replication is much faster as all three steps (denaturation, annealing and replication) happen simultaneously whereas in PCR it happens one by one which takes longer.</p> <p>[Accept any other valid answer]</p>	<p>5</p>

Q.60	<p>A possible complete answer:</p> <p>According to Chargaff's rule,</p> <p>If, C = 35%, then G = 35%</p> <p>If C and G make up 70% of the sequence then A and T will make up 30% So, A = T = 15%</p> <p>[0.5 marks for mentioning the rule</p> <p>0.5 marks for calculating the percentage of guanine nucleotides</p> <p>0.5 marks for calculating the percentage of A + T nucleotides</p> <p>0.5 marks for finding the percentage of adenine nucleotides]</p>	2
Q.61	<p>1 mark for each correct point:</p> <p>It is considered efficient because they catalyse polymerisation of a large number of nucleotides in a very short time.</p> <p>They are highly accurate to avoid mutations.</p> <p>Even though the process needs a lot of energy the deoxyribose triphosphates act both as substrate and energy providers for the reaction as the two terminal phosphates are high-energy phosphates.</p>	3
Q.62	<p>(a) 0.5 marks for each of the following:</p> <p>can replicate</p> <p>should be stable</p> <p>allow for slow mutations</p> <p>ability to express itself</p> <p>(b) 0.5 marks for each comparison:</p> <p>Both, DNA and RNA can replicate.</p> <p>RNA is unstable when compared to DNA, due to the presence of the 2'-OH group at every nucleotide which makes it easily degradable.</p> <p>Both, DNA and RNA can mutate.</p> <p>Both can express themselves - RNA can do it directly by forming proteins whereas DNA can do it by forming an RNA first.</p> <p>[Award marks even if only the comparison between RNA and DNA is mentioned]</p>	4
Q.63	<p>RNA polymerase is only capable of catalysing the process of elongation. It associates transiently with the initiation factor and the termination factor to initiate and terminate the transcription, respectively.</p>	2

	The terminator sequence is located at the 3' end of the coding strand and can help identify the coding strand, the opposite of which is the template strand.	
Q.64	<p>(a) 1 mark each for the following:</p> <ul style="list-style-type: none"> <li>- Identify the complementary strand 3' - ATTGCTAGCATGTACCTA - 5'</li> <li>- Find the mRNA sequence:</li> </ul> <p>UAA CGA UCG UAC AUG GAU</p> <p>[Marks to be awarded if only the mRNA sequence is mentioned]</p> <p>(b) 0.5 marks each for the following:</p> <p>No</p> <p>The first codon of this sequence codes for a stop codon.</p>	3
Q.65	<p>A translation unit is the sequence of mRNA that codes for an amino acid sequence (polypeptide) with a start codon on one end and a stop codon on the other.</p> <p>[1 mark for mentioning all three parts. No marks are to be awarded for missing any of the parts of a unit]</p> <p>0.5 marks for each step:</p> <p>Charging of tRNA: Arginine is charged in the presence of ATP and linked to its specific tRNA molecule.</p> <p>The small subunit encounters the mRNA.</p> <p>The large subunit, which has two sites for tRNAs to bind, which have the initiator tRNA and the arginine tRNA bound to it.</p> <p>Here, methionine and arginine form a peptide bond with each other in the presence of a catalyst before the ribosome moves ahead.</p>	3
Q.66	<p>1 mark each for the following:</p> <p>Glucose in the body is used by cells to produce energy, which causes glucose levels in the blood to reduce and signal the pancreas to produce less insulin, thereby reducing the transcription and translation of genes coding for insulin.</p> <p>The presence of mutagens in the environment impacts the expression of genes related to growth such that excessive uncontrolled growth begins in some cells, leading to cancer.</p> <p>[Accept any other valid answer]</p>	2

## 9. ORGANISMS AND POPULATION

Q. No	Question	Marks
<b>Multiple Choice Question</b>		
Q.67	<p>The larvae of insects such as the African midge inhabit temporary pools in hollows of rocks when water evaporates in their arid environment. These larvae revive when immersed in water even after a few years.</p> <p>Which response to abiotic stress does the statement depict?</p> <p>A. regulation B. migration C. suspension D. conformation</p>	1
Q.68	<p>Trees in some regions have very thin barks, broad leaves placed at different angles to allow them to capture adequate sunlight and leaves with pointed tips that allow water to run off easily.</p> <p>In which biome are such trees likely to be found?</p> <p>A. arctic B. desert C. coastal D. rainforests</p>	1

### Answer Key & Marking Scheme

Q. No	Answers	Marks
Q.67	C. suspension	1
Q.68	D. rainforests	1

## 10. PRINCIPLES OF INHERITANCE AND VARIATION

Q. No	Question	Marks												
<b>Multiple Choice Question</b>														
Q.69	<p>In mice, brown fur is dominant and white fur is recessive. A biologist crossed a brown fur male with a white fur female and obtained two brown fur and two white fur offspring. Which of the following statements is MOST likely to be true?</p> <p>A. Both parents are heterozygous.            B. Only the male parent is homozygous.            C. Only the male parent is heterozygous.            D. Only the female parent is heterozygous.</p>	1												
Q.70	<p>In which of the following process would genetic variation occur?</p> <p>P) mutation in liver cells            Q) development of a zygote to an embryo            R) gene flow from one population to another</p> <p>A. only P            B. only Q            C. only P and Q            D. only P and R</p>	1												
Q.71	<p>Which of the following was a reason that Mendel's experiments showed reproducible results?</p> <p>use of mathematical logic            use of large sample sizes            use of true breeding parental lines            use of pea plants that had a quick growth time</p> <p>Kernel colour in wheat ranges from dark red to white depending on the number of dominant alleles in the genotype of the plant as shown below.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>kernel colour</th> <th>no. of dominant alleles</th> </tr> </thead> <tbody> <tr> <td>dark red</td> <td>4</td> </tr> <tr> <td>medium red</td> <td>3</td> </tr> <tr> <td>intermediate red</td> <td>2</td> </tr> <tr> <td>light red</td> <td>1</td> </tr> <tr> <td>white</td> <td>0</td> </tr> </tbody> </table>	kernel colour	no. of dominant alleles	dark red	4	medium red	3	intermediate red	2	light red	1	white	0	1
kernel colour	no. of dominant alleles													
dark red	4													
medium red	3													
intermediate red	2													
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white	0													

