Competency Focused Practice Questions

Biology (Volume 1) | 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 283 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.

Please write back to us to give your feedback.

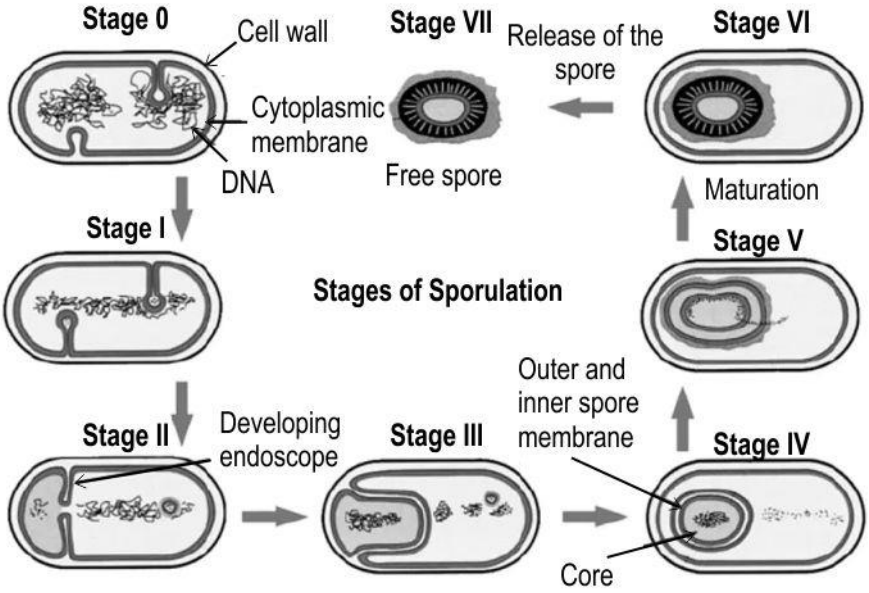
Team CBSE

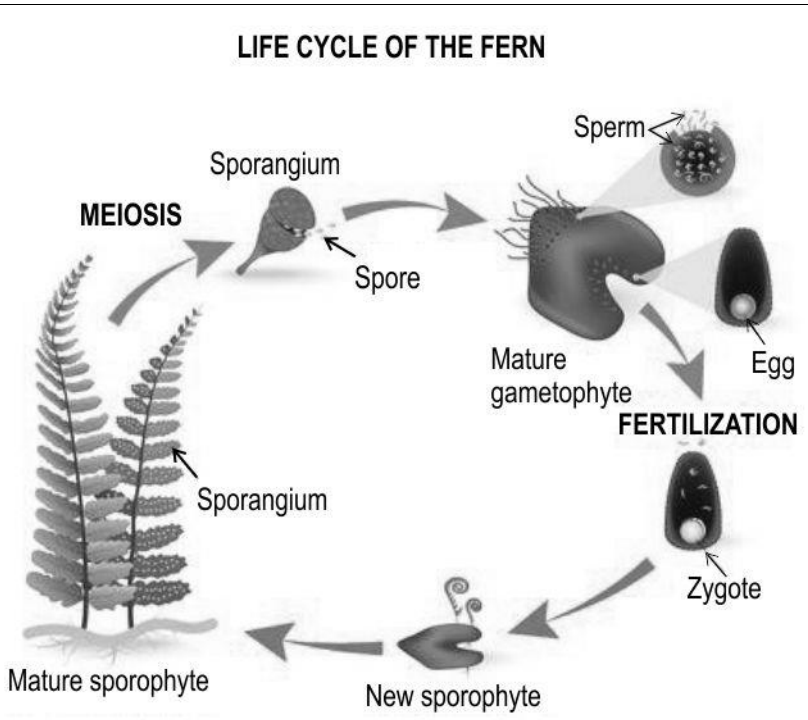
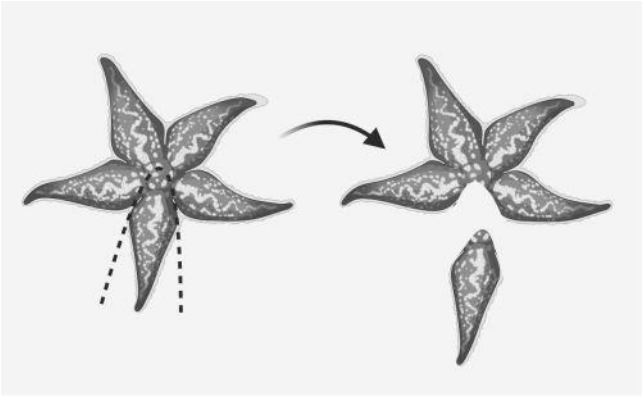
CONTENTS

1. CHAPTER: REPRODUCTION IN ORGANISMS

Q.No	Question	Marks
	Multiple Choice Question	
Q.1	Which of the following population definitely has/have a greater chance of survival in a stable habitat? P) Those with greater variation. Q) Those with a greater number of individuals expressing the dominant trait. R) Those living in environmental conditions that provide an advantage to the species. A. Only Q B. Only R C. Only P and R D. All - P, Q and R	1
Q.2	Which of the following statements is TRUE about the gamete mother cells in human beings? A. They are diploid and undergo mitotic divisions. B. They are diploid and undergo meiotic divisions. C. They are haploid and undergo meiotic divisions. D. They are haploid and do not undergo cell division.	1
Q.3	Cultivated potato varieties are generally tetraploid (4n) with 48 chromosomes. These potatoes reproduce through eye buds that sprout or "germinate". What is the chromosome number in the cells of the eye buds that help in reproduction? A. 6 B. 12 C. 24 D. 48	1
Q.4	Which of the following is/are always TRUE for sexually reproducing organisms? X) Fertilization involves the fusion of the male and the female gamete. Y) Both the male and female gametes move towards each other. A. only X	1

	B. only Y C. both X and Y D. neither X nor Y	
Q.5	Two statements are given - one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): Organisms like Amoeba produce multiple minute amoebae through sporulation. Reason (R): Sporulation involves meiotic division to produce multiple cells from one cell. Which of the following is CORRECT? A. Both A and R are true, but R is not the correct explanation of the assertion. B. Both A and R are true, and R is the correct explanation of the assertion. C. A is true, but R is false. D. A is false, but R is true.	1
Q.6	Listed below are some phases and events from the life of living organisms. P) Juvenile/Vegetative Q) Gametogenesis R) Fragmentation Which among the above are usually found in a plant that undergoes only sexual reproduction? A. Only P B. Only Q C. Only P and Q D. All- P, Q and R	1
Q.7	Given below is a list of some statements about reproduction in organisms. P) Reproduction must involve the fusion of gametes. Q) Heterogametes can be formed from two parents. R) Reproduction always creates genetically different offspring. Which among the above is/are TRUE? A. Only P B. Only Q C. Only P and Q	1

	D. Only P and R	
Free Response Questions/Subjective Questions		
Q.8	One of the major advantages of sexual reproduction is that it ensures genetic variation and helps in evolution because of the involvement of two parents. Asexual reproduction, on the other hand involves only one parent. (a) Can genetic variation take place in case of asexual reproduction? Justify. (b) How is constancy of chromosomal numbers maintained in both sexual and asexual reproduction?	3
Q.9	A meiocyte has a chromosome number of 34. What would be the chromosome number of the gamete formed and why?	1
Q.10	State whether the following statements are TRUE or FALSE and give a reason for each: (a) The embryo formed through apomixis is haploid because there is no fertilisation. (b) Parthenocarpy is an asexual method of reproduction.	2
Q.11	Cloning is a method of producing offsprings that are genetically similar to the parent organisms. Clones are genetically and morphologically exact copies of their parents and are generally created in controlled laboratory conditions. Mention ONE point each of similarity and difference between cloning and asexual reproduction.	2
Q.12	The images below show methods of reproduction in bacteria (top) and ferns (bottom) through spore formation:  	3

	 (a) State TWO points of difference between the two methods shown in the images. (b) Which of the methods above is more likely to create a genetically variant offspring? Give a reason for your answer.	
Q.13	Arm autotomy is a phenomenon in starfish where starfish typically shed arms with part of the central disk attached. This arm regenerates into a full starfish.  (a) Can the process of arm autotomy be called reproduction? Give a reason for your answer. (b) What is the ploidy of the cells and genetic constitution of regenerated starfish as compared to that of the original starfish? (c) Justify your answer to (b).	3
Q.14	Water hyacinth or *Eichhornia crassipes* is a perennial aquatic plant that is native to the tropical regions of South America. It was introduced in India for its beautiful flowers and leaves. It reproduces sexually as well as asexually. However, it has been found to be depleting the oxygen content in water.	3

	Raghav rears fish in a pond in his farmland. He introduces water hyacinths to beautify his farm. (a) What can be the possible impact of the water hyacinth on his fish production? (b) Raghav removes the reproductive parts from the flowers of water hyacinths to control their growth. What will happen to the water hyacinth population? (c) Raghav's friend Roshni collects a leaf with a stalk from Raghav's pond and plants it in the soil in her garden. She notices that the plant does not spread as much as it did in Ragav's pond. What could be the possible reason for this?	
Q.15	Amoebiasis is an infection with *Entamoeba histolytica*. It is acquired by faecal-oral transmission. Infection is commonly asymptomatic, but symptoms ranging from mild diarrhoea to severe dysentery may occur. Extraintestinal infections include liver abscesses. Such infection by amoeba is treated with drugs like metronidazole. The mechanism of action of metronidazole occurs through a four-step process where step one is the entry into the organism by diffusion across the cell membranes of anaerobic and aerobic pathogens. (a) In a case where metronidazole does not work in curing a patient suffering from amoebiasis, what characteristic of the structure of the amoeba could be hindering the action of metronidazole? (b) The amoeba is able to reproduce through binary fission immediately after infection till it reaches the human stomach. Why does amoeba not reproduce in the stomach? (c) Mention TWO characteristics of binary fission that distinguish it from a sexual reproduction process. (d) Which part of the amoebic cell should the drug attack to control its growth? Justify.	5

Answer key and Marking Scheme

Q.No	Answers	Marks
Q.1	C. only P and R	1
Q.2	B. They are diploid and undergo meiotic divisions.	1
Q.3	D. 48	1
Q.4	A. only X	1
Q.5	C. A is true, but R is false.	1
Q.6	C. Only P and Q	1
Q.7	B. Only Q	1
Q.8	(a) - yes - due to a random mutation [0.5 marks for each] (b) 1 mark for each correct answer: - In sexual reproduction, gametes are formed by meiotic or reduction division so that gametes have haploid/ half the number of chromosomes. Thus, zygotes have the actual /diploid set. - In asexual reproduction, organisms divide by simple mitosis and thus the chromosomal number is maintained.	3
Q.9	*[0.5 marks for each of the following]* - The chromosome number of its gamete would be 17. - Meiocytes undergo meiosis which results in the halving of the chromosome number in the daughter cells.	1
Q.10	(a) False. - The diploid egg cells do not go through meiosis to form the seeds. (b) True. - The process does not involve fertilisation or fusion of gametes.	2

<table>
<tr><td>Q.11</td><td>1 mark for each correct similarity and difference:

Similarity: off springs are genetically and morphologically similar to their parents in both cloning and asexual reproduction.

Difference: asexual reproduction can be natural while cloning is always a man-made process.</td><td>2</td></tr>
<tr><td>Q.12</td><td>(a) 1 mark for each correct point:

<table><tr><th>Bacteria</th><th>Fern</th></tr><tr><td>Spores formed by mitosis</td><td>Spores formed by meiosis</td></tr><tr><td>Reproduction is asexual</td><td>Reproduction is sexual</td></tr></table>
[Accept any other valid answer]

(b) 0.5 marks each for name and reason:

- the fern

- it involves fertilisation

OR

- it is a sexual mode of reproduction</td><td>3</td></tr>
<tr><td>Q.13</td><td>(a) 0.5 marks for each correct answer:

- Yes, it can be called reproduction

- A new individual is created from an existing one.

(b) 0.5 marks for each correct answer:

- ploidy: the regenerated starfish will be diploid

- the genetic constitution of the regenerated starfish is exactly the same as the parent starfish

(c) The process of regeneration does not involve gametes or meiotic division. Hence, the new individual is exactly similar to the parent starfish.

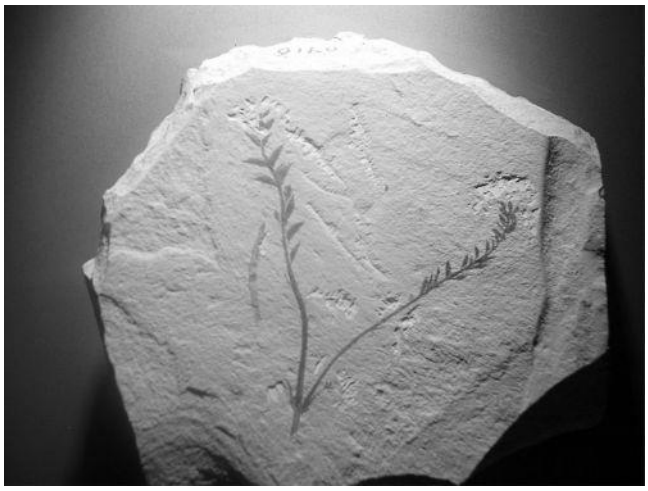
[Accept any other valid answer]</td><td>3</td></tr>
<tr><td>Q.14</td><td>(a) The fish will eventually die due to lack of oxygen.