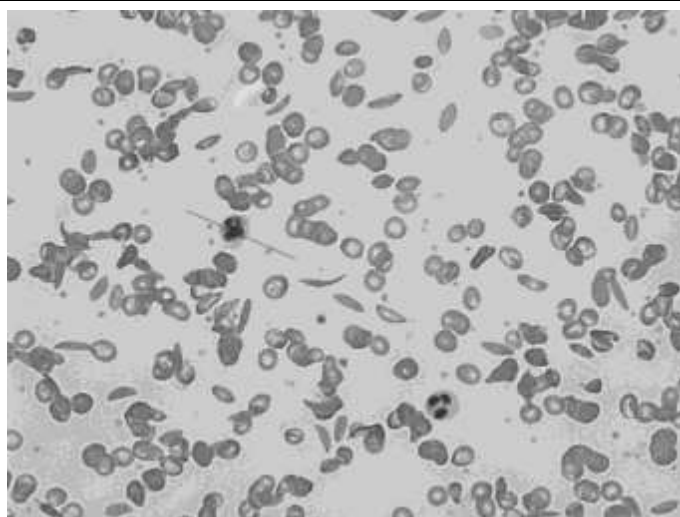


	<p>Assuming that a cross is performed between a homozygous dominant male and a homozygous recessive female, answer the questions that follow.</p> <p>Answer the Questions from Q72-Q75.</p>	
Q.72	<p>What will be the kernel colour of offspring in the F1 generation?</p> <p>A. white B. dark red C. medium red D. intermediate red</p>	1
Q.73	<p>How many genes code for kernel colour in wheat?</p> <p>A. 1 B. 2 C. 4 D. (Cannot say from the information provided)</p>	1
Q.74	<p>What would be the ratio of kernel colours in the F2 generation?</p> <p>A. 1:2:1 B. 9:3:3:1 C. 1:4:6:4:1 D. 1:6:15:20:15:6:1</p>	1
Q.75	<p>Which of the following phenomenon is/are exhibited by alleles coding for kernel colour in wheat?</p> <p>P) co-dominance Q) incomplete dominance R) polygenic inheritance</p> <p>A. only P B. only R C. only P and R D. only Q and R</p>	1
Q.76	<p>In a cross between pea plants having round green seeds (RRGG) and wrinkled yellow seeds (rrgg), what percentage of eggs will carry both the round and green alleles for the F2 generation?</p> <p>A. 9% B. 93% C. 64% D. D. 25%</p>	1
Q.77	<p>Which of the following processes helped scientists corroborate Mendel's findings much after he had discovered them?</p>	1

	<ul style="list-style-type: none"> <li>A. recombinant DNA technology</li> <li>B. DNA transcription</li> <li>C. DNA replication</li> <li>D. cell division</li> </ul>	
Q.78	<p>Marfan syndrome is a connective tissue disorder in humans caused due to the mutation of the FBN1 gene coding for fibrillin-1. Some symptoms of this disease are abnormally long limbs, heart murmurs, and extreme nearsightedness.</p> <p>Marfan syndrome is an example of .</p> <ul style="list-style-type: none"> <li>A. a chromosomal disorder</li> <li>B. polygenic inheritance</li> <li>C. codominance</li> <li>D. pleiotropy</li> </ul>	1
<b>Free Response Question/ Subjective Question</b>		
Q.79	<p>Mendel crossed a pea plant having inflated pods with another pea plant having constricted pods. Both parents were pure-lines. Next, he crossed the progeny obtained in the F1 generation.</p> <p>(a) Depict the cross and observations using a Punnett square.</p> <p>(b) How did his findings lead to the inference of the law of segregation?</p> <p>(c) State two findings that Mendel would have made if there was no segregation.</p>	5
Q.80	State two ways in which sex determination in humans is different from that in honeybees.	2
Q.81	<p>The pea plant is a self-pollinating plant.</p> <p>(a) Why was this fact about the pea plant a concern in Mendel's experiments?</p> <p>(b) How did Mendel ensure that self-pollination was avoided in his experiments?</p>	2
Q.82	<p>The stem colour of a plant is characterised by a green (G) dominant allele and a yellow (g) recessive allele.</p> <p>(a) What would be the genotype/s of a plant with a green phenotype of the stem colour?</p> <p>(b) Using an illustration, explain how we can ascertain the correct genotype of the plant mentioned in (a).</p> <p>(c) Name and define the process followed in (b).</p>	5

Q.83	<p>In the process of sperm formation, a cell called the spermatogonium undergoes mitosis first to form the primary spermatocyte, which then undergoes meiosis to form the spermatozoa or the sperm cell.</p> <p>What percentages of the primary spermatocyte and the spermatozoa would have the X chromosome? Justify your answer.</p>	2
Q.84	<p>(a) What is the mode of inheritance of traits causing haemophilia?</p> <p>(b) What would be the possibility of a female and male child having haemophilia in the following scenarios?</p> <p>(i) the mother is a unaffected and the father is affected</p> <p>(ii) the mother is a carrier and the father is unaffected</p>	3
Q.85	<p>(a) State two points of difference between aneuploidy and polyploidy.</p> <p>(b) Failure in which phase of cell division can cause the conditions mentioned in (a)?</p>	3
Q.86	<p>In pea plants, inflated (A) and green (B) pods with round (C) seeds and the male with constricted (a) and yellow (b) pods with wrinkled (c) seeds.</p> <p>Mendel performed a cross to study the inheritance of these three traits. He performed a cross between two parents that were heterozygous for all the traits.</p> <p>Identify the:</p> <p>(a) Genotype of the gametes.</p> <p>(b) Number of offspring in the F1 generation. Give a reason to support your answer.</p> <p>(c) Number of offspring who are homozygous for all traits. State their phenotype.</p>	5
Q.87	<p>A colour-blind father will not have a colour-blind son.</p> <p>State if the above statement is true and justify your answer if the mother is homozygous for the:</p> <p>(a) colour blind trait</p> <p>(b) normal vision trait</p>	2
Q.88	<p>Rett syndrome is a rare X-linked dominant genetic neurological and developmental disorder that affects the way the brain develops.</p> <p>What would be the occurrence of the disease in their daughter and son, if:</p> <p>(a) a normal male marries a female with Rett syndrome</p> <p>(b) a normal female marries a male with Rett syndrome</p>	2

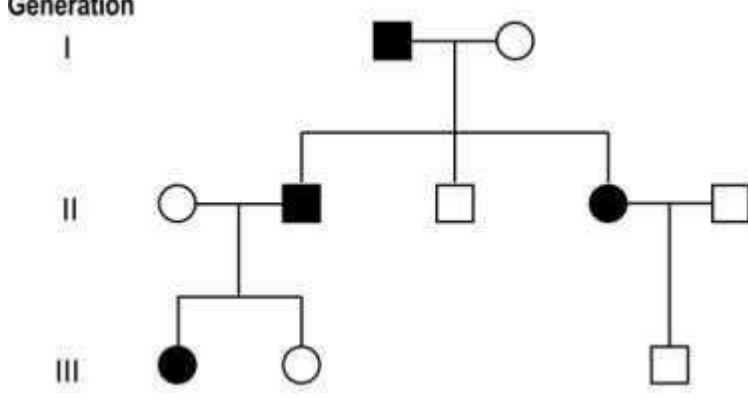
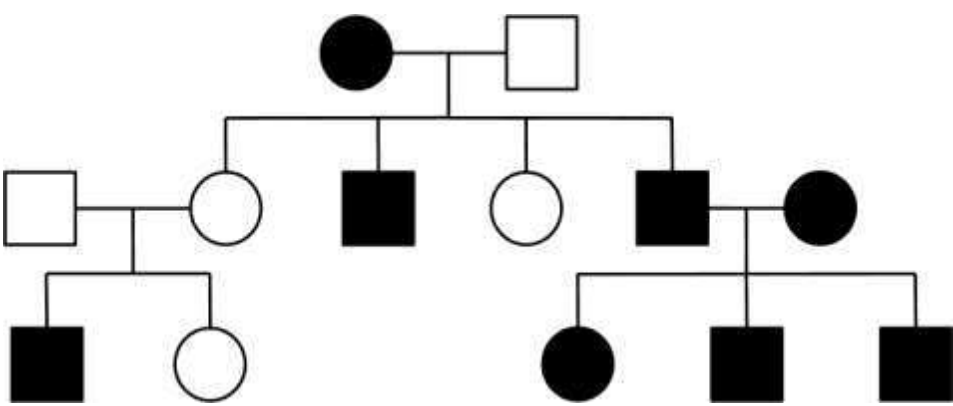
Q.89	State TWO points of difference and TWO points of similarity between Klinefelter's syndrome and Turner's syndrome.	2
Q.90	Using a Punnett square, determine the genotype of the parents if their child can have any of the four blood groups.	2
Q.91	Duchenne muscular dystrophy is an X-linked recessive genetic disease that is also caused by mutations in the DMD gene.  Predict the genotypic and phenotypic ratios of the possible offspring of a male with muscular dystrophy and a female who is a carrier using suitable symbols for the alleles in a Punnett grid.	3
Q.92	A gardener has been planting white flowers that grow on the terminal ends of the plant in a garden for several months.  One day, a purple flower along the terminal end of the plant grows. The gardener wants to know if these flowers would give rise only to purple terminal flowers if pollinated. She knows that purple axial alleles are recessive over white terminal ones.  (a) What are the possible genotypes of the new purple flower that sprouted?  (b) If she wants to use only one generation to determine its genotype, what should she do?  (c) With the help of a Punnett grid/s, help her make inferences to arrive to the conclusion she desires.	5
Q.93	Sickle cell anemia (allele a) is a disorder where the RBCs stretch out and become thin as opposed to the round normal (allele A) RBCs. A person who is homozygous for normal RBCs marries a person who is heterozygous for sickle cell RBCs.  What is the probability of the off-springs to be homozygous for the sickle cell trait?  Blood from one of the off-springs was checked and the microscopic image of its RBCs is shown below.	3

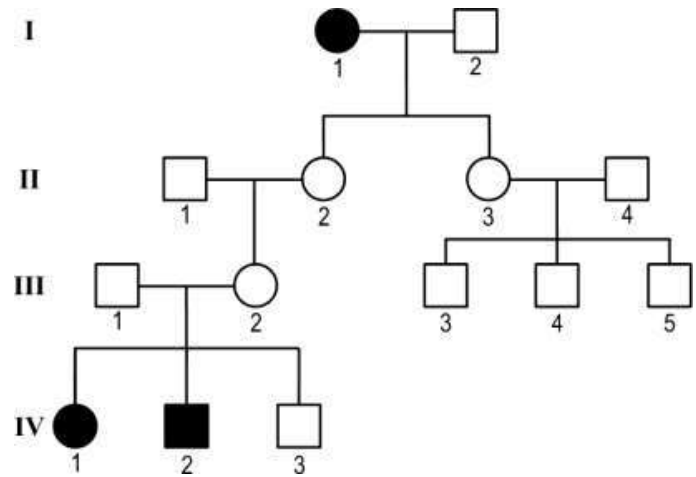


What is the genotype of this individual?

(c) Based on the image shown, explain the type of dominance exhibited by the sickle cell allele?