(b) The water hyacinth population will eventually continue to increase as it will propagate asexually.</td><td>3</td></tr>
</table>

	(c) Water hyacinth is an aquatic plant and will not be able to propagate asexually due to lack of water in the soil.	
Q.15	(a) Amoeba could be encysted. (b) Growth and replication of amoeba is impacted by acidic environment of the stomach. (c) 1 mark for each correct difference such as: - Sexual reproduction involves the fusion of two gametes while binary fission involves the splitting of one cell into two individuals. - Sexual reproduction involves gamete formation through meiotic division while binary fission involves mitotic division only. *[Accept any other valid difference]* (d) 0.5 marks for each correct answer: - the nucleus - it will disrupt mitotic division *[Accept any other valid answer.]*	5

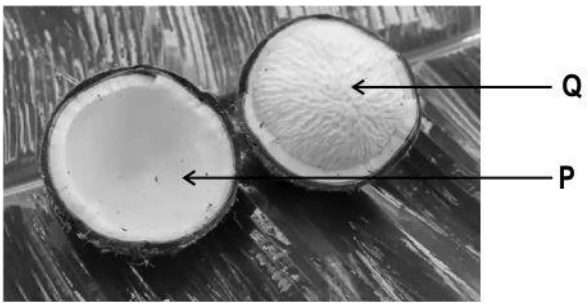
2. CHAPTER: SEXUAL REPRODUCTION IN FLOWERING PLANTS

Q.No	Question	Marks
	Multiple Choice Question	
Q.16	During apomictic seed formation, there is no reduction division and the gametes (both egg cell and the pollen/sperm cells) are diploid. What is the ploidy of the endosperm formed through apomixis? A. 2n B. 3n C. 4n D. 6n	1
Q.17	"Cells of the tapetum of a microsporangium are usually multinucleate". Which of the following can be a reason for the tapetal cells to become multinucleate? A. They fuse with the polar cells of the megasporangium. B. They do not undergo karyokinesis. C. They do not undergo cytokinesis. D. They do not undergo mitosis.	1
Q.18	Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): Pollen tube germinates through the germ pores on the pollen grains. Reasoning (R): Pollen-pistil compatibility chemicals help to dissolve sporopollenin for the pollen tube to germinate. Which of the following is correct? 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.	1
Q.19	The image below is that of an extinct angiosperm species *Archaefructus*.	1

	 In a *science fiction movie*, scientists find fossilised pollen grains of *Archaefructus* and use them to fertilise a modern genus of *Archaefructus.* Nitya thinks that these pollen grains can be found under polar ice sheets where the temperature is around -40°C. Is she correct and why? A. Yes, because -40°C is enough to keep pollen grains viable. B. No, because the pollen grains will get wet and won't function. C. Yes, because pollen grains are viable at any temperature for several years. D. No, because pollen grains need to be stored at much lower temperatures to be viable.	
Q.20	Which of the following is TRUE for a flower giving rise to a false fruit in apple? A. The ovary is infertile. B. The ovary does not undergo fertilisation. C. The thalamus undergoes fertilisation. D. The thalamus forms a part of the fruit.	1
Q.21	Two statements are given - one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): Endosperm in a flowering plant is formed before the formation of the embryo. Reason (R): The endosperm provides food to the developing embryo. Which of the following is correct? A. Both A and R are true, but R is not the correct explanation of the assertion B. Both A and R are true, and R is the correct explanation of the assertion. C. A is true, but R is false. D. A is false, but R is true	1
Free Response Questions/Subjective Questions		

Q.22	The exine layer of pollen grains contains sporopollenin which is a highly resistant chemical. Sporopollenin allows pollen grains to be well-preserved as fossils. (a) Can fossilised pollens fertilise an ovum of the same species in the present day? Justify. (b) How do scientists preserve pollen grains for later use?	2
Q.23	State ONE characteristic of a pollen grain that can help students identify: (a) a water-pollinated pollen grain (b) an animal-pollinated pollen grain.	2
Q.24	"Continued self-pollination results in inbreeding depression". (a) Mention ONE impact of inbreeding depression on the upcoming generations in a farmland. (b) State ONE way in which cross-pollination helps in avoiding inbreeding depression.	2
Q.25	Pollen grains are shed at either a two-celled stage or a three-celled stage and may take some time to reach the stigma for fertilisation. The pollen grains germinate on the stigma of the flowers. (a) Where do the pollen grains get the nutrition to remain viable and germinate on the stigma? (b) Mention the cell divisions that a microspore mother cell goes through to reach a three-celled pollen grain stage.	3
Q.26	*Set up:* An area with different species of plants. A colour tracer is added to the pollen of species A. *Observation:* The pollen from species A reaches the flowers of species A as well as species B. However, pollination occurs only with the flower of the species A. (a) Name and explain the phenomenon underlying this observation. (b) How can a farmer prevent any more pollen grains from landing on the stigma of flowers of the same species after she has artificially pollinated the flowers?	3
Q.27	Bees transfer pollen from the younger flowers at the top of a plant to the older flowers at the base. Is this an example of self-pollination or cross-pollination? Justify.	2
Q.28	A floral formula is a concise representation of the structure of a flower. the following symbols are used to represent different facts about the flower: K= calyx C= corolla	5

	A= androecium G= gynoecium For example, a floral formula $K_5C_5A_5G_2$ means that the flower has 5 sepals, 5 petals, 5 stamens and 2 carpels in the ovary. Rishabh comes across a floral formula $K_6C_6A_{10}G_0$ for **all flowers** in a plant. (a) What does the floral formula indicate about the sexuality of the flowers? (b) What kind of pollination (self or cross) will the plant show? Justify. (c) What kind of fruits will this plant bear and why? (d) If this flower is seen to have large, yellow showy petals, what is the most likely pollinating agent for the flower?	
Q.29	The embryo sac represents the female gametophyte in a flowering plant. (a) What are the constituents of the egg apparatus in the embryo sac? (b) What is the ploidy of the cells of the egg apparatus? (c) The formation of the embryo sac involves mitotic divisions that are "free nuclear" till the 8-celled stage. What does the term "free nuclear" mean? (d) The filiform apparatus at the micropylar end forms an important part of the embryo sac. What is the importance of the filiform apparatus?	5
Q.30	(a) The image below shows a blue-throated hummingbird visiting a flower.  What is the benefit that the flower derives from the hummingbird? Justify. (b) What kind of pollen grains would a flower most likely have when it is seen to be visited regularly by birds and butterflies? (c) "Self-pollinated flowers mostly do not need pollinating agents." Mention whether this statement is true or false with a reason for your answer.	5
Q.31	Give a reason for each of the following: (a) The exine of pollen grains is very hard. (b) The endosperm of flowering plants is triploid.	5

	(c) A pollen grain landing on a stigma does not ensure fertilisation. (d) Sexual reproduction brings in variation. (e) Seeds of hybrid varieties need to be produced afresh every year.	
Q.32	"A typical angiosperm anther is bilobed and dithecous". Draw a labelled diagram to show how the anther would look like in a transverse section.	2
Q.33	Cells of the microspore tetrads are diploid. Is this statement TRUE? Justify your answer.	2
Q.34	A farmer sowed tomatoes (plants with both sexes in the same flower) and bitter gourd (plants with both sexes in different flowers on the same plant) on his farmland. (a) To ensure cross-pollination, what should the farmer do in each of the cases? (b) If the male flowers from the tomato plant are removed and pollen is dusted, can the flower grow into a fruit? Why or why not?	2
Q.35	Describe a process that can enable you to observe pollen tube germination under laboratory conditions.	3
Q.36	Sudha cracked open a coconut and found the following content as shown in the image below:  (a) Identify the parts of the seed labelled P and Q. (b) What is most likely to have happened to the coconut water? (c) What is the ploidy of the coconut water that we drink from the tender coconut? Justify.	3
Q.37	Some scientists have used modified techniques of the conventional methods of artificial hybridisation. One such reference is that of Reddy *et al* (1970) where: - a razor blade is used to make an incision on one side of a flower bud and some petals are removed. - forceps are used to emasculate the flower - the bud is covered with a drinking straw made of plastic.	3

	- the open end of the straw is bent. - the straw is removed during pollination and replaced once pollination is completed. [Ref: http://oar.icrisat.org/959/1/RA_00166.pdf] (a) What process of a conventional method of artificial hybridisation method is the straw mimicking? (b) State 2 possible benefits of bending the straw.	
Q.38	Consider two plants species as described below: Species P: bisexual, androecium and gynoecium mature at the same time and anther and style are almost of the same height Species Q: unisexual, androecium matures later than the gynoecium and anthers are longer than the styles (a) What kind of pollination is likely to be seen in species P and Q. Give a reason for your answer in each case. (b) If a plant cultiver wants more viable varieties of offsprings, which species should he choose to cultivate and why?	3

Answer key and Marking Scheme

Q.No	Answers	Marks
Q.16	D. 6n	1
Q.17	C. They do not undergo cytokinesis.	1
Q.18	C. A is true, but R is false.	1
Q.19	D. No, because pollen grains needs to be stored at much lower temperatures to be viable.	1
Q.20	D. The thalamus forms a part of the fruit.	1
Q.21	B. Both A and R are true, and R is the correct explanation of the assertion.	1
Q.22	(a) 0.5 marks each for stating yes/no and reason: - no - because pollen grains cannot remain viable for such a long time as that taken for fossilization. (b) in liquid nitrogen at very low temperature conditions	2
Q.23	1 mark for each correct answer: (a) The pollen grain will have a mucilagenous covering to avoid getting wet. (b) The pollen grains will have a sticky exterior. *[Accept any other valid answer]*	2
Q.24	(a) Inbreeding depression can result in loss of fertility and vigour in the existing population. (b) Cross pollination brings about variation of characters that help in increased vigour of the population	2
Q.25	(a) The vegetative cell of the two or three- celled pollen grains provide nutrition. (b) 1 mark for each correct division: - microspore mother cells undergoes meiotic division to form the microspores - microspores undergo mitotic division to form the three-celled stage	3

Q.26	(a) 1 mark each for correct name and explanation: - pollen-pistil interaction - The ability of a pollen grain to germinate its pollen tube on the stigma of a flower is controlled by certain chemical interactions. This chemical compatibility is termed as pollen-pistil interaction. (b) by the technique of bagging or covering the stigma of the flower with a bag made of butter paper	3
Q.27	1 mark each for identification and reason: - self pollination - because it is the transfer of pollen grains from the anther of a flower to the stigma of another flower on the same plant	2
Q.28	(a) It is an unisexual /staminate flower (b) 0.5 marks each for identification and reason: cross-pollination because all flowers on the plant are unisexual (c) 1 mark each for identification and reason: - The plant will not bear fruits because it is a staminate flower. (d) insects/small animals/birds	5
Q.29	(a) 1 mark for each correct name: - synergids - egg cell (b) haploid (c) Nuclear divisions are not followed by cell wall formation/cytoplasmic division (d) The filiform apparatus guides the pollen tube into the synergids.	5
Q.30	(a) 1 mark each for reward and reason: - The hummingbird aids in pollination. - Pollen grains stick to the beak of the bird when it inserts its beak into the flower. (b) sticky pollen grains	5

	(c) 1 mark each for identifying true or false and reason: - True - The pollen grains are not carried too far to be dependent on agents for transfer.	
Q.31	(a) to protect the generative cells (b) one of the male gametes fuse with two polar nuclei forming (n+n+n) nucleus of the endosperm (c) there is a pollen-pistil compatibility factor that allows fertilisation (d) fusion of two gametes coming from two parents ensures mixing of characters (e) the characters in the progeny separate out and do not maintain hybrid characters	5
Q.32	0.5 marks each for each of the following: - four lobes - lines of dehiscence - pollen sacs - pollen grains	2
Q.33	False. Microspore tetrads develops from diploid sporogenous tissue by meiosis.	2
Q.34	(a) 0.5 marks for each of the following: - Emasculation will be required in tomato plants. - Removal of female flowers in the bitter gourd plant. *[Accept any other valid answer.]* (b) 0.5 marks for each of the following: - Yes - The ovary needs to be present for fertilization to happen.	2
Q.35	1 mark for each of the following: - dust some pollen grains onto a slide	3

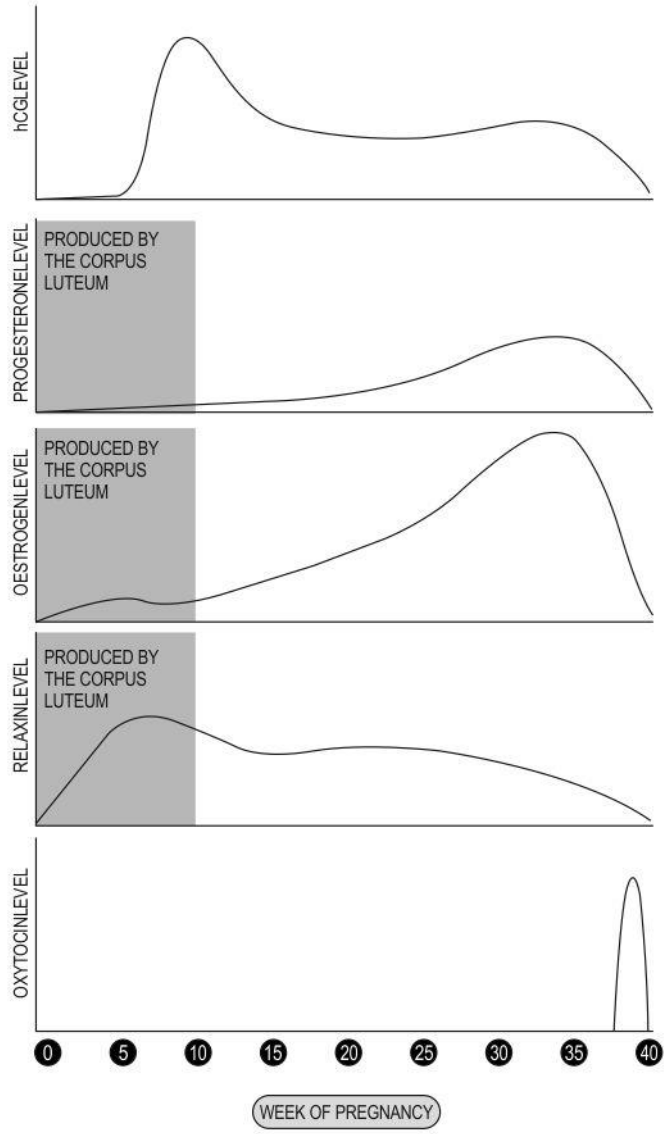
	- add a drop of sugar solution - allow the slide to rest for 10-15 minutes and observe under a microscope	
Q.36	(a) 0.5 marks for each correct answer: - P: endosperm - Q: embryo (b) The coconut water would have been consumed by the developing embryo. (c) 0.5 marks for each correct answer: - 3n - it is free-nuclear endosperm	3
Q.37	(a) bagging (2 marks) (b) 1 mark for each correct answer: - prevents contamination of the style from unwanted pollen grains - prevents loss of pollen grains after pollination *[Accept any other valid answers]*	3
Q.38	(a) 0.5 marks each for : Species P: self pollination Reason: androecium and gynoecium mature at the same time/ anthers and styles are of the same length. Hence, the pollen grains of the same plant can pollinate/fertilise the ovary of the same flower. Species Q: cross pollination Reason: unisexual/androecium and gynoecium mature at different times/anthers and styles are of different length. Hence, the pollens of the same plant will not be able to reach the stigma of the flowers of the same plant. [Consider any ONE reason and accept any other valid reason] (b) 0.5 marks each for name and reason: Species Q as it undergoes cross pollination	3

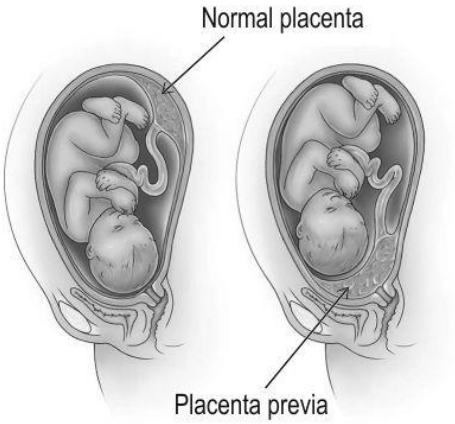
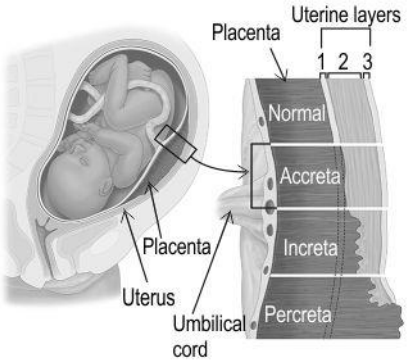
3. CHAPTER: HUMAN REPRODUCTION