Q.94	<p>Mia's family consists of her grandparents, brother, sister and parents. Her parents are the only off-springs of her paternal and maternal grandparents. She is the only one in her family who has thalassemia. Of her 4 grandparents, her maternal grandmother had thalassemia.</p> <p>Describe the method she can use to analyse the inheritance of thalassemia in her family.</p> <p>Draw an illustration to show the pattern of inheritance.</p> <p>What is the mode of inheritance? Justify your answer.</p>	5
Q.95	<p>A roan cattle is an animal that has both red (R) and white (R') hair on its coat.</p> <p>Consider that two cows - one pure line for white hair and one pure line for red hair are crossed.</p> <p>What would be the genotype and phenotype of the F1 and F2 generations?</p> <p>What kind of dominance does the gene for hair colour exhibit? Give a reason to support your answer.</p>	3
Q.96	<p>State THREE advantages of using Drosophila as the model organism for studying genetics as compared to Mendel's pea plant.</p>	3
Q.97	<p>Given below is a pedigree chart for an autosomal dominant disorder characterised by trait 'A'.</p>	2

	<p style="text-align: center;">Generation I</p>  <p>What evidence in the pedigree chart helps establish that the condition is caused by a dominant allele?</p> <p>What are the genotypes of the affected and unaffected individuals?</p>	3
Q.98	<p>Given below is the pedigree of a family for a trait.</p>  <p>Identify the mode of inheritance of the trait. Give a reason(s) to support your answer.</p> <p>Choose the correct answer to complete the following sentence:</p> <p>Colour blindness is a sex-linked condition. However, a (heterozygous/homozygous) (male/female) will always have normal vision.</p>	3
Q.99	<p>Cystic fibrosis is a condition in which a defective cf gene (consider allele c) produces faulty transport channels that causes mucus to build up in the ducts of different organs leading to vitamin deficiency diseases, respiratory infections and excessive loss of salt through sweat.</p> <p>Given below is a pedigree chart for a family. The great-grandmother, represented as I- 1, suffers from cystic fibrosis.</p>	3



Identify the type of expression of the cystic fibrosis gene. Give a reason to support your answer.

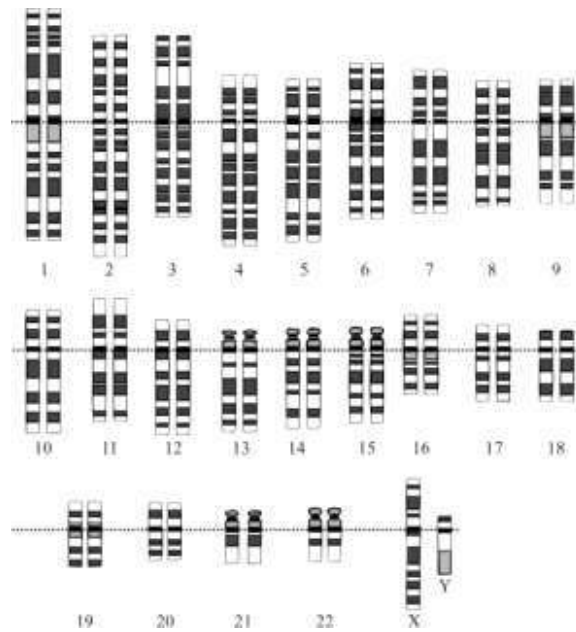
From the pedigree, deduce the pattern of inheritance exhibited by the gene. Justify your answer.

Identify the genotypes of II-2 and III-2.

Q.100

Given below is the karyotype of an individual.

2



What are the characteristic reproductive and physical features of such an individual?

What is the category of such disorders called? How is it caused?

## Answer Key & Marking Scheme

Q. No	Answers	Marks
Q.69	C. Only the male parent is heterozygous.	1
Q.70	D. only P and R	1
Q.71	C. use of true breeding parental lines	1
Q.72	D. intermediate red	1
Q.73	B. 2	1
Q.74	C. 1:4:6:4:1	1
Q.75	B. only R	1
Q.76	D. 25%	1
Q.77	D. cell division	1
Q.78	D. pleiotropy	1
Q.79	<p>(a) Draws correct Punnett squares for F1 and F2 offsprings with the correct signs and ratios</p> <p>(b) Since the recessive parental trait is expressed without any blending in the F2 generation, the alleles from the parental pair separate or segregate from each other and only one allele is transmitted to the offspring.</p> <p>(c) 1 mark each for the following:</p> <ul style="list-style-type: none"> <li>- He would have arrived at a 1:1 ratio in the F1 generation</li> <li>- A trait would not disappear in F1 and reappear in F2.</li> </ul>	5
Q.80	<p>1 mark each for any two differences such as:</p> <ul style="list-style-type: none"> <li>- Sex determination in humans is of the XY type i.e the male has 2 different sex chromosomes (X and Y) and females have 2 copies of X chromosome whereas it is of the haplodiploid type in bees i.e, females are diploid and males are haploid (only one set of chromosomes)</li> <li>- Males in bees are produced by parthenogenesis and females by fertilization, whereas both male and female offspring in humans are produced by fertilization.</li> <li>- Sperm production by mitosis in bees and by meiosis in humans.</li> </ul>	2



	[Accept any other point of difference]	
Q.81	(a) In Mendel's experiment, self-pollination would have led to unknown and undesirable results as the experiment would not have been controlled.  (b) by the removal of stamen or anther from the flower bud	2
Q.82	(a) 0.5 marks each for the following: - GG (homozygous) - Gg (heterozygous)  (b) Punnett square for GG x gg with the correct result and interpretation [1.5 marks]  Punnett square for Gg x gg with the correct result and interpretation [1.5 marks]  (c) 0.5 marks each for the following: - test cross  - A genetic cross between a homozygous recessive parent and a parent with unknown genotype to determine the genotype of the latter.	5
Q.83	100% of primary spermatocyte will have the X chromosome whereas 50% of the sperm cells will have the X chromosome.  Since the spermatogonium undergoes mitosis the number of chromosomes remains the same in the daughter cell i.e all cells get all the chromosomes whereas when the primary spermatocyte undergoes meiosis, where the number of chromosomes divide, only half the cells get the X chromosome.	2
Q.84	(a) X-linked recessive transmission  (b) 0.5 marks for each of the following: (i) male child: all will be unaffected female child: all will be carriers  (ii) male child: half will be affected and half will be unaffected female child: half will be carriers and half will be unaffected	3
Q.85	(a) 1 mark each for the following: - Aneuploidy is the loss or gain of an extra chromosome whereas polyploidy is the gain of an entire chromosome set(s). - Aneuploidy is common in humans whereas polyploidy is common in plants. [Accept any other valid point of difference]  (b) 0.5 marks each for the following: Aneuploidy - anaphase	3

	Polyploidy - anaphase/cytokinesis	
Q.86	<p>(a) Genotype of gametes: ABC, ABc, AcB, aBC, Abc, abC, aBc, abc</p> <p>(b) Number of offsprings: 64</p> <p>Reason: Since 8 gametes will be produced by each parent, the cross will result in <math>8 \times 8 = 64</math> offsprings</p> <p>[1 mark each for the correct number of offsprings and the reason]</p> <p>(c) 2 offsprings will be homozygous for all traits [1 mark]</p> <p>0.5 marks for each of the following:</p> <ul style="list-style-type: none"> <li>- inflated, green pods with round seeds</li> <li>- constricted, yellow pods with wrinkled seeds</li> </ul>	5
Q.87	<p>[marks to be given only if the mode of inheritance is mentioned]</p> <p>(a) Since colour blindness is an X-linked recessive disorder, a colour blind male will share the normal Y chromosome and the colour blind mother will share a chromosome with the colour blindness trait to the child, making him a carrier but having normal vision.</p> <p>(b) A colour blind male will transfer the normal Y chromosome and the mother with normal vision will transfer a chromosome with the normal vision trait to the child so the child will not be a carrier too.</p>	2
Q.88	<p>(a) 0.5 marks for each of the following:</p> <p>son: will have Rett syndrome</p> <p>daughter: will have Rett syndrome</p> <p>(b) 0.5 marks for each of the following:</p> <p>son: will not have Rett syndrome</p> <p>daughter: will have Rett syndrome</p>	2
Q.89	<p>0.5 marks each for any TWO points of difference such as:</p> <ul style="list-style-type: none"> <li>- Klinefelter's syndrome is caused due to the presence of an additional copy of the X chromosome whereas Turner's syndrome is caused due to the absence of an X chromosome.</li> <li>- Klinefelter's syndrome occurs in both genders whereas Turner's syndrome is found in females.</li> </ul> <p>[Accept any other valid point]</p> <p>0.5 marks each for any TWO similarities such as:</p> <ul style="list-style-type: none"> <li>- Both are chromosomal disorders related to the sex chromosomes</li> </ul>	2

	<p>- In both disorders, the individuals are sterile.</p> <p>[Accept any other valid point]</p>										
Q.90	<p>1 mark for drawing the Punnett square and 1 mark for identifying both the parental genotypes correctly.</p> <p>- Child can have any of the four blood groups - IAi, IBi, IAIB, ii</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td>IB</td> <td>i</td> </tr> <tr> <td>IA</td> <td>IAIB</td> <td>IBi</td> </tr> <tr> <td>i</td> <td>IAi</td> <td>ii</td> </tr> </table> <p>- The parent genotypes would have to be IAi, IBi</p>		IB	i	IA	IAIB	IBi	i	IAi	ii	2
	IB	i									
IA	IAIB	IBi									
i	IAi	ii									
Q.91	<p>Punnett grid [1 mark]</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td>XH</td> <td>Xh</td> </tr> <tr> <td>Xh</td> <td>XHXh</td> <td>XhXh</td> </tr> <tr> <td>Y</td> <td>XHY</td> <td>XhY</td> </tr> </table> <p>Genotypic ratio [0.5 marks] 1 XHXh: 1XhXh: 1XHY: 1XhY</p> <p>Phenotypic ratio [1.5 marks] 1 female with muscular dystrophy: 1 carrier female: 1 male with muscular dystrophy: 1 normal male</p> <p>OR</p> <p>50% offsprings with muscular dystrophy: 50% without muscular dystrophy</p> <p>OR</p> <p>50% offsprings with muscular dystrophy: 25% normal: 25% carriers</p>		XH	Xh	Xh	XHXh	XhXh	Y	XHY	XhY	3
	XH	Xh									
Xh	XHXh	XhXh									
Y	XHY	XhY									
Q.92	<p>(a) 0.5 marks for each of the following:</p> <ul style="list-style-type: none"> <li>- wwTT</li> <li>- wwTt</li> </ul> <p>(b) She will need to perform a test cross with a purple axial flower that are homozygous for both alleles.</p> <p>(c) 1 mark for each grid and 0.5 marks for each inference:</p>	5									

Possibility 1:  $wwTt \times wwtt$

	wT	wt	wT	wt
wt	wwTt	wwtt	wwTt	wwtt
wt	wwTt	wwtt	wwTt	wwtt
wt	wwTt	wwtt	wwTt	wwtt
wt	wwTt	wwtt	wwTt	wwtt

- Inference: If the genotype of the unknown flower is  $wwTt$  then only 50% progeny will have purple terminal flowers.

Possibility 2:  $wwTT \times wwtt$

	wT	wT	wT	wT
wt	wwTt	wwTt	wwTt	wwTt
wt	wwTt	wwTt	wwTt	wwTt
wt	wwTt	wwTt	wwTt	wwTt
wt	wwTt	wwTt	wwTt	wwTt

- Inference: If the genotype of the unknown flower is  $wwTT$  only then all progeny will have purple terminal flowers.

Q.93

Probability of offspring being homozygous for sickle cell anemia - 0%  
Heterozygous (Aa) for sickle cell anemia.  
co-dominance - as both parental alleles are expressed in the offspring

3

Q.94

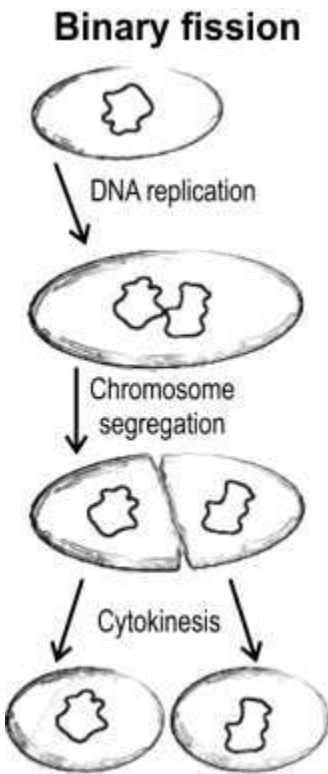
(a) 0.5 marks each for the following:  
Pedigree analysis can be done to analyse the inheritance of thalassemia in her family.  
It is the study and representation of the family history with respect to inheritance of a particular trait.  
1 mark for correct drawing of the pedigree and 1 mark for the correct symbols.