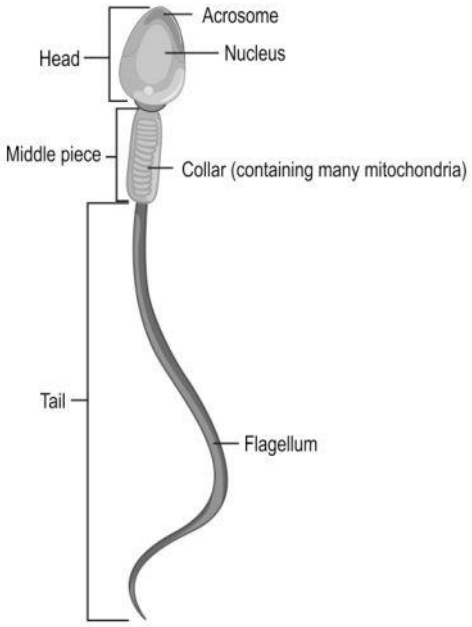
Q.No	Question	Marks
	Multiple Choice Question	
Q.39	Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): Only one sperm can fertilise an ovum. Reasoning (R): During fertilisation, a sperm comes in contact with zona pellucida layer of the ovum. Which of the following is correct? 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.	1
Q.40	Organisms possessing identical sex chromosomes are referred to as the homogametic sex. Organisms with different sex chromosomes are known as the heterogametic sex. Which of the following is CORRECT about humans? A. Both males and females are homogametic. B. Both males and females are heterogametic. C. Males are homogametic while females are heterogametic. D. Males are heterogametic while females are homogametic.	1
Q.41	Which of these cells of the human male reproductive system is haploid? A. Spermatid B. Sertoli cell C. Leydig cell D. Spermatogonium	1
Q.42	Globozoospermia is a condition where sperms have a characteristic round head lacking the acrosome. Which of the following functions will a sperm NOT be able to do because of the above condition? A. Enter the cervix B. Penetrate the ovum	1

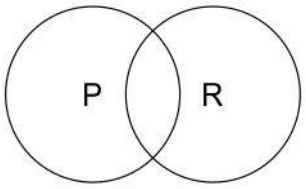
	C. Leave the ejaculatory duct D. Swim to the Fallopian tube	
Q.43	Which of these statements about the female reproductive system is FALSE? A. Menarche marks the initiation of oogenesis. B. The germ layers start forming after implantation. C. The oocyte completes meiosis after the entry of sperm. D. Ovulation and menstruation stop permanently after menopause.	1
Q.44	Which of these hormones would be detected in both a pregnant female and a female who is not pregnant? A. Relaxin B. Prolactin C. Progesterone D. Human chorionic gonadotropin	1
Q.45	Which of the following statements describes the difference between placenta and umbilical cord? A. The placenta secretes hormones whereas the umbilical cord does not. B. The placenta persists after pregnancy while the umbilical cord is expelled. C. The placenta is lined with veins and arteries while the umbilical cord is not. D. The placenta interlocks with foetal tissues whereas the umbilical cord interlocks with the uterine tissue.	1
Q.46	Some events of pregnancy in humans are written below in a sequence. (i) complete development of foetus (ii) uterine contraction (iii) dilation of cervix (iv) delivery of the baby (v) lactation Between which of the following events does the shedding of the placenta happen? A. (i) and (ii) B. (ii) and (iii) C. (iii) and (iv) D. (iv) and (v)	1
Free Response Questions/Subjective Questions		

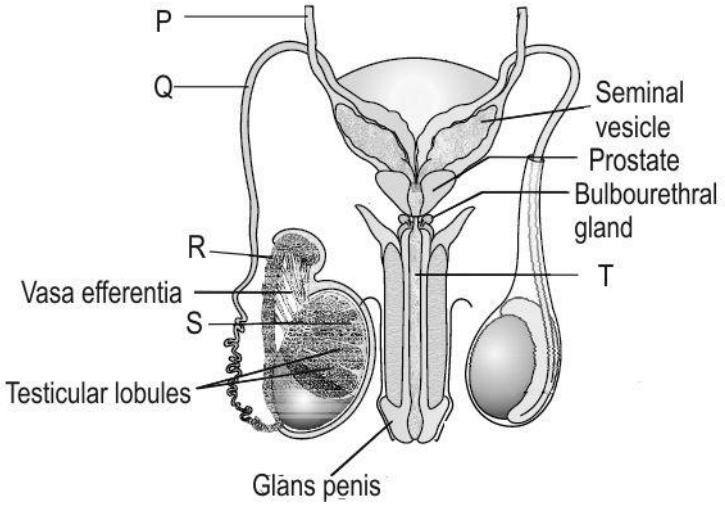
Q.47	(a) Hormones play a crucial role in maintaining balance in living systems through feedback loops. This means that release of a hormone regulates (increases/decreases) its further release in the body. One such example is oxytocin in the female reproductive system. Explain the feedback loop for oxytocin by answering the following questions. (i) From where is oxytocin released? (ii) At what stage of pregnancy do oxytocin levels peak? (b) Is the feedback mechanism for oxytocin positive or negative in nature? Justify.	2
Q.48	Spermatozoa are the mature male gametes in many sexually reproducing organisms. Thus, spermatogenesis is the male version of gametogenesis, of which the female equivalent is oogenesis. The cells in the germline that undergo meiosis, primary spermatocytes or primary oocytes, are derived from the zygote by a long series of mitoses before the onset of meiosis. Male and female gametes have different histories, marked by different patterns of gene expression that reflect their developmental origin as XY or XX embryos. *Source: https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/gametogenesis* The spermatozoa fuses with the egg cell to create a viable embryo. The ovum is released by the action of gonadotropins in the female body. (a) Does ovulation happen during the period of pregnancy? Give a reason for your answer. (b) Why are contraceptive pills able to inhibit ovulation?	2
Q.49	The image below shows the levels of various hormones measured in a human female throughout the course of her pregnancy.	5

	 Based on the image, answer the following questions. (a) In which week of pregnancy does the corpus luteum degenerate? (b) Which hormone peaks around the time in (a)? Name the organ that secretes it. (c) Name three hormones from the above image that are secreted by the ovary. (d) Which hormone level rises near the end of pregnancy? Mention its role. (e) Of the hormones secreted ONLY during pregnancy: (i) Which one has low levels in early weeks of pregnancy? (ii) Which one starts declining 15 weeks before parturition?	
Q.50	Study each of the diagrams below and answer the questions that follow them. (a) The image shows a normal pregnancy and the condition of placenta previa.	3

	 (i) Which part of the reproductive tract is the placenta obstructing? (ii) Which part does (i) open into? (b) The image shows a normal pregnancy and three conditions related to placenta (accreta, increta, and percreta).  Name the layer of the uterus being penetrated in the following conditions. State the function of the layer during pregnancy. (i) placenta accreta (ii) placenta increta	
Q.51	In the diagram of a human sperm given below:	2

	 (a) What is the ploidy of the nucleus? (b) Why does the middle piece have a lot of mitochondria? (c) What is the role of the acrosome? (d) Only one sperm is able to fertilise the egg. How is this ensured?	
Q.52	A period tracking app is a mobile application that maintains information such as date of onset of menstruation, ovulation, duration of menstrual cycle, etc. A female who got her period on January 22 is using the period tracking app. Based on your understanding of the menstrual cycle, what will be the tentative date of ovulation estimated by the app? Provide a reason.	2
Q.53	Polyspermy is an extremely rare condition in which an ovum is fertilised by more than one sperm. (a) How many chromosomes will a zygote contain if 2 sperms fertilised an ovum? (b) How is polyspermy prevented in humans?	2
Q.54	Answer the following questions: (i) For a human male, out of the two sex chromosomes, we can tell which sex chromosome is from which parent. Can we assume the same for a human female? Give a reason for your answer. (ii) What is the probability of fertilisation between an ovum and a sperm containing the Y chromosome? Give a reason.	2
Q.55	Answer the following questions about the human female reproductive system. (a) Name the part where the secondary oocyte completes meiosis.	2

	(b) Complete this statement. The completion of the second meiotic division of secondary oocyte is triggered by the _____. (rupture of the Graafian follicle in the ovary, penetration of zona pellucida by the sperm) (c) The ploidy of the secondary oocyte before reaching (a) is ___ and after (b) is ___.	
Q.56	Read the two statements below and answer the questions that follow. Statement I: Pregnancy is characterised by the lack of menstruation. Statement II: Lack of menstruation definitely indicates pregnancy. (a) Mark each of statements as true or false. (b) Give reason for to support your answer in (a).	3
Q.57	Read the information below and answer the questions that follow. A scientist harvested an embryo from the womb of a sheep just after implantation for the purpose of cloning. *(Note: Assume that the female reproductive system and development stages of sheep are the same as humans.)* Draw the stage of the embryo at which the scientist harvested it and label the part which: (a) attaches to the endometrium (b) is capable of giving rise to a clone	3
Q.58	(a) Highlight one aspect by which meiosis during oogenesis differs from regular meiosis. (b) Name two hormones that are common to spermatogenesis and oogenesis. (c) State the function of hormone identified in (b) in both human male and female.	3
Q.59	Read the two statements below and answer the questions that follow: Statement I: Female P has been a surrogate mother once. Statement II: Female Q is a national-level swimmer. (a) Is it correct to say that the hymen is DEFINITELY broken in both females P and Q? (b) Give a reason to support your answers to (a).	2
Q.60	Refer to the diagram below.  	5

	where, the first circle (P) includes parts of the human female reproductive system that support conception and the second circle (R) includes parts that support pregnancy. (a) Name two parts each that belong to (i) P (ii) R (b) Name two parts that support both contraception and pregnancy. (c) Name two parts that function as endocrine glands and indicate whether they belong to P or R. (d) Which part from (c) is temporary?	
Q.61	Observe the diagram of the human male reproductive system shown below with some of its parts marked P, Q, R, S, and T.  (a) For each of the following statements pertaining to male infertility, identify and name the parts between which sperm transfer is obstructed. (i) The obstruction of the vas deferens leads to low sperm count. (ii) Epididymitis is the inflammation of the epididymis. (b) Fill in the blank using one of the options enclosed in the brackets. Retrograde ejaculation occurs when the semen enters the urinary bladder. This is possible because of the existing anatomy of the human male reproductive system, i.e., the _____ (vas deferens merges with ureter, urinary bladder opens into the vas deferens, urethra emerges from the urinary bladder).	5
Q.62	For each of the following parameters, compare the processes of oogenesis and spermatogenesis and comment if they are similar or different. Enter your answer in the format as shown:	3

Parameter	Oogenesis	Spermatogenesis	Similar/Different
Number of gametes			

		produced from one oocyte or primary spermatocyte					
		Onset					
Q.63	The table below outlines some milestones of pregnancy. **Day 1** — **fertilisation** Day 2 — morula is formed Day 5 — inner cell mass is formed Day 7 — implantation Pregnancy tests detect the presence of the human chorionic gonadotropin (hCG) in blood or urine to confirm. (a) A pregnancy test done after which day is likely to yield a positive result? (b) Give reason for your answer to (a).						2
Q.64	(a) Cryptorchidism is a condition in which one or both of the testes fail to descend from the abdomen. (i) If cryptorchidism of both testes is left untreated, would it lead to infertility? Give reason. (ii) Can a male with cryptorchidism of only one testis produce sperm? Give reason. (b) Orchidopexy is a surgical procedure for treating cryptorchidism. (i) Name the part to which the testes are moved outside the abdomen. (ii) Write the exact temperature range of the testes after orchidopexy.						3
Q.65	Mark the following statements as true or false and provide a reason for each. (a) The Graafian follicle persists in the absence of fertilisation. (b) The corpus luteum is detected only in pregnant women. (c) The urethra serves as the common opening for the elimination of urine, unfertilised egg, and menstrual blood.						3
Q.66	Mark the following statements as true or false and provide an explanation for each. (a) The umbilical cord contains blood vessels that connect the foetus to the mother's heart.						5

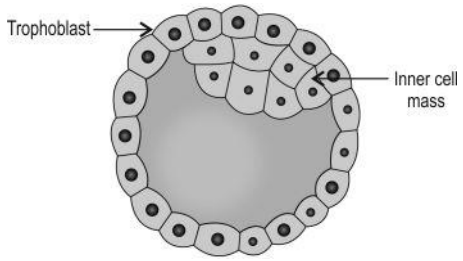
	(b) The mitotic differentiation of immature male and female germ cells begins at puberty. (c) The meiotic divisions in oogenesis are unequal. (d) Sexual intercourse between a healthy male and female might not always lead to fertilisation. (e) The sex of the child depends on the sex chromosome contributed by the ovum.	
Q.67	Answer the following questions about the human female reproductive system: (a) The consumption of alcohol during pregnancy causes birth defects in the foetus. What is the function of placenta due to which alcohol should be avoided during pregnancy? (b) Indu gave birth to a pair of female twins. How many egg/s were released at the start of her pregnancy? (c) C-section is a surgical procedure performed when there are complications during the delivery. The baby is safely delivered through an incision in the abdominal wall and uterus. Which two parts of the female reproductive tract does the baby NOT pass through? (d) To delay menstruation, a synthetic form of progesterone called progestin is commonly prescribed. This is administered by a medical professional for managing heavy or painful periods or preventing menstrual symptoms during important events or vacations. What could be the possible role of progesterone here? (e) Infants suffer from the risk of infection if they are not breastfed within few hours of birth. What could be the reason?	5

Answer key and Marking Scheme

Q.No	Answers	Marks
Q.39	A. Both A and R are true, and R is a correct explanation of A.	1
Q.40	D. Males are heterogametic while females are homogametic.	1
Q.41	A. spermatid	1
Q.42	B. penetrate the ovum	1
Q.43	A. Menarche marks the initiation of oogenesis.	1
Q.44	C. progesterone	1
Q.45	A. The placenta secretes hormones whereas the umbilical cord does not.	1
Q.46	D. (iv) and (v)	1
Q.47	(a) 0.5 marks for each correct answer: (i) pituitary (ii) initiation of parturition (b) positive - because the secretion of oxytocin stimulates the release of further oxytocin	2
Q.48	(a) - no - because levels of luteinizing hormone (LH) drop very low during pregnancy [o.5 marks for each correct answer] (b)- because high levels of progesterone inhibit the production of follicles	2
Q.49	(a) week 10 (b) 0.5 mark for each of the following: - hCG or human chorionic gonadotropin - placenta (c) 0.5 mark for each of the following:	5

	- progesterone - oestrogen - relaxin (d) 0.5 mark each for naming and describing role: - oxytocin - It stimulates contractions of the uterus and leads to childbirth (e) 0.5 mark for each of the following: (i) hCG (ii) relaxin	
Q.50	(a) 0.5 mark for each of the following: (i) cervix (ii) vagina (b) (i) 0.5 mark for each of the following: - endometrium - prepare the uterus for implantation or protecting the embryo (b) (ii) 0.5 mark for each of the following: - myometrium - exhibits strong contractions	3
Q.51	(a) haploid (b) to provide energy to the sperm to swim (c) contains enzymes that help in the process of fertilization (d) The first sperm induces changes in the ovum membrane to block the entry of other sperms.	2
Q.52	1 mark for each of the following: -Tentative date: between February 4 and February 6 - Reason: Ovulation happens between 14th-16th day from the onset of latest or previous menstruation/period	2