5

	<p>Autosome linked recessive trait [1 mark]</p> <p>Justification: This is an autosome-linked recessive blood disease transmitted from parents to the offspring when both the partners are unaffected carriers for the gene. [1 mark]</p>	
Q.95	<p>(a) 0.5 marks each for the following:</p> <p>F1 generation genotype: all RR'</p> <p>F1 generation phenotype: all roan cows</p> <p>F2 generation genotype: 1RR:2RR':1R'R'</p> <p>F2 generation phenotype: 1 red hair cow, 2 roan hair cows, 1 white hair cow.</p> <p>(b) 0.5 marks each for the following:</p> <p>codominance</p> <p>both alleles are equally expressed in the offsprings</p>	3
Q.96	<p>1 mark each for the following:</p> <p>Drosophila can be grown on a simple synthetic medium making growth faster and more controlled whereas pea plants were grown naturally, making growth slower and unpredictable.</p> <p>Drosophila complete their life cycle in about two weeks whereas pea plants take 10-12 weeks.</p> <p>In Drosophila, there is a clear differentiation of the sexes whereas pea plants are bisexual.</p>	3
Q.97	<p>1 mark for any one reason such as:</p> <p>In every generation, there is an affected individual. OR</p> <p>An affected offspring has an affected parent.</p> <p>0.5 marks each for the following:</p> <p>Affected individual - heterozygous dominant OR Aa</p>	2

	Unaffected individual - homozygous recessive OR aa	
Q.98	<p>(a) 1 mark for each correct answer: X-linked recessive disorder</p> <p>The affected mother has all affected male children but female children are not affected.</p> <p>(b) 0.5 marks each for the following: heterozygous female</p>	3
Q.99	<p>(a) 0.5 marks each for the following: pleiotropy</p> <p>One gene is affecting multiple organs and therefore contributing to multiple phenotypes. [Accept any other valid answer]</p> <p>(b) 0.5 marks each for the following: recessive disorder</p> <p>Expression of the trait is skipping generations so it cannot be dominant. [Accept any other valid answer]</p> <p>(c) 0.5 marks each for the following: II-2 - Cc III-2 - Cc</p>	3
Q.100	<p>(a) 0.5 marks for each of the following: may or may not have an impact on reproductive features short stature with a small round head [Accept any other valid answer]</p> <p>(b) 0.5 marks each for the following: category: chromosomal disorders/aneuploidy cause: failure of segregation of chromatids during cell division</p>	2

## 11. REPRODUCTION IN ORGANISMS

Q. No	Question	Marks
<b>Free Response Question / Subjective Question</b>		
Q.101	<p>Amoeba reproduce through a process called binary fission as shown in the diagram below:</p> <div data-bbox="628 555 957 1326" style="text-align: center;"><p><b>Binary fission</b></p></div> <p>(a) How is this different from mitosis with reference to:</p> <ol style="list-style-type: none"><li>types of cells where these processes take place?</li><li>how the genetic material is divided?</li></ol> <p>(b) In case of binary fission, are the daughter cells genetically similar to the parent cells? Justify.</p>	2

## Answer Key & Marking Scheme

Q. No	Answers	Marks
Q.101	<p>(a) 0.5 marks for each correct answer:</p> <p>Mitosis occurs in eukaryotic cells while binary fission occurs in prokaryotic cells.</p> <p>In binary fission, the genetic material is simply cut into two halves / there is no spindle formation while in mitosis, spindle formation divides the nuclear material.</p> <p>(b) - Yes. [0.5 marks]</p> <p>- The parental genetic material is divided into two and passed on to the daughter cells formed by binary fission. [0.5 marks]</p>	2



## 12. REPRODUCTIVE HEALTH

Q. No	Question	Marks
<b>Multiple Choice Question</b>		
Q.102	<p>Which of the following is an indicator of a reproductively unhealthy society?</p> <p>A. increase in infant mortality rate            B. decline in maternal mortality rate            C. widespread awareness of contraceptive methods            D. detection and cure of sexually transmitted diseases</p>	1
Q.103	<p>Amniocentesis is a medical procedure where some of the amniotic fluid of the developing foetus is drawn to analyse the foetal cells and dissolved substances. It was banned in India around 1994 under the Pre-Conception and Prenatal Diagnostic Techniques Act in order to stop female foeticides.</p> <p>Which of the following highlight the importance of amniocentesis despite the ban?</p> <p>A. identification of a decline in sex ratio            B. prevention of sexually transmitted diseases            C. determination of biological sex of the unborn baby            D. detection of genetic disorders</p>	1
Q.104	<p>Two statements are given below - one is an Assertion (A) and the other is a Reason (R).</p> <p>Assertion (A): Periodic abstinence is a natural method of birth control where couples avoid intercourse from day 10 to 17 of the menstrual cycle.</p> <p>Reason (R): Ovulation occurs around the middle of the menstrual cycle.</p> <p>Which of the following is correct?</p> <p>A. Both A and R are true, and R is a correct explanation of A.            B. Both A and R are true, but R is not a correct explanation of A.            C. A is true, but R is false.            D. A is false, but R is true.</p>	1
<b>Free Response Question / Subjective Question</b>		
Q.105	<p>The Medical Termination of Pregnancy (Amendment) Act, 2017 dictates that a pregnancy may be terminated on certain considered <i>grounds</i> within the first 12 weeks of pregnancy on the opinion of one registered medical practitioner. If the pregnancy has lasted more than 12 weeks, but fewer than 24 weeks, two</p>	2

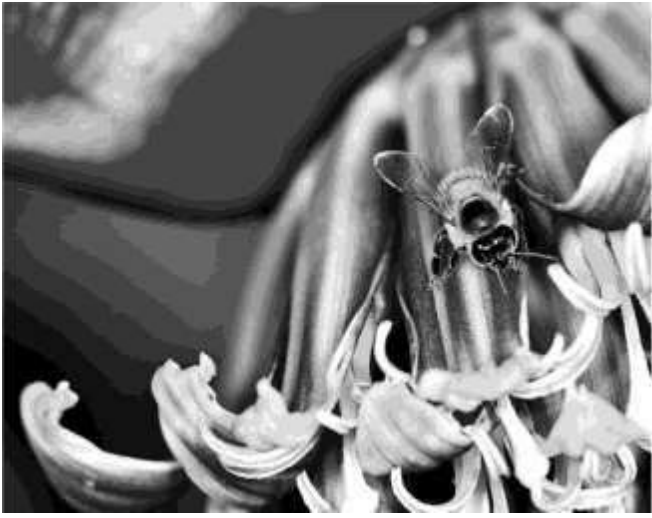
	<p>registered medical practitioners must be of the opinion, formed in good faith, that the required <i>ground</i> exist.</p> <p><i>[Note: Grounds refer to circumstances or conditions.]</i></p> <p>Describe two grounds under which medical termination of pregnancy is permitted.</p>	
Q.106	<p>Given below are two statements. State whether each of them is true or false and justify, using examples.</p> <p>(a) All contraceptives have the added advantage of protection against sexually transmitted diseases.</p> <p>(b) Natural birth control methods have negligible side effects.</p>	2
Q.107	<p>As a volunteer for creating sexual health awareness in rural areas, you have been asked to create a poster highlighting birth control options available to males.</p> <p>State two contraceptive methods with negligible chances of failure available to males. For each method, mention the working principle briefly.</p>	2

## Answer Key & Marking Scheme

Q. No	Answers	Marks
Q.102	A. increase in infant mortality rate	1
Q.103	D. detection of genetic disorders	1
Q.104	A. Both A and R are true, and R is a correct explanation of A.	1
Q.105	<p>1 mark each for any two of the following:</p> <p>If pregnancy is continued, it would threaten the mental, emotional, and physical well-being of the pregnant woman.</p> <p>There is possibility that the infant would suffer from physical or mental abnormalities as to be seriously handicapped.</p> <p>The pregnancy is unwanted by the pregnant woman.</p> <p>[Accept any other valid answer.]</p>	2
Q.106	<p>(a) 0.5 mark for each of the following:</p> <p>The statement is false.</p> <p>Contraceptives like IUDs and pills do NOT protect against STDs.</p> <p>(b) 0.5 mark for each of the following:</p> <p>The statement is true.</p> <p>No medicines or devices are used in natural birth control options such as periodic abstinence, lactational amenorrhea, and coitus interruptus.</p>	2
Q.107	<p>0.5 marks for each contraceptive method and 0.5 marks for each working principle:</p> <p>Method: condoms</p> <p>Working: act as a barrier between sperms and ovum</p> <p>Method: sterilisation/surgical method/vasectomy</p> <p>Working: blocks the transport of sperm to the urethra</p> <p>[Accept any other valid answer.]</p>	2

### 13. SEXUAL REPRODUCTION IN FLOWERING PLANTS

Q. No	Question	Marks
<b>Multiple Choice Question</b>		
Q.108	<p>Consider three plants with the following modes of pollination:</p> <p>Plant P: autogamy</p> <p>Plant Q: xenogamy</p> <p>Plant R: geitonogamy</p> <p>Which of the above case/s is/are most likely to NOT show genetic variation in the offspring?</p> <p>A. only P B. only Q C. only P and R D. only Q and R</p>	1
<b>Free Response Question/ Subjective Question</b>		
Q.109	<p>(a) Plants have two phases in their life cycle: sporophytic phase and gametophytic phase. The sporophytic phase is diploid and vegetative while the gametophytic phase is haploid and reproductive. From this information, identify the male gametophyte in angiosperms.</p> <p>(b) The megasporangium is the female spore-bearing structure which carries the megaspore mother cell. This gives rise to the megaspores. Name the megaspore in angiosperms.</p>	1
Q.110	<p>In angiosperms, the male gametophyte has a simple structure while the female gametophyte has a much more complex structure with multiple supporting cells in it.</p> <p>How does such a structural difference help each gametophyte perform their functions better?</p>	2
Q.111	<p>Emasculation is the process of removal of anthers from a flower and is practised in artificial hybridisation techniques.</p> <p>(a) Mention ONE case where emasculation is compulsory and ONE where it is not required during such hybridisation processes.</p> <p>(b) Why is bagging a compulsory technique even when emasculation is not required?</p>	2
Q.112	Angiosperms undergo double fertilisation.	3

	<p>(a) What is/are the product/s of double fertilisation?</p> <p>(b) If you are given a pea pod, how can you identify the product/s of double fertilisation in it?</p>	
Q.113	<p>Banana and many citrus fruits are formed without fertilisation.</p> <p>(a) Name the process of fruit/seed formation in both.</p> <p>(b) Mention ONE similarity and ONE difference between the two processes.</p>	3
Q.114	<p>The image below shows a bee visiting an inflorescence on a banana plant.</p>  <p>Considering the fact that banana is a parthenocarpic fruit, what would be MOST LIKELY the reason for the bee to visit the banana flowers?</p>	1

## Answer Key & Marking Scheme

Q.No	Answers	Marks
Q.108	C. only P and R	1
Q.109	0.5 marks for each correct answer: (a) pollen grain (b) ovule	1
Q.110	1 mark each for mentioning the following: - The pollen grain needs to be transferred to the stigma. Hence, smaller size makes it easier for the movement. - The ovule develops into the seed and supports the growing embryo. The supporting cells provide nourishment to the growing embryo.	2
Q.111	(a) 0.5 marks for each correct answer: - compulsory for bisexual flowers - not required in case of unisexual flowers (b) to prevent unwanted cross pollination in unisexual flowers	2
Q.112	(a) 0.5 marks for each correct name: - embryo - endosperm (b) 1 mark for each correct answer: - The embryo is represented by the entire pea seed. - The endosperm is consumed by the developing embryo and cannot be identified as such.	3
Q.113	(a) 0.5 marks for each correct name: -banana: parthenocarpy - citrus fruits: apomixis (b) 1 mark for each correct similarity and difference respectively: Similarity: Both are asexual modes of reproduction. Difference: Apomixis is a process of seed formation while parthenocarpy creates seedless fruits.	3
Q.114	to collect nectar	1