Q.53	1 mark for each of the following: (a) 69 chromosomes (b) Contact between a sperm and ovum causes changes in the zona pellucida that block the entry of other sperms.	2
Q.54	(i) 0.5 mark for each of the following: - No - Reason: Unlike males, a human female contains of a pair of the same sex chromosome 'X', one from each parent. (ii) 0.5 mark for each of the following: - 50% - Reason: Half of the sperms (**50%**) carry **X chromosome** and the other half (**50%**) carry **Y chromosome**.	2
Q.55	(a) Fallopian tube or oviduct (b) penetration of zona pellucida by sperm (c) 0.5 marks for each of the following: first blank - n second blank - n	2
Q.56	(a) 0.5 mark for each of the following: - I is true. - II is false. (b) 1 mark for each of the following reasons: I - The level of estrogen and progesterone is high during pregnancy to maintain the endometrium which in turn suppresses gonadotropins needed for development of the follicle. II - Lack of menstruation could also be due to stress, poor health, etc. [Accept any other valid reason.]	3
Q.57	1 mark for drawing and 1 mark each for the correct label as follows: (a) trophoblast	3

	(b) inner cell mass  	
Q.58	(a) 1 mark for the following: - oogenesis results in a one gamete and some polar bodies, while meiosis results in the production of four haploid gametes. (b) 0.5 mark each for any two of the following: - FSH or follicle-stimulating hormone - LH or Luteinizing hormone - GnRH or Gonadotropin-releasing hormone [Accept any other relevant answer.] (c) 0.5 mark for each of the following: - In females, FSH stimulates the development of follicles in ovary. - In males, LH stimulates the production of testosterone hormone by Leydig cells. OR - In females, LH triggers ovulation. - In males, FSH acts on the Sertoli cells and stimulates them to secrete some factors which help in spermiogenesis. [Accept any other relevant answer.]	3
Q.59	(a) 0.5 marks for each of the following: - Female P - No - Female Q - No (b) 1 mark for any of the following: Hymen can persist after childbirth or coitus or even after intense physical activity.	2

<table>
<tr>
<td>Q.60</td>
<td>(a) 0.5 mark each for naming any two of the following:

(i) P: vagina, oviducts, ovaries, uterus

(ii) R: uterus, cervix, placenta

(b) 0.5 mark each for any two of the following:

- oviducts

- ovaries

- uterus

(c) 0.5 marks each for identifying the following organs and indicating the category

- ovaries (P)

- placenta (R)

(d) placenta</td>
<td>5</td>
</tr>
<tr>
<td>Q.61</td>
<td>(a) (i) 0.5 marks each for indicating the parts from the diagram and 0.5 marks each for naming them

- R (epididymis)

- T (urethra)

(a) (ii) 0.5 marks each for indicating the parts from the diagram and 0.5 marks each for naming them

- S (rete testes)

- Q (vas deferens)

(b) urethra emerges from the urinary bladder</td>
<td>5</td>
</tr>
<tr>
<td>Q.62</td>
<td>0.5 mark for each blank cell

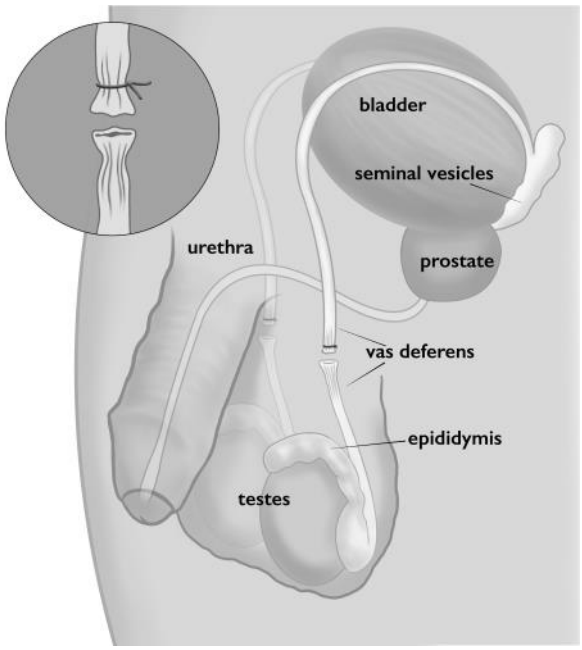
<table>
<tr><th>Parameter</th><th>Oogenesis</th><th>Spermatogenesis</th><th>Similar/Different</th></tr>
<tr><td>Number of gametes produced from
one oocyte or primary spermatocyte</td><td>1</td><td>4</td><td>Different</td></tr>
</table>
</td>
<td>3</td>
</tr>
</table>

	Onset	fetal development	puberty	Different	
Q.63	(a) after day 7 OR after implantation (b) Placenta is formed after implantation and it secretes hCG.				2
Q.64	(a) (i) 0.5 each mark for answering and giving reason: - Cryptorchidism of both testes means infertility. - Spermatogenesis cannot happen at the normal internal body temperature. (a) (ii) 0.5 each mark for answering and giving reason: - A male with cryptorchidism of one testes might be able to produce sperm. - Spermatogenesis can occur in the descended testis as its temperature will be lower than the normal internal body temperature. (b) 0.5 mark for each of the following: (i) scrotum (ii) 34.5 °C - 35 °C				3
Q.65	(a) 0.5 mark for stating and giving reason. - false - The Graafian follicle releases the ovum and transforms into the corpus luteum. (b) 0.5 mark for stating and giving reason. - false - The corpus luteum is detected in both pregnant and non-pregnant women. It is formed after ovulation. (c) 0.5 mark for stating and giving reason. - false - The urethra is the passage for urination only OR - The unfertilised egg and menstrual blood pass through the vagina.				3
Q.66	(a) 0.5 mark for each of the following:				5

	- false - The umbilical cord contains blood vessels that connect the foetus to the placenta. The placenta serves as an interface between maternal and foetal circulation. (b) 0.5 mark for each of the following: - false - The female germ cells (oogonia) undergo mitotic differentiation during fetal life to form primary oocytes. (c) 0.5 mark for each of the following: - true - A meiotic division in oogenesis give rise to oocyte and polar body, instead of two oocytes. [Accept any other relevant answer.] (d) 0.5 mark for each of the following: - true - Fertilisation occurs when ovum and sperms are transported simultaneously to the ampulla of the oviduct. [Accept any other relevant answer.] (e) 0.5 mark for each of the following: - false - The sex of the child depends on the sex chromosome contributed by the sperm. 50% of sperms carry the X chromosome while the other 50% carry the Y chromosome. [Accept any other relevant answer.]	
Q.67	(a) The placenta facilitates the supply of nutrients from the mother to the foetus. (b) 0.5 mark for each of the following: - 1 egg in the case of identical twins - 2 eggs in the case of fraternal twins (c) 0.5 mark for each of the following: - cervix	5

	- vagina (d) 1 mark for any of the following: - Progesterone prevents the shedding of endometrium. OR - Progesterone prevents ovulation. (e) 1 mark for the following: - Breast milk contains antibodies which provide resistance to the newborn baby. [Accept any other relevant answer.]	

4. CHAPTER: REPRODUCTIVE HEALTH

Q.No	Question	Marks
	Multiple Choice Question	
Q.68	Which of the following methods of assisted reproductive technologies (ART) can be a more viable process of pregnancy in a woman after menopause? A. Gamete intra fallopian transfer B. Zygote intra fallopian transfer C. Artificial insemination D. Pregnancy is not possible after menopause	1
Q.69	Vasectomy is a permanent contraception method where the vasa deferentia are cut and tied.  Which of the following does vasectomy prevent? A. Entry of urine in to the urethra B. Spermatogenesis in the seminiferous tubules C. Release of spermatozoa in to the sperm ducts D. Secretion of prostaglandins by the seminal vesicles	1
	Free Response Questions/Subjective Questions	
Q.70	Write down three ways by which an adult human can contract the HIV.	3

Q.71	Shown below are some details pertaining to an oral contraceptive pill. Carefully study them and answer the questions that follow. (a) Name ANY TWO reproductive processes blocked by the oral pill shown below.  (b) A patient X took the pills as instructed for one month. Why is there a gap of 7 days after 21st day indicated on the pack? (c) Patient X suspects that her partner is suffering from hepatitis-B. In such a situation: (i) Would you recommend her to use oral pills shown above as the ONLY contraceptive? Support your answer with a reason. (ii) What is an alternative contraceptive that can be suggested to patient X and her partner?	3
Q.72	Answer the following questions: (i) Based on the site of fertilisation, state one difference between Intra-Uterine Transfer (IUT) of embryo and Intra-Uterine Insemination (IUI). (ii) All Assisted Reproductive Technologies (ARTs) require the extraction of the female gamete from the ovary. Is this statement TRUE or FALSE? Give a reason. (iii) State one characteristic each of the donor and recipient's reproductive system that enables them to participate in Gamete Intra Fallopian Transfer (GIFT).	3

Answer key and Marking Scheme

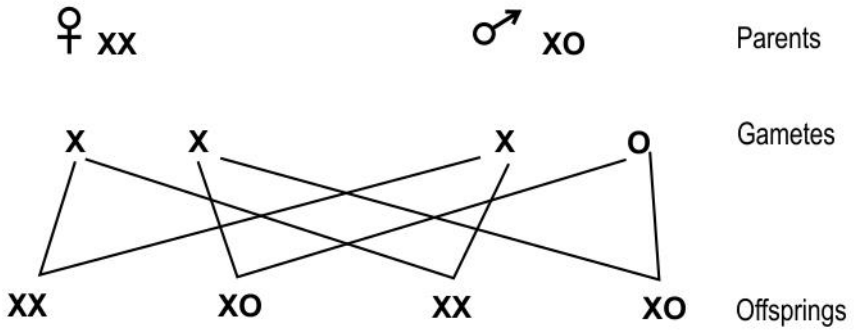
Q.No	Answers	Marks
Q.68	B. zygote intra fallopian transfer	1
Q.69	C. release of spermatozoa in to the sperm ducts	1
Q.70	1 mark each for writing the following: (i) sharing of injection needles or surgical instruments with infected person, (ii) blood transfusion from an infected person (iii) sexual contact with an infected person	3
Q.71	(a) 0.5 marks each for writing any TWO of the following: - ovulation - implantation - entry of sperm through the cervix [Accept any other valid answer.] (b) After 21st day when the patients stop taking the pills, menstruation occurs. (c) (i) 0.5 marks each for writing the following: - No - Hepatitis-B is a sexually transmitted disease. Oral pills do not prevent the transmission of STDs. (c) (ii) condom	3
Q.72	(i) 0.5 mark for each of the following: - In IUT, fertilisation is in-vitro/outside the body/in the laboratory - In IUI, fertilisation is in-vivo/inside the body (ii) 0.5 mark for each of the following: - The statement is FALSE. - In artificial insemination, only semen is transferred to the female reproductive tract. The ovum is not extracted.	3

	(iii) 0.5 mark for each of the following: - The donor can produce ovum/cannot conceive/cannot support full term of pregnancy - The receiver can support fertilisation/support pregnancy/cannot produce ovum	

5. CHAPTER: PRINCIPLES OF INHERITANCE AND VARIATION

Q.No	Question	Marks
	Free Response Questions/Subjective Questions	
Q.73	Sex determination in cockroaches is the same as that seen in some other insects like grasshoppers. (a) Illustrate a cross between a female (XX) cockroach and a male (XO) cockroach. (b) What will be the chromosome number of the off springs formed, if the number of autosomes is 22?	3
Q.74	(a) State ONE point of difference between a monohybrid cross and a test cross. (b) What is/are the possible genotypic ratio/s in a test cross?	2
Q.75	ACHOO syndrome is characterized by uncontrollable sneezing in response to the sudden exposure to bright light, typically intense sunlight. It is inherited as an autosomal dominant condition. (a) Draw a Punnett grid to determine the probability of producing an unaffected child by a heterozygous father and an unaffected mother. (b) Depict the inheritance using a pedigree.	3

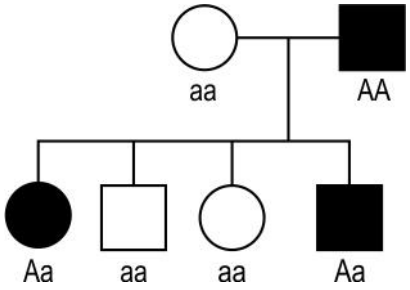
Answer key and Marking Scheme

Q.No	Answers	Marks
Q.73	(a)  *[1 for gamete formation and 1 for offsprings]* (b) 0.5 marks each for the following: - XO - 23 chromosomes - XX - 24 chromosomes	3
Q.74	(a) 1 mark for any one correct point of difference: - Monohybrid cross takes place between two parents of any genotype whereas in a test cross one parent is necessarily homozygous recessive for a/multiple trait/s. - Monohybrid cross between known parents is done to determine the pattern of inheritance of one single gene whereas a test cross is done to determine the unknown genotype of one individual/parent of the cross. *[Accept any other valid answer]* (b) 0.5 marks for each of the following: - **all heterozygous dominant**, if the unknown genotype is homozygous dominant **- 1:1 (heterozygous dominant: homozygous recessive)** if the unknown genotype is heterozygous dominant. *[Award marks if only the text in bold is written]*	2
Q.75	(a) 1 mark for the Punnett grid and 1 mark for determining the possibility:	3

	A	a
a	Aa	aa
a	Aa	aa

Possibility of producing an unaffected child is 50%

(b)



[Marks to be awarded for any gender combination of affected offsprings]

6. CHAPTER: MOLECULAR BASIS OF INHERITANCE

<table>
<tr><th>Q.No</th><th>Question</th><th>Marks</th></tr>
<tr><td colspan="3">Multiple Choice Question</td></tr>
<tr><td>Q.76</td><td>Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R).

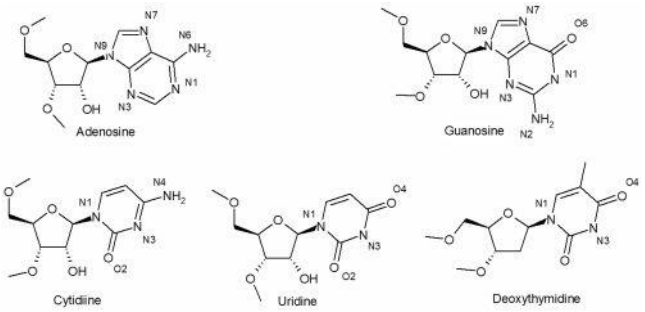
Assertion (A): Only one strand of DNA is transcribed.

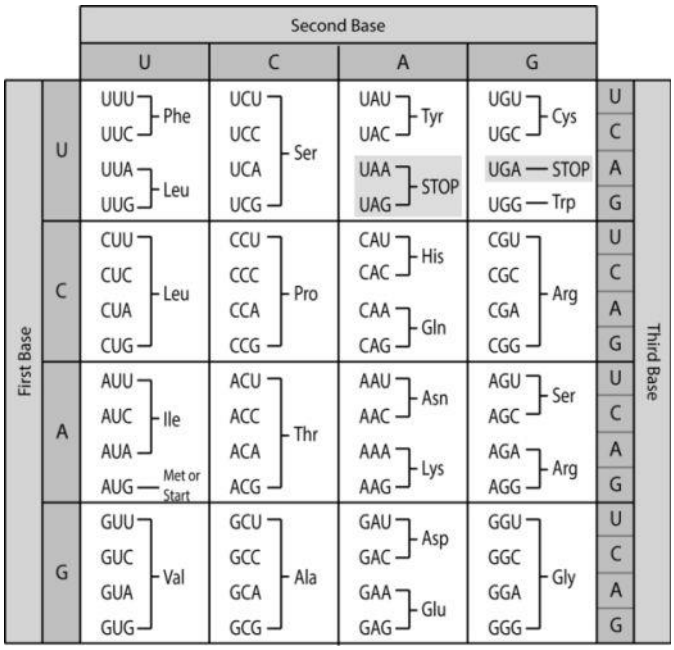
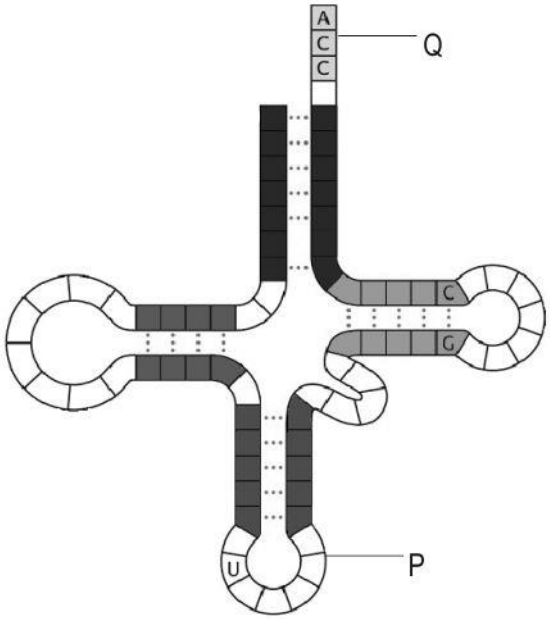
Reason (R): Strands having complementary bases code for the same proteins.

Which of the following is correct?

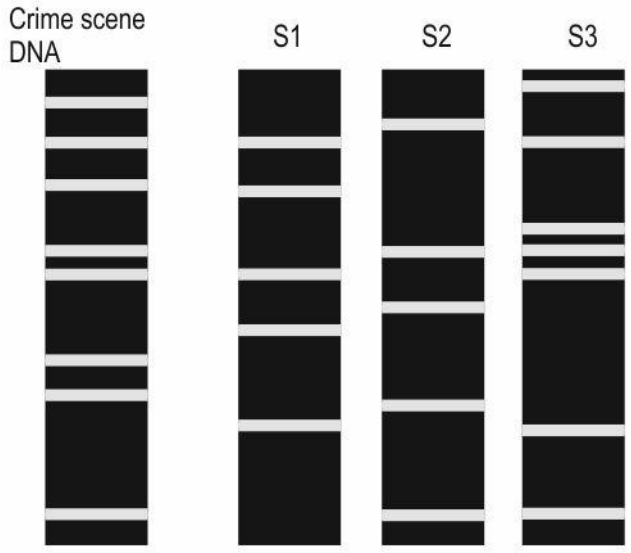
A. Both A and R are true, and R is the correct explanation for A.
B. Both A and R are true, but R is not the correct explanation for A.
C. A is true, but R is false.
D. A is false, but R is true.</td><td>1</td></tr>
<tr><td>Q.77</td><td>If a bacterial cell contains 'x' g of DNA, which of the following correctly depicts the amount of DNA at the end of each phase of the cell cycle?

<table><tr><th></th><th>G1</th><th>S</th><th>G2</th><th>M</th></tr><tr><td>P</td><td>x</td><td>2x</td><td>x</td><td>x</td></tr><tr><td>Q</td><td>2x</td><td>2x</td><td>x</td><td>x</td></tr><tr><td>R</td><td>2x</td><td>2x</td><td>2x</td><td>x</td></tr><tr><td>S</td><td>x</td><td>2x</td><td>2x</td><td>x</td></tr></table>
A. P
B. Q
C. R
D. S</td><td>1</td></tr>
<tr><td colspan="3">Free Response Questions/Subjective Questions</td></tr>
<tr><td>Q.78</td><td>Purines have two rings in their nucleotide structure whereas pyrimidines have only one ring. Given below is an image of their structures.</td><td>2</td></tr>
</table>

	 (a) The distance between the two strands of a DNA molecule _____ (increases/decreases/remains the same) from one end to another. (b) Under what hypothetical circumstances would the distance between two strands be different from what is seen presently?	
Q.79	With the help of experiments done by various scientists over 40 years, it was finally concluded that DNA is the genetic material. (a) Before DNA, which molecules were considered to be genetic material? (b) What was concluded from Griffith's experiments using S and R strains of mice? (c) Briefly describe two experiments that led to the conclusion that DNA is the genetic material. (d) Today, if the contents of a nucleus of a human cell were extracted, it can be concluded that DNA is the genetic material as that is the only biomolecule present in the nucleus. Justify this statement as true or false.	5
Q.80	Give a reason why: (a) The absence of RNA polymerase III can interfere with the translation of nuclear genes. (b) Defining a gene present in DNA is complicated, particularly in eukaryotes. (c) In bacteria, translation and transcription happen almost simultaneously.	3
Q.81	Given below is the sequence of an mRNA the image of the genetic code. Assume that this sequence begins with a start codon. 5' - GCUAUCAAGUACCUA - 3'	3

	 (a) Identify the amino acid sequence to which this mRNA will get translated. (b) Identify the type of mutation and the change in the protein sequence in the following: (i) cytosine in codon 4 gets modified to uracil (ii) GCU gets added after the second cytosine in the sequence	
Q.82	Given below is a representation of the structure of the tRNA with two of its parts marked P and Q. Q is the amino acid acceptor end of the tRNA.  (a) What is loop P called? (b) How can the polarity of the tRNA molecule be identified from the image? (c) Write the 5'-3' anticodon sequence in a tRNA molecule for the start and stop codon.	2

Q.83	The *lac* operon is a polycistronic gene that helps a bacterial cell in metabolising lactose. It consists of an inducer (*i*) gene that represses the transcription of *lac* genes under certain environmental conditions. (a) Why is the *lac* gene called polycistronic? (b) What would happen if there was a mutation blocking the translation of: (i) gene z (ii) gene y (c) What happens to the expression of the lac operon when the growth medium is provided with: (i) both glucose and lactose (ii) only galactose	5
Q.84	Like the *lac* operon, prokaryotes contain several other operons that are regulated in different ways. *Trp* operon is one such operon that has five genes that code for enzymes required for tryptophan biosynthesis. Tryptophan is an amino acid that is required by the bacterial cell for the formation of various proteins. Tryptophan itself regulates the expression of the *trp* operon. The *lac* operon is induced by lactose whereas the *trp* operon is repressed by tryptophan. Using the understanding of how the *lac* operon works, justify why this statement could be true.	2
Q.85	Describe TWO DNA technological processes that were used in the Human Genome Project.	2
Q.86	Expressed sequence tags (ESTs) are short cDNA molecules formed from mRNA molecules isolated from a cell. In eukaryotes, ESTs are said to be useful to identify coding regions of a genome but not DNA sequences. Justify why this statement is TRUE.	3
Q.87	Over the years, researchers have gathered enough evidence to suggest that RNA was the first genetic material which was slowly replaced by DNA. Give TWO reasons why RNA was replaced by DNA as the genetic material.	2
Q.88	Justify the following statements: (a) The amino acid sequence can be derived from the mRNA sequence but the reverse cannot be done easily. (b) mRNA synthesis happens in the nucleus but protein synthesis happens outside the nucleus. (c) Splicing of the hnRNA is an important post-translational modification.	3
Q.89	The process of DNA fingerprinting involves the use of the Southern blotting technique. In this technique, DNA that has run on an agarose gel and then	3

	transferred to a nitrocellulose or nylon membrane. Finally, the DNA bands are visualised through autoradiography. (a) Share your understanding of why the DNA needs to be transferred to the nitrocellulose membrane. (b) What would be the charge on the nitrocellulose membrane? Give a reason to support your answer. (c) Identify the type of label present on the VNTR probe. Justify your answer.	
Q.90	In a quiet neighbourhood, a woman had been murdered at her home when her roommates were supposedly away. Her roommates were two twin brothers (S1 and S2) and another woman (S3). The investigating officer found the skin of the murderer under her fingernails. The officer sent the DNA from the skin sample along with DNA from the roommates for DNA profiling. Given below is an image of the bands obtained.  (a) Who is likely to be the murderer? Give a reason to support your answer. (b) S1 and S2 are twin brothers. What can you conclude about them from the image?	2

Answer key and Marking Scheme

Q.No	Answers	Marks
Q.76	C. A is true, but R is false.	1
Q.77	D. S	1
Q.78	(a) remains the same (b) The distance would vary if purines or pyrimidines base paired within themselves i.e if a purine paired with another purine that part of the double strand would be broader than areas where two pyrimidines paired with one another.	2
Q.79	(a) proteins (b) The transfer of genetic material can transform a cell to perform a different function. (c) 1 mark each for the following: - Avery, MacLeod and McCarthy purified biochemicals (DNA, RNA and protein) from the heat-killed S cells to see which ones could transform live R cells into S cells and found that DNA alone from S bacteria caused R bacteria to become transformed. - Hershey and Chase allowed bacteriophages with radioactively (^{32}P) labelled DNA and bacteriophages with radioactively (^{35}S) labelled protein coats to infect two separate populations of bacteria and found that only radioactively (^{32}P) labelled DNA was found to enter/get transferred to the bacterial cells. (d) - false *[0.5 marks]* - The nucleus contains other biomolecules such as proteins as well and so the extract would also show the presence of other biomolecules. *[1 mark]*	5
Q.80	(a) RNA polymerase III is responsible for the transcription of tRNA which is crucial for the process of translation. (b) In eukaryotes, the coding sequences (exons) are interrupted by non-coding sequences (introns) which do not appear in the mature mRNA which complicates the definition of a gene in a DNA segment. (c) Since the mRNA does not require any processing to become active	3

	OR Since transcription and translation take place in the same compartment of the cell.	
Q.81	(a) ALA ILE LYS TYR LEU (b) 0.5 marks each for the following: (i) - point mutation - no change in the protein sequence (ii) - frameshift mutation/insertion - An alanine amino acid gets added between isoleucine and lysine. OR An amino acid, alanine, gets added in the third position. *[Accept any other valid answer]*	3
Q.82	(a) anticodon loop (b) The amino acid acceptor end is 3' (c) 0.5 marks each for the following: - Start codon anticodon: 5' - UAC - 3' - Stop codon does not have a tRNA molecule.	2
Q.83	(a) It has a single promoter for multiple connected genes. OR A single mRNA is transcribed to be translated to multiple proteins. (b) 1 mark each for the following: (i) Lactose would not be able to enter/permeate into the bacterial cell. (ii) Lactose would enter the cell but not be broken down into glucose and galactose. (c) 1 mark each for the following:	5

	(i) Glucose is the preferred carbon source is consumed first while lactose induces the *lac* operon producing small levels of the *lac* proteins. (ii) In the absence of lactose, the repressor protein will continue binding to the operator of the *lac* operon preventing transcription of its genes.	
Q.84	1 mark each for the following: - The *lac* operon encodes for proteins required for the breakdown of lactose and hence needs to be produced when lactose is present in the cell. So here lactose acts as an inducer of gene expression. - The *trp* operon encodes for proteins required for tryptophan biosynthesis and hence is not required when tryptophan is present in the medium. So tryptophan acts as a repressor to prevent the expression of the *trp* operon genes. *[Accept any other valid answer]*	2
Q.85	1 mark each for the following: - Restriction digestion: DNA being very long, had to be broken into smaller pieces which could be done using restriction digestion. - rDNA technology: The small sequences of DNA had to be amplified for sequencing and since the sequence was not known, it had to be cloned in a suitable host using vectors for amplification. *[Accept any other valid answer.]*	2
Q.86	1 mark for each of the following: - Genes in eukaryotes generally have non-coding sequences called introns present between the coding sequences or exons. - The mRNA in eukaryotes is formed after post-transcriptional modifications such as intron splicing and the addition of a poly-A chain. - So, the cDNA formed from it will not have the intron sequence in the actual DNA sequence but just have the sequence of the exons.	3
Q.87	1 mark each for any two of the following: - RNA consists of ribose sugars where the hydroxyl group (-OH) is exposed to hydrolysis and degradation whereas DNA consists of deoxyribose sugars. - RNA is single-stranded whereas DNA is double-stranded with complementary bases forming hydrogen bonds that release free energy making it thermodynamically stable.	2

	- The double helix helps to keep the nucleotide bases away from reactive species that may exist in the cell's environment. *[Accept any other valid answer]*	
Q.88	1 mark each for the following: (a) Each codon codes for only one amino acid and so the amino acid sequence can be derived from an mRNA sequence, however, each amino acid is coded for by more than one codon and so each amino acid can be back-traced to one or more codons. (b) The DNA is transcribed into an mRNA sequence which is present in the nucleus whereas translation is done by ribosomes which are present in the cytoplasm or on the rough endoplasmic reticulum. (c) If splicing does not happen, the non-coding portions of the DNA/introns will also get translated disrupting the amino acid sequence of the intended protein. *[Accept any other valid answer]*	3
Q.89	(a) An agarose gel contains pores and DNA may not firmly attach on the gel. For hybridization and visualization, the DNA needs to be immobilised for which a nitrocellulose membrane is used. *[Accept any other valid answer]* (b) 0.5 marks each for the following: - positively charged - Since DNA is negatively charged, the positive charge on the membrane will help with easy binding. (c) 0.5 marks each for the following: - radioactive label - Since autoradiography is used, it can be concluded that the VNTR probe would be radioactively labelled.	3
Q.90	(a) 0.5 marks each for the following: - S3/woman is the murderer - The DNA profile of S3 has the greatest match/50% match with the DNA obtained on the crime scene. (b) 0.5 marks each for the following:	2

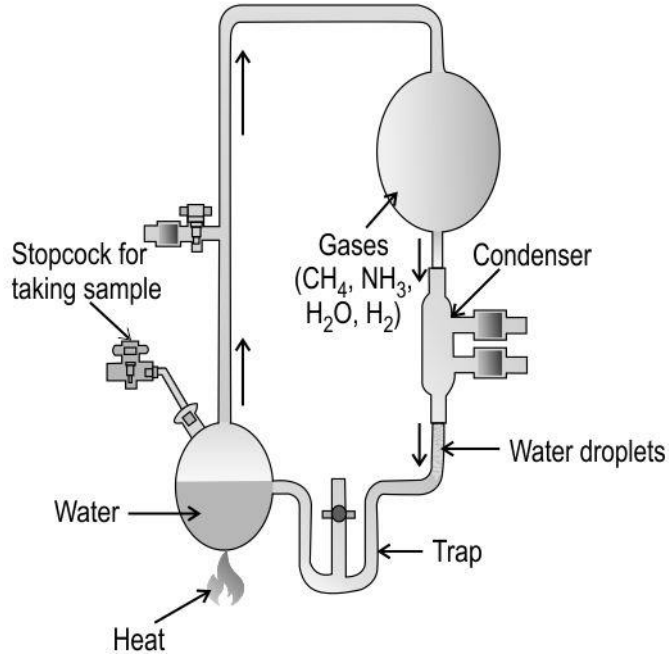
	- They could be non-identical twins. - Since their DNA profiles do not match completely with each other they are likely to be non-identical twins.	