## 14. STRATEGIES FOR ENHANCEMENT IN FOOD PRODUCTION

Q. No	Question	Marks
<b>Multiple Choice Question</b>		
Q.115	<p>Two statements are given below - one is an Assertion (A) and the other is Reasoning (R).</p> <p>Assertion (A): Continued inbreeding increases fertility and heterozygosity. Reasoning (R): Closely related individuals within the same breed who do not have a common ancestor for 4-6 generations are mated to develop pure lines.</p> <p>Which of the following is correct?</p> <p>A. Both A and R are true, and R is a correct explanation for A. B. Both A and R are true, but R is not a correct explanation for A. C. A is true, but R is false. D. A is false, but R is true.</p>	1
Q.116	<p>In Multiple Ovulation Embryo Transfer Technology (MOET), a sheep who acts as the genetic mother is artificially inseminated. The embryos are recovered non-surgically and transferred to surrogate mothers.</p> <p>What is the purpose of having separate genetic and surrogate mothers?</p> <p>A. The surrogate mother has a shorter pregnancy term. B. The genetic mother cannot mate with the bull naturally. C. The surrogate mother cannot produce multiple eggs per cycle. D. The genetic mother can undergo multiple rounds of super ovulation.</p>	1
Q.117	<p>A laboratory is developing a hybrid Basmati rice cultivar with the objective of increased grain length. Following are some details:</p> <p>Desired characteristics: require less water and mature early than traditional Basmati cultivars.</p> <p>Parent cultivars: Pusa 614–1-2 and Pusa 614–2–4-3 States grown in: Punjab, Haryana, and Uttarakhand</p> <p>A scientist outlined the steps for testing it before the release:</p> <p>growing the cultivar in research fields recording yield under ideal irrigation growing in farmers' fields for at least three growing seasons at several locations in the country representing all the agroclimatic zones where the crop is usually grown</p>	1

	<p>As a fellow scientist, you have to recommend another key aspect of testing that your colleague has missed. Select the appropriate recommendation from below.</p> <p>A. growing in coastal belts of India  B. cultivating for atleast 4 growing seasons  C. choosing parents with disease resistance  D. comparing the yield against a reference cultivar</p>	
Q.118	<p>The Neelagiri breed of sheep are distributed in Tamil nadu. For a few generations, the animals have been producing poor quality of wool.</p> <p>To improve the wool quality, one Neelagiri sheep has been selected for out-crossing with another sheep.</p> <p>Select the statement that describes the relationship between the two sheep.</p> <p>A. They are animals of different breeds.  B. They are animals of different species.  C. They are related animals of the same breed.  D. They are unrelated animals of the same breed.</p>	1
Q.119	<p>Consider two statements.</p> <p>The capacity to generate a whole plant from any cell is called totipotency.</p> <p>Any part of a diseased plant can be cultured in laboratory to recover healthy plants.</p> <p>Choose the correct option.</p> <p>A. Statement I is true, and II is the reason.  B. Statement II is true, and I is the reason.  C. Statement I is true, but statement II is false.  D. Statement II is true, but statement I is false.</p>	1
Q.120	<p>Complete the following sentence by selecting the correct option.</p> <p>The tangelo is a fruit produced by crossing <i>Citrus reticulata</i> and <i>Citrus maxima</i> plants. It is an example of _____.</p> <p>A. inbreeding  B. out-crossing  C. cross-breeding  D. interspecific hybridisation</p>	1
Q.121	<p>Somatic hybridisation is the artificial technique of creating a hybrid plant combining the desirable characteristics of two plants.</p> <p>Which of the following conditions MUST be satisfied by the two cells used for somatic hybridisation?</p> <p>A. They are gametes.  B. They lack cell wall.</p>	1



	<p>C. They contain chlorophyll.</p> <p>D. They belong to same species.</p>	
<b>Free Response Question / Subjective Question</b>		
Q.122	<p>Sugarcane varieties that were earlier found in North India did not have enough sugar content. So, scientists decided to initiate a project to develop varieties of sugarcane which produce higher content of sugar.</p> <p>Given that the scientists had no prior information about sugarcane, describe the steps that they need to go through to create a high-sugar variety of sugarcane that can be tested.</p>	4
Q.123	<p>Two laboratories (Alpha and Bravo) executed different approaches to create a mustard plant variety that is resistant to aphids. Alpha laboratory followed the steps of conventional breeding technique as described below.</p> <p>germplasm collection</p> <p>evaluation and selection of parents</p> <p>cross-hybridisation among selected parents</p> <p>selection and testing of superior recombinant</p> <p>testing, release, and commercialisation of new cultivars</p> <p>Bravo laboratory followed mutation breeding to develop pest-resistant variety of mustard.</p> <p>Which step of Alpha's approach would be different from Bravo's approach?</p> <p>In the mutation breeding method, how is the step identified in (a) different?</p> <p>Name two ways by which Bravo laboratory could introduce variation in the mustard plant.</p>	2

## Answer Key & Marking Scheme

Q. No	Answers	Marks
Q.115	D. A is false, but R is true.	1
Q.116	D. The genetic mother can undergo multiple rounds of super ovulation.	1
Q.117	D. comparing the yield against a reference cultivar	1
Q.118	D. They are unrelated animals of the same breed.	1
Q.119	C. Statement I is true, but statement II is false.	1
Q.120	D. interspecific hybridisation	1
Q.121	B. They lack cell wall.	1
Q.122	<p>1 mark for each of the following:</p> <p>Collection of variability: The team will need to collect and preserve all the different wild varieties, species and relatives of the cultivated species (followed by their evaluation of their characteristics) for effective exploitation of natural genes available in the populations.</p> <p>Evaluation and selection of parents: The germplasm is evaluated so as to identify plants with a desirable combination of characteristics. These parents are multiplied to create pure lines.</p> <p>Cross hybridisation among the selected parents: The parents are cross hybridized to produce variants with the desired characteristics.</p> <p>Selection and testing of the best recombinants: Since all offspring may not have the desired characteristics, it is important to select those that have the desired combination from among all the progeny. These are self-crossed for several generations till homozygous plants are obtained for testing.</p>	4
Q.123	<p>step I</p> <p>Genetic variability is introduced by artificial means.</p> <p>0.5 marks for each of the following:</p> <p>exposure to chemicals</p> <p>exposure to radiation</p> <p>[Award marks for any other relevant answer.]</p>	2

**Ei**



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