7. CHAPTER: EVOLUTION

Q.No	Question	Marks
	Multiple Choice Question	
Q.91	A group of students are trying to replicate the famous Miller-Urey experiment using a different set of molecules compared to those employed in the original study. Their experiment will be deemed supportive and aligning with the Miller-Urey experiment solely on the condition that the molecular weight of - A. reactants ≥ products B. reactants < products C. reactants = products D. reactants > products	1
Q.92	Some herbivorous organisms such as giraffes and brachiosaurus are known to have evolved long necks which helps them access food that is not available to other shorter herbivores. Which of the following type of evolution do the statements shown above describe? A. co-evolution B. microevolution C. divergent evolution D. convergent evolution	1
Q.93	Billions of years ago, when Earth had a reducing atmosphere containing methane and ammonia along with high temperatures, the organisms that came to existence would have been - A. aerobic and chemo-autotrophic B. anaerobic and chemo-heterotrophic C. aerobic and chemo-heterotrophic D. anaerobic and chemo-autotrophic	1
Q.94	*Ginkgo biloba is* also known as a living fossil as it has changed very little over time. It is resistant to disease and pests, is tolerant of a wide range of environmental conditions and is the last-standing member of its botanical family. The above is an example of which of the following phenomena? A. speciation	1

	B. fossilization C. adaptive radiation D. survival of the fittest	
Q.95	Which of the following phenomena significantly contributes to speciation? P) Natural Selection Q) Genetic Drift R) Gene flow S) Geographic Isolation T) Stabilizing Selection A. only Q and S B. only R and T C. only P, Q and S D. only Q, R and T	1
Q.96	Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): Genetic makeup serves as the primary factor in shaping the phenotype of a species and not vice versa. Reason (R): Adaptation involves the phenotype's interaction with the environment, leading to changes in genetic makeup over generations. Which of the following is correct? 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.	1
Q.97	A population of grey treefrog lives on deciduous trees where they blend well in with the bark. Some members of the population have variations in body colour - with different shades of grey as well as yellow on their ventral side. Due to changes in the environmental conditions, yellow lichen start growing on the trees. The grey treefrogs can now be easily spotted by predators such as birds and snakes against the yellow background. Which of the following BEST describes 'survival of the fittest' in this scenario? A. Only the biggest and strongest treefrogs will survive and reproduce. B. Treefrogs will change their colour to yellow to avoid being eaten by predators.	1

	C. Some treefrogs that might have slightly yellowish skin will survive and reproduce. D. Treefrogs with slightly yellowish skin will feed on gray treefrogs to eliminate them.	
Q.98	In pigeons, one gene controls the appearance of a crest on the head. The allele C (smooth head) is dominant to allele C' (crested head). In a population of pigeons, the frequency of the allele responsible for a smooth head is 0.7 and for a crested head, it is 0.4. Which of the following conditions should be satisfied for the population to be in Hardy-Weinberg equilibrium? A. The sum total of the frequency of C and C' is equal to 1. B. The sum total of the frequency of C and C' is less than 1. C. The sum total of the frequency of C and C' is more than 1. D. (Cannot be said without knowing the frequency of CC' individuals.)	1
Q.99	Different species of prokaryotes can withstand and survive in different environmental conditions, ranging from normal to extreme temperature, pH, salinity, and oxygen availability. Over an extended period of time, each species has become well-adapted to its environment, while their fundamental structures remain largely similar. Which of the following type of evolution do the statements shown above describe? A. Coevolution B. Microevolution C. Divergent evolution D. Convergent evolution	1
Q.100	The Hardy-Weinberg principle is a foundational principle for understanding population genetics with several assumptions. Which of the following is NOT an assumption of this principle? A. Random mating B. Emigration of species C. Large population size D. Non-occurrence of mutations	1
Q.101	Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): Lichens are used as indicators of pollution.	1

	Reason (R): A polluted environment accelerates the growth of lichens by providing them with more nutrition. Which of the following is correct? 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.	
Free Response Questions/Subjective Questions		
Q.102	Bees and flowering plants are known to have co-evolved and incorporated each other as a part of their lifestyle. (a) How do they mutually benefit from each other? (b) Describe any TWO adaptations of bees that help them benefit from flowering plants. (c) Describe any TWO adaptations of flowering plants that help them benefit from bees.	5
Q.103	A group of students designed and executed an experiment similar to the Miller-Urey experiment, but missed a component. The experimental setup used by them is shown below.  They performed the experiment and analysed the sample after it. What compounds are they likely to find in the sample? Justify your answer.	2
Q.104	Consider a hypothetical situation: A species of butterflies exhibit a range of wing colours. Butterflies with extremely bright wing colours attract predators easily as compared to the ones	5

	with very dull wing colours. Butterflies with very dull wing colours fail to attract mates as compared to the ones with bright wing colours. Butterflies with intermediate wing colours have the best chance of both avoiding predators and finding mates. (a) Which type of natural selection does this phenomenon exemplify? Justify your answer. (b) A few years later, the rise in industries and pollution, causes the habitat to become darker. How would it affect the survival of the different kinds of butterflies belonging to this species? Which type of natural selection does this phenomenon exemplify? (b) In a specific region where this species is prevalent, a mutation in its population leads to butterflies with a shade of wing colours brighter than the existing shades. How would the long-term survivability of this variant be?	
Q.105	A large population of a species of fish in a lake has been relatively genetically unchanged for a long time. A small bird species from an island migrate to the forest around the lake and prey on the smaller-sized fish. Would the population of the fish species adhere to the Hardy-Weinberg law? Justify your answer.	2
Q.106	Arrange the following evolutionary phenomenon with respect to their contribution to evolution (from most significant to least significant). Justify your answer with respect to each phenomenon. (A) Vegetative propagation (B) Natural selection (C) Hybridisation (D) Genetic drift	5
Q.107	Lake Tanganyika harbours a wide variety of cichlid fish. These fish have minor modifications in the jaw shape, number of teeth, and intestine length amongst various other features, and have evolved to feed on algae, plankton, plants, insects, and other fish of various sizes also residing in the lake. (a) Which of the following evolutionary phenomenon does the above scenario describe? (b) Based on (a), mention any FOUR advantages of this phenomenon.	3
Q.108	Over the course of human evolution, the size of the brain has consistently grown larger. (a) Mention any TWO factors that could be responsible for this continual expansion. (b) Which category of evolution does this pattern align with - stabilising, directional, or disruptive? Justify your answer.	3

Q.109	Among 1000 rabbits of a population, 360 have long ears (LL), 150 have medium ears (Ll), and 490 have short ears (ll). Calculate the following in detail - (a) frequency of individuals per each genotype (b) allele frequencies of L and l (c) Based on (a) and (b), determine if the population is in Hardy-Weinberg equilibrium. Justify your answer.	5
Q.110	What is the frequency of heterozygous genotype (Aa) in a randomly mating population in which the frequency of all dominant phenotypes is 0.36?	2
Q.111	Thalassemia is a disease caused by a specific gene mutation and it affects individuals who inherit two copies of the mutant allele. In a population, the frequency of homozygous recessive individuals is 1 in 100. Calculate the frequencies of the following - (a) recessive allele (a) (b) dominant allele (A)	2
Q.112	A population of a certain plant species inhabits an area with variable water availability. The plant species carries a gene that influences drought resistance, with two alleles, D and d, where D confers extreme drought resistance and d confers poor drought resistance. Plants with the heterozygous genotype (Dd) were able to survive in different water conditions. In a population of 1000 plants, it was found that 250 plants had the DD genotype. (a) Calculate the frequency of the DD, Dd and dd genotypes in the population. Show calculation. (b) Which kind of graph would it represent - Stabilising, Directional or Disruptive? Justify your answer. (c) Due to climate changes, the frequency of drought periods has increased and the dd genotype is put under selective pressure. At this stage, which kind of graph would it represent - Stabilising, Directional or Disruptive? Justify your answer.	5
Q.113	Genetic flow and genetic drift are the same phenomena. Mark the above statement as true or false and justify your answer.	2
Q.114	'Fitness is a result while natural selection is a process.' Explain the above statement.	3
Q.115	Isolation of the Galapagos Islands led to diverse habitats. Tortoises on different islands adapted to specific challenges for survival. A key adaptation was shell shape variation among Galapagos tortoises. Lush, humid islands led to dome-shaped shells, elevating tortoises for plant access. Arid islands favoured saddleback-shaped shells, aiding neck stretching to reach taller vegetation and	3

<table>
<tr><td></td><td>offering support. Gradual genetic and physical differences among tortoise groups on separate islands over time resulted in distinct species formation in the present time.
(a) Mention any TWO evolutionary phenomena the above is an example of.
(b) If the current complete tortoise population of the islands is plotted for their shell shapes, the category of the graph would accurately depict it - Stabilising, Directional or Disruptive? Justify your answer.</td><td></td></tr>
<tr><td>Q.116</td><td>Prokaryotic and eukaryotic cells have distinct flagella with differences in structure and mechanism. Prokaryotic flagella are helical and driven by a rotary motor powered by ion flow. Eukaryotic flagella feature a 9+2 microtubule arrangement, propelled by microtubule sliding via dynein motor proteins.
Identify if the above can be classified as homologous or analogous structures. Justify your answer.</td><td>2</td></tr>
<tr><td>Q.117</td><td>A group of students perform the following experiment -
Three plates of nutrient media were taken - A, B and C and studied for the extent of microbial growth in the plate post-incubation of 24 hours.
<table><tr><th>Plate</th><th>Incubation condition</th></tr><tr><td>A</td><td>The sterile plate was sealed and incubated</td></tr><tr><td>B</td><td>The sterile plate was not sealed and incubated</td></tr><tr><td>C</td><td>A microbial culture was spread on the plate and it was sealed and incubated</td></tr></table>(a) What would be the post-incubation results for the three plates?
(b) Which widely believed theory of the origin of life does this experiment disprove? Justify your answer.
(c) Based on (b), how was it originally disproved?</td><td>5</td></tr>
<tr><td>Q.118</td><td>From an evolutionary point of view, predict the possible consequential events arising from the following situations:
(a) A population of mammals is split by a geographic barrier, leading to two isolated subpopulations. Over time, the environments on either side of the barrier changed, favouring different traits in each subpopulation.
(b) In a forest ecosystem, a species of herbivores consume plants that produce deterrent chemicals. A minority of herbivores possessing a genetic mutation can metabolize these compounds.</td><td>2</td></tr>
<tr><td>Q.119</td><td>Among plants, angiosperms, or flowering plants, stand out as the most diverse and numerous group of plants on Earth today, a reflection of their evolutionary triumph.</td><td>5</td></tr>
</table>

<table>
<tr><td></td><td>Mark this statement as TRUE/FALSE and give any FOUR reasons for your answer using the characteristic features of angiosperms.</td><td></td></tr>
<tr><td>Q.120</td><td>In a population of birds, individuals with intermediate beak sizes can effectively feed on a range of available seeds while birds with either small or large beak sizes find it difficult to access certain seeds.
(a) Which birds are more likely to be naturally selected?
(b) Based on (a), which type of natural selection does this phenomenon exemplify?</td><td>2</td></tr>
<tr><td>Q.121</td><td>A group of amphibians arrives on a newly formed archipelago with diverse habitats - from lush forests to arid deserts, with each island presenting unique ecological niches. Currently, the animals are capable of utilizing only a few, yet abundant, resources on each island, which has numerous resources that remain inaccessible to them, except for certain mutated individuals that enable them to exploit these previously inaccessible resources.

From an evolutionary point of view, predict the consequential events arising from the above situation in TWO points.</td><td>2</td></tr>
<tr><td>Q.122</td><td>Genetic drift will lead to speciation in very large populations.
Explain why this statement is false in TWO points.</td><td>2</td></tr>
<tr><td>Q.123</td><td>Match the examples with the correct evolutionary process.
<table><tr><th>Example</th><th>Evolutionary process</th></tr><tr><td>(a) Humans with a mutation in the lactase gene were able to produce lactase even as adults which was not possible for humans without the mutation</td><td>(i) Adaptive Radiation</td></tr><tr><td>(b) Euphorbia, a genus of flowering plant, and Cactus, an unrelated species, have both developed spines to cope with the low rainfall and arid climate of desert regions.</td><td>(ii) Convergent Evolution</td></tr><tr><td>(c) Brocolli is a species that is derived from wild mustard plants whose flower and buds have been modified. Cabbage also comes from wild mustard plants where the internode length has been suppressed.</td><td>(iii) Natural Selection</td></tr><tr><td></td><td>(iv) Divergent Evolution</td></tr></table></td><td>3</td></tr>
<tr><td>Q.124</td><td>A population of peppered moths is in Hardy-Weinberg equilibrium for a gene with two alleles. The 'A' allele for dark-coloured wings is dominant over the 'a' allele for light-coloured wings.</td><td>3</td></tr>
</table>

<table>
<tr><td></td><td>The frequency of homozygous dominant individuals is 0.36. Based on this information, calculate the frequency of:
(a) allele A in the population
(b) allele a in the population
(c) heterozygous individuals</td><td></td></tr>
<tr><td>Q.125</td><td>A group of palaeontologists aim to characterize fossil samples based on their age amongst other parameters. They collected the samples from different depths in the ground. They have recorded the values of these samples from the ground level and compiled them in the following table:
<table><tr><th>Sample Name</th><th>Depth from the ground level (m)</th></tr><tr><td>A</td><td>4000</td></tr><tr><td>B</td><td>6000</td></tr><tr><td>C</td><td>1500</td></tr></table>Arrange the sample names with respect to their age (oldest to youngest). Justify your answer.</td><td>2</td></tr>
</table>

Answer key and Marking Scheme

Q.No	Answers	Marks
Q.91	B. reactants < products	1
Q.92	D. convergent evolution	1
Q.93	B. anaerobic and chemo-heterotrophic	1
Q.94	D. survival of the fittest	1
Q.95	C. only P, Q and S	1
Q.96	B. Both A and R are true, but R is not a correct explanation for A.	1
Q.97	C. Some treefrogs that might have slightly yellowish skin will survive and reproduce.	1
Q.98	A. The sum total of the frequency of C and C' is equal to 1.	1
Q.99	C. divergent evolution	1
Q.100	B. emigration of species	1
Q.101	C. A is true, but R is false.	1
Q.102	(a) Bees and flowering plants have a mutually beneficial relationship, where bees help in pollinating the flowers and flowering plants provide the bees with nectar and pollen. This relationship helps both kinds of species survive in nature. *[0.5 marks each for the role of each organism]* (b) *[1 mark each for any TWO of the following]*: - longer tongues to reach the nectaries of the flowers and obtain nectar. - improved sensory organs to detect floral colours, patterns and scents to detect the presence and location of flowering plants - improved communication and navigation systems for reaching the flowering plants. (c) *[1 mark for any TWO of the following]*: - sticky pollen that can stick to the body hair and legs of bees so that it can be transferred to plants at farther locations.	5

	- flowers have a variety of colours, shapes and patterns to attract the bees towards them. - Plants produce nectar and protein-rich pollen *[Accept any other valid answer]*	
Q.103	*[1 mark each for each of the following]* - CH_4, H_2O, H_2, NH_3 - The experimental setup does not have a source of electric sparks/energy, that could provide the energy necessary to initiate chemical reactions among the gases and form various organic molecules. *[Do not award marks if any compound is not written.]*	2
Q.104	(a) *[1 mark each for each of the following]* - Stabilizing selection. - Stabilizing selection occurs when the intermediate traits of a population, the intermediate wing colour in this case, are favoured over the extreme traits, such as wings with extremely bright or dull colours. (b) *[1 mark each for each of the following]* - The darker environment aids camouflage for dull-winged butterflies, reducing predator visibility. Over time, the population could shift towards duller-winged individuals for increased survival and reproduction in the altered habitat. - Directional selection (c) The brighter wing colour variant's long-term survivability would decrease due to heightened predator attraction.	5
Q.105	*[1 mark for each of the following]* - No - The scenario violates the rule of 'no gene flow/migration' from the Hardy-Weinberg law.	2
Q.106	*[1 mark for the following]* *[Appropriate marks to be deducted even if anyone is incorrect]* Natural selection >Hybridisation >Genetic drift >Vegetative propagation *[1 mark for each of the following justifications]*	5

	- Natural selection - It acts by favouring the variations and traits that increase an organism's fitness in its environment and leads to their accumulation over time. Hence, natural selection is considered the most significant factor driving evolution. - Hybridisation - It involves the interbreeding of different variants, leading to the mixing of genetic material. This can enhance the genetic diversity that might contribute to the creation of new species making it an important factor in evolution. - Genetic drift - occurs due to random changes in gene frequencies in small populations due to chance events. It could be less significant than natural selection and hybridisation as its effects are less predictable and may not always lead to adaptive changes. - Vegetative propagation - is a form of asexual reproduction that produces genetically identical individuals. Thus, it contributes the least to overall genetic diversity and is the least significant factor in terms of evolution.	
Q.107	(a) Adaptive radiation (b) This diversification allows the fish in the lake to - exploit different food sources - exploit different habitats - reduce competition - maximizing their chances of survival - increase beneficial traits and specialization - creates a more stable ecosystem *[0.5 marks each for any four of the above]* *[Accept any other valid answer]*	3
Q.108	(a) *[1 mark each for any two of the following points]* The human brain evolved to occupy a larger volume and become complex because of the following reasons - - development and use of tools by early humans required higher cognitive abilities. - need to adapt, innovate, and exploit resources. - need for complex interactions, cooperation, and communication within social groups.	3

	- need for problem-solving capabilities. - need for enhanced memory and learning capabilities - transmission of knowledge through generations *[Accept any other valid answers]* (b) *[0.5 marks each for any two of the following points]* - Directional selection - The increase in brain size over time suggests a consistent directional shift toward larger brains due to the adaptive advantages conferred by cognitive enhancements. *[Accept any other valid answers.]*	
Q.109	(a) *[0.5 marks each for each genotypic frequency value]* Homozygous dominant (LL) individuals: 360 / 1000 = 0.36 (or 36%) Heterozygous (Ll) individuals: 150 / 1000 = 0.15 (or 15%) Homozygous recessive (ll) individuals: 490 / 1000 = 0.49 (or 49%) (b) *[1 mark each for each allele frequency]* if $p^2 = 0.36$ p = 0.6 if $q^2 = 0.49$ q = 0.7 (c) *[1 mark for calculation-based justification and 0.5 marks for the answer]* For the population of rabbits to be in the Hardy-Weinberg theorem, $p^2 + 2pq + q^2 = 1$ Substituting the values p = 0.6 and q = 0.7 $p^2 = 0.36$	5

	$q^2 = 0.49$ 2pq = 0.84 Since $p^2 + 2pq + q^2$ is greater than 1, this population of rabbits is not in Hardy Weinberg equilibrium.	
Q.110	*[1 mark for the detailed calculation and 1 mark for the answer]* According to the Hardy-Weinberg equilibrium, $p^2 + 2pq + q^2 = 1$ The dominant phenotype (AA and Aa) can be represented by $p^2 + 2pq$ is equal to 0.36. $q^2 = 1 - (p^2 + 2pq) = 1- 0.36 = 0.64$ q = 0.8 p = 1- 0.8 = 0.2 2pq = 2*0.2*0.8 = 0.32 Therefore, the frequency of the heterozygous genotype is 0.32.	2
Q.111	(a) Since q^2 is 1 in 100, $q^2 = 1/100$ and q = 0.1 (b) p + q = 1 p = 1 - q = 0.9	2
Q.112	(a) Frequency of DD = p^2 = 250/1000 = 0.25 *[1 mark]* p = 0.5 Therefore, q = 1 - p = 1 - 0.5 = 0.5 Frequency of dd = q^2 = 0.25 *[1 mark]* Frequency of Dd = 2pq = 2*0.5*0.5 = 0.5 *[1 mark]* (b) 0.5 marks each for each of the following points: - Stabilizing evolution - The DD genotype (extreme drought resistance) and the dd genotype (poor drought resistance) are not favoured due to their disadvantages under varying	5

	water availability. The Dd genotype (intermediate drought resistance) has the highest fitness and is favoured, leading to a peak in the middle of the graph. (c) 0.5 marks each for each of the following points: - Directional evolution - Due to the increased drought periods, the selective pressure will favour genotypes with better drought resistance (like DD and possibly Dd), reducing the frequency of the dd genotype, leading to a directional shift towards the D allele.	
Q.113	False Genetic flow involves the movement of individuals and their genes between populations, actively influencing genetic diversity, whereas genetic drift is a random process that can lead to changes in allele frequencies within populations, often leading to a decline in genetic diversity.	2
Q.114	*[1 mark each for each of the following points]* - Fitness refers to the outcome of an organism's adaptation, where its ability to produce offspring with advantageous traits for survival and reproduction is enhanced. - Natural selection is a mechanism by which heritable traits that confer greater success in a given environment become more prevalent over generations, illustrating the process through which advantageous traits are favoured and passed on. - In essence, fitness is the consequence/result of successful adaptation, while natural selection is the dynamic process that drives the persistence of adaptive traits in a population over time.	3
Q.115	- Adaptive radiation - Speciation *[Accept any other valid answer]* *[1 mark each for each of the following points]* - Disruptive selection plot - Disruptive selection arises when extreme trait variations are favoured due to differing environmental conditions, leading to a bimodal distribution in the population, as seen in tortoises with dome-shaped shells in lush areas and saddleback-shaped shells in arid regions.	3
Q.116	*[1 mark for each of the following points]*	2

	- Analogous structures - The prokaryotic and eukaryotic flagella, though they have a similar function, differ in structure and mechanism, due to independent evolution, and hence are analogous structures.	
Q.117	(a) *[1 mark each for each of the following points]* - A - No microbial growth would be observed since it was sterile and sealed. - B - Microbial growth could potentially occur due to airborne contaminants reaching the nutrient media. - C - Microbial growth from the initially spread culture would likely be observed, as the sealed environment would prevent external contaminants from entering. (b) *[0.5 mark each for each of the following points]* - It disproves the theory of spontaneous generation. - The lack of growth on the sterile, sealed plate (A) contradicts the idea of life spontaneously forming. (c) Louis Pasteur's swan-necked flask experiment involved sealed and unsealed flasks containing broth to demonstrate that microorganisms do not spontaneously generate but come from external sources, supporting the concept of biogenesis.	5
Q.118	(a) Isolated by a geographic barrier, two subpopulations adapt to their changing environments through distinct traits, possibly leading to the formation of separate species. [Accept any other valid answer.] (b) Over generations, the frequency of the herbivores with the mutation for metabolizing the compounds may increase as they can access a broader food source, potentially leading to a more specialized herbivore population.	2
Q.119	*[1 mark for the following]* - True *[1 mark each for any FOUR of the following points]* - Angiosperms adapt widely, spanning deserts to rainforests, and high altitudes to aquatic habitats, driving global diversity and distribution. - Angiosperms' flower and fruit evolution enables efficient reproduction by luring diverse pollinators, promoting successful pollination and genetic variety.	5

	- Angiosperms use varied strategies — self and cross-pollination — to thrive in diverse conditions, leading to their evolutionary triumph. - They co-evolve with pollinators, developing traits that attract specific species, and enhancing pollination efficiency. This symbiotic bond boosts both plant and pollinator success. - Many angiosperms have relatively short life cycles, allowing them to reproduce and spread rapidly. This quick turnaround time increases their evolutionary potential. *[Accept any other valid answers]*	
Q.120	(a) Birds with intermediate beak sizes have a feeding advantage, driving the population towards increased intermediate sizes due to their higher survival and reproductive success, reducing extremes. (b) Stabilizing selection	2
Q.121	1 mark for each of the following: - The mutated population of amphibians are likely to exploit unique ecological niches in the archipelago. - This may eventually lead to the formation of different species. *[Accept any other valid answer]*	2
Q.122	1 mark for each of the following: - Genetic drift is the change in frequency of an existing gene variant in the population due to random chance. - This effect is negligible when population sizes are very large and speciation may not occur.	2
Q.123	1 mark for each correct match: - (a) with (iii) - (b) with (ii) - (c) with (iv)	3
Q.124	(a) 0.5 mark each for stating the formula and calculating frequency: frequency of homozygous dominant individuals = 0.36 = p^2 frequency of allele A = p = √(0.36) = **0.6**	3

	(b) 0.5 mark each for stating the formula and calculating frequency: p+q=1 frequency of allele a = q = 1-p = 1-0.6 = **0.4** (c) 0.5 mark each for stating the formula and calculating frequency: frequency of heterozygous individuals = 2pq = 2×0.6×0.4 = **0.48**	
Q.125	The age of the fossil samples in the order of oldest to youngest is - Sample B > Sample A > Sample C. *[Appropriate marks to be deducted even if anyone is incorrect]* The depth of a fossil sample can indicate its age because new sediment layers settle on top of existing ones, compressing and solidifying them. Older layers and fossils are found at greater depths than younger ones.	2

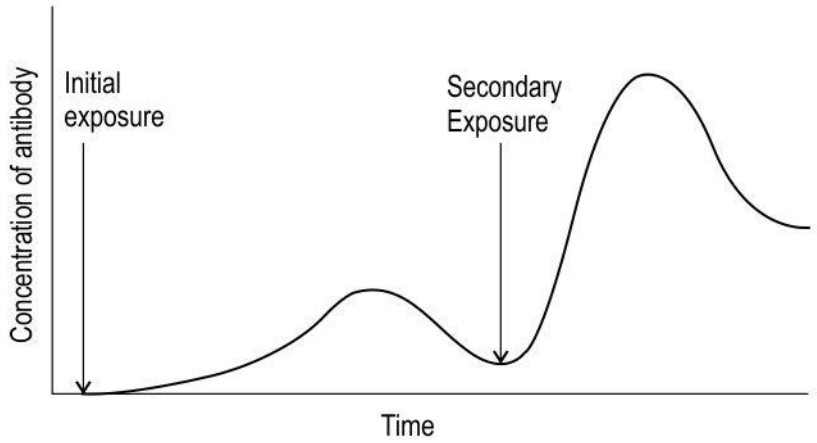
8. CHAPTER: HUMAN HEALTH AND DISEASE

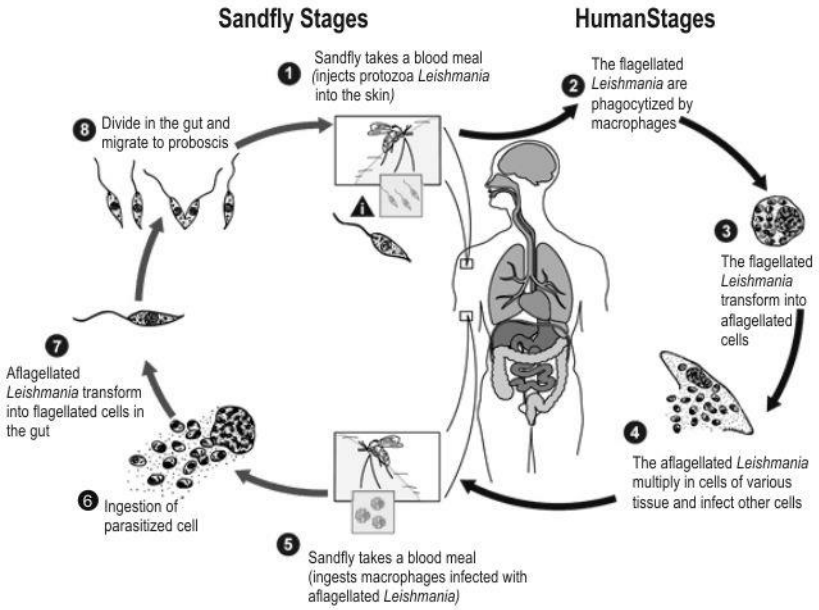
Q.No	Question	Marks
	Multiple Choice Question	
Q.126	Enzyme-linked immunosorbent assay (ELISA) is used for testing if the patient is suffering from AIDS or not. In this test, the enzyme-linked antibodies bind to _____ in the blood sample and help in their detection. Fill in the blank - A. HIV DNA B. HIV RNA C. HIV antibody or antigen D. HIV reverse transcriptase	1
Q.127	As a part of increasing immunity against COVID-19, a small part of the virus is administered to people as a vaccine. Which of the following types of immunity is the above an example of? A. Naturally acquired active immunity B. Naturally acquired passive immunity C. Artificially acquired active immunity D. Artificially acquired passive immunity	1
Q.128	Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): *Salmonella* infects various human organs via the bloodstream. Reason (R): Only *Salmonella spps.* can withstand the high pH of the blood. Which of the following is correct? 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.	1
Q.129	During plasma transfusions from healthy persons, individuals acquire all the components present in the plasma of the healthy person. Which of the following types of immunity is the above an example of? A. Naturally-acquired active immunity B. Artificially-acquired active immunity C. Naturally-acquired passive immunity	1

	D. Artificially-acquired passive immunity	
Q.130	Complete DiGeorge Syndrome is when the child is born without the thymus. Which of the following processes is likely to be impaired in such individuals? A. Red blood cell production B. Thyroxine production C. Antibody production D. Antigen production	1
Q.131	Antibiotics are most effective against which type of infection? A. Filaria B. Ringworm C. Tuberculosis D. Rheumatoid arthritis	1
Q.132	*- It is caused by a fungi.* *- An individual infected with it shows dry scaly lesions on various body parts.* Which of the following disease do these hints refer to? A. Ringworm B. Filariasis C. Amoebiasis D. Ascariasis	1
Q.133	Which of these infections is NOT caused by a worm? A. Filariasis B. Ringworm C. Round worm D. Elephantiasis	1
Q.134	Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): Malignant tumors are more dangerous to the affected organism than benign tumors. Reason (R): Unlike malignant tumors that tend to stay localized in the same region, benign tumors spread to various body organs. Which of the following is correct? 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.	1

	C. A is true, but R is false. D. A is false, but R is true.	
Q.135	A research team working on a rapid diagnostic test to detect *Haemophilus influenzae* is in search of appropriate candidates to obtain patient samples. Patients with which of the following symptoms would serve as suitable candidates to obtain samples? A. Abdominal pain, fatigue, nausea and fever B. Cough, chest pain, and fever C. A history of asthma D. Swelling in the legs	1
Q.136	Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): The liver is the highest affected organ by the consumption of alcohol as compared to the other organs. Reason (R): Alcohol received by the liver gets chemically reduced to produce alkanes, which are very harmful. Which of the following is correct? 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.	1
Free Response Questions/Subjective Questions		
Q.137	An individual has been consuming drugs of a specific kind which has caused high blood pressure, anxiety, paranoia, and aggressive behaviour. (a) Identify the class of drugs that could potentially be detected in his bloodstream. (b) Based on the class identified in (a), State any TWO (i) examples of drugs that belong to it. (ii) long-term physical and mental effects EACH if consumption of the drugs is continued. (iii) treatment or support strategies that could assist him in addressing his drug usage.	5
Q.138	Two patients - X and Y, who had recently consumed drugs, were brought to a rehabilitation centre. While it is established that each of them consumed either morphine or cocaine, their specific drug consumption remained undisclosed. During the mandatory tests, X exhibited heightened alertness with bouts of	5

	hallucinations while Y appeared drowsy. Further, the resting heart rate of X was high and that of Y was slower than normal. (a) Based on these observations, identify the drug that each patient is likely to have consumed. (b) Which category of drugs does each drug identified in (a) belong to? (c) Mention any THREE ways in which society's overall well-being is likely to get affected by the misuse of such drugs.	
Q.139	Human Immunodeficiency Virus (HIV) causes Acquired Immunodeficiency Syndrome (AIDS). (a) Mention any FOUR characteristics of the HIV virus that contributes to its severity? (b) Why is AIDS classified as a syndrome and not a disease?	3
Q.140	A group of researchers want to study a protein's involvement in promoting contact inhibition. (a) Suggest a type of cells into which they can express this protein, allowing them to evaluate the extent of its functional capabilities. Give a reason to support your answer. (b) Mention any FOUR factors that can lead to the formation of cells identified in (a).	3
Q.141	Mark the following statement as true or false and give a reason for your answer. Immune responses to allergens is an example of passive acquired immunity.	2
Q.142	HIV-infected cells continue to remain alive while the viruses are being replicated inside them and released. Describe THREE ways in which this strategy helps the viral infection process.	3
Q.143	Why does a malarial parasite invade red blood cells instead of other cells? Mention any THREE reasons to explain the same.	3
Q.144	An example of active acquired immunity is when an Rh-negative pregnant woman is given Rh immunoglobulin to prevent her immune system from reacting against Rh-positive fetal blood cells, to reduce the chances of hemolytic diseases in the newborn. Mark the above statement as true or false and justify your answer.	2
Q.145	Movement of cilia in coordinated waves to sweep mucus and trapped pathogens out of the respiratory tract is an example of passive innate immunity. Mark the above statement as true or false and justify your answer.	2
Q.146	A patient with a viral infection is showing symptoms such as cough, nasal congestion, sore throat, and tiredness and is diagnosed with the common cold.	3

	(a) Mention the causative agent and the mode of spreading of the disease that could result in the above symptoms and the disease. (b) Arrange the respiratory regions from most to least concentration of virus particles and the infected cells: trachea, bronchioles, and alveoli. Justify your answer.	
Q.147	From an immunological point of view, predict the consequential events arising from the following situations: (a) A person is transplanted with a kidney without tissue matching. (b) A person with the O+ blood group receives a blood transfusion from a donor with A+ blood group.	2
Q.148	The graph given below shows the levels of antibodies against a pathogen over a period of 30 years in a person's body.  (a) What do the 2 peaks mean? (b) Explain the reason behind the difference in the size of the 2 peaks.	2
Q.149	Name the technique that relies on the difference in response to help an individual fight a disease. Explain the underlying mechanism of the technique.	1
Q.150	What happens when: (a) A newborn is not breastfed. (b) A tumour cell enters the bloodstream.	2
Q.151	The image depicts the transmission of Leishmaniasis, a disease prevalent in the tropics and sub-tropics of Africa, Asia, the Americas, and southern Europe. The symptoms include skin ulcers, fever, low erythrocyte count, and enlarged spleen and liver.	2

	 Based on the image, identify the: a) Pathogen b) Vector c) Host	
Q.152	Mark the following statements as TRUE or FALSE, and support your answer with a reason. (i) Vector-borne diseases are caused only by protozoans. (ii) All infectious diseases caused by bacteria spread through air. (iii) Only infectious diseases are caused by virus.	3
Q.153	An infection with *Wuchereria bancrofti* leads to symptoms such as swollen lymph nodes. (a) What are the hosts that *Wuchereria bancrofti* resides in? (b) Give TWO reasons why the lymphatic system provides a better environment for *Wuchereria bancrofti* than the circulatory system.	3

Answer key and Marking Scheme

Q.No	Answers	Marks
Q.126	C. HIV antibody or antigen	1
Q.127	C. Artificially acquired active immunity	1
Q.128	C. A is true, but R is false.	1
Q.129	D. Artificially-acquired passive immunity	1
Q.130	C. Antibody production	1
Q.131	C. Tuberculosis	1
Q.132	A. Ringworm	1
Q.133	A. Filariasis	1
Q.134	C. A is true, but R is false.	1
Q.135	B. Cough, chest pain, and fever	1
Q.136	C. A is true, but R is false.	1
Q.137	(a) The class of drugs that could potentially be detected in his blood is stimulants. *[1 mark]* (b) (i) *[0.5 marks each for any two of the following]:* - Cocaine - Nicotine - Caffeine - Ephedrine - Amphetamines (b) (ii) *[0.5 marks each for any two of the following physical effects]:* - Respiratory problems - Cardiovascular problems like heart strokes - Liver damage	5

	- Kidney damage - Gastrointestinal problems like ulcers, and acidity. *[0.5 marks each for any two of the following mental effects]:* - Higher risk of suicidal thoughts - Depression and anxiety - loneliness due to loss of relationships - lower attention span - Mood swings (b) (iii) *[0.5 marks each for any two of the following]:* - Counselling - Help from support groups and proper education - Help from family members and friends - Medication - Rehabilitation programs *[Accept any other valid answers for the above questions and provide marks for the same]*	
Q.138	(a) 0.5 marks each for each of the following: - X - Cocaine - Y - Morphine (b) 0.5 marks each for each of the following: - Cocaine - Coka alkaloids - Morphine - Opioids (c) 1 mark each for any THREE of the following: - Increase in crime rate - Increase in the number of unhealthy people due to short-term and long-term effects of drugs	5

	- Burden on healthcare systems - Disruption in relationships with family and friends - Reduction in educational attainment and workforce productivity *[Accept any other valid answer]*	
Q.139	(a) 1 mark each for the following*:* - While different viruses attack various organ systems, HIV targets the immune cells such as T cells, impairing the immune response, and making the body more susceptible to infections and cancers. - It has a higher mutation rate that helps its rapid evolution and the emergence of new variants that can evade immune responses and antiretroviral drugs. - HIV integrates its genetic material into the host cell's genome, making it difficult for the immune system to eliminate infected cells. This allows the virus to persist in the body over time. - HIV causes a latent infection in some cells, where it remains inactive and hidden from the immune system. This latent reservoir makes complete eradication of the virus extremely challenging. *[Accept any other valid answers]* (b) AIDS is a collection of symptoms/diseases rather than a single distinct condition.	3
Q.140	(a) 0.5 marks for each of the following: - Tumor/Cancerous cells - Expressing them in tumour cells will help in identifying their ability to promote contact inhibition as these cells already have lost that property. (b) 0.5 marks for each of the following points: - Ionising radiations like X-rays and gamma rays - Non-ionizing radiations like UV rays - Chemical carcinogens - Infection by oncogenic viruses *[Accept any other valid answers.]*	3
Q.141	False	2

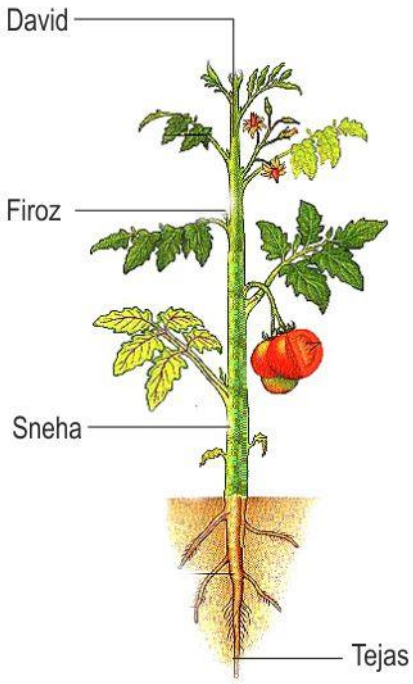
	Immune responses to allergens involve the production of specific antibodies leading to allergic reactions and is not the result of receiving pre-formed antibodies. Hence, it is an example of active acquired immunity but not passive acquired immunity. *[No marks to be awarded if the correct justification is not provided.]*	
Q.142	1 mark each for any THREE of the following: - Infected cells provide a protected environment where the virus can constantly replicate and assemble new viral particles. - Infected cells help the viral particles in evading immune detection. - Some infected cells enter a latent state, allowing the virus to persist without active replication. - The slow release of viruses from infected cells ensures a continuous supply of virus particles, increasing the chances of infecting neighbouring cells and spreading the infection. *[Accept any other valid answers]*	3
Q.143	*[1 mark each for any THREE of the following]* *[Accept any other valid answers]* Attacking the red blood cells of the human hosts helps the plasmodium in - - evade detection by the immune system - access nutrients and oxygen-carrying haemoglobin - development of sexual-stage parasites (gametocytes) in red blood cells ensuring that the parasite can continue its life cycle in the mosquito host. - the periodic release of merozoites leads to synchronized cycles of fever in the host, increasing the likelihood of mosquito feeding during a period when the gametocytes are present, facilitating transmission.	3
Q.144	False An Rh-negative pregnant woman does not produce any antibodies, but receives Rh immunoglobulin containing pre-formed antibodies against Rh-positive blood cells from an external source. This is not an example of active acquired immunity but is an example of passive acquired immunity	2
Q.145	False It is an active physical defense mechanism that helps to prevent the entry and build-up of pathogens in the respiratory system and does not involve any	2

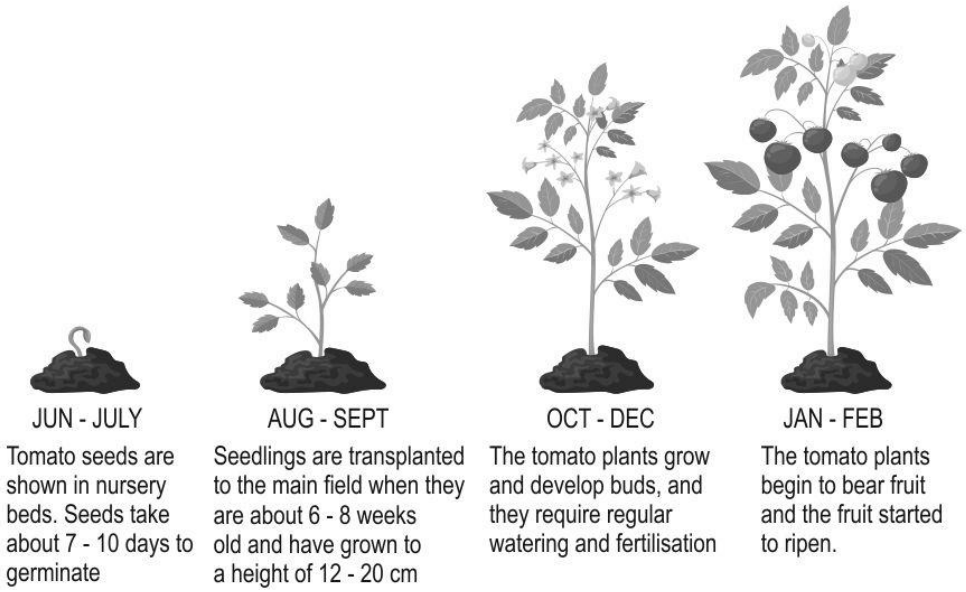
	external source of immune components. Thus it is an example of active innate immunity.	
Q.146	(a) 0.5 marks for each of the following: - Rhinovirus - spread if the droplets resulting from the cough or sneezes of an infected person are inhaled or through shared contaminated items (b) *[1 mark for the sequence of organs and 1 mark for justification]* - Trachea>Bronchioles>alveoli - Rhinovirus attaches and infects cells in the upper respiratory tract, and typically does not reach this deep into the respiratory system.	3
Q.147	(a) Immune system may recognize the kidney as foreign and a cell-mediated immune response develops that can lead to inflammation, tissue damage, and rejection of the transplanted organ. (b) Anti-A antibodies in the recipient's plasma will react with A antigens on the transfused red blood cells, causing agglutination, hemolytic reaction, and possible tissue damage.	2
Q.148	(a) The two peaks represent primary and secondary immune responses/the increase in antibody levels in the blood due to infection. (b) The difference in peak sizes is due to memory cells: the primary response takes time to recognize the pathogen and generate antibodies, while memory cells formed during this response enable a faster and stronger secondary response, producing a larger peak.	2
Q.149	1 mark for each of the following: - Vaccination. - Vaccination uses harmless pathogen components to trigger memory cells for a rapid, potent immune response upon real pathogen exposure, aiding in the fight against the actual pathogen.	1
Q.150	(a) Lack of breastfeeding in new-borns can result in lower passive immunity, potentially increasing susceptibility to infections due to the absence of protective factors present in breast milk. (b) A tumour cell that enters the bloodstream can reach a distant tissue and possibly form a secondary tumour, or metastasis, in that location.	2
Q.151	a) *LEISHMANIA* or protozoa	2

	b) Sandfly c) 0.5 marks for each of the following: - human - sandfly	
Q.152	(i) 0.5 marks for each of the following: - FALSE - Elephantiasis is a vector-borne disease caused by worms. (ii) 0.5 marks for each of the following: - FALSE - Typhoid is caused by a bacterium and it spreads through contaminated food and water. 0.5 marks for each of the following: - FALSE - Some forms of cancer are caused by oncogenic viruses.	3
Q.153	(a) The hosts that *Wuchereria bancrofti* resides in, are as follows *[0.5 marks each for the following]:* - *Humans* - *Mosquitoes* (b) The lymphatic system offers a more favourable environment for *Wuchereria bancrofti* as compared to the circulatory system because of the following reasons *[1 mark each for any two of the following reasons]:* - The slower flow rate of the lymphatic system as compared to the circulatory system makes it a more stable environment for the parasite to thrive in. - As the lymphatic system contains fewer immune cells than the circulatory system, parasites residing in it can evade detection by the immune system. - As compared to blood, the lymphatic fluid is a more constant source of lipids, proteins and other essential nutrients needed for the growth of *Wuchereria bancrofti.* *[Accept any other valid answer]*	3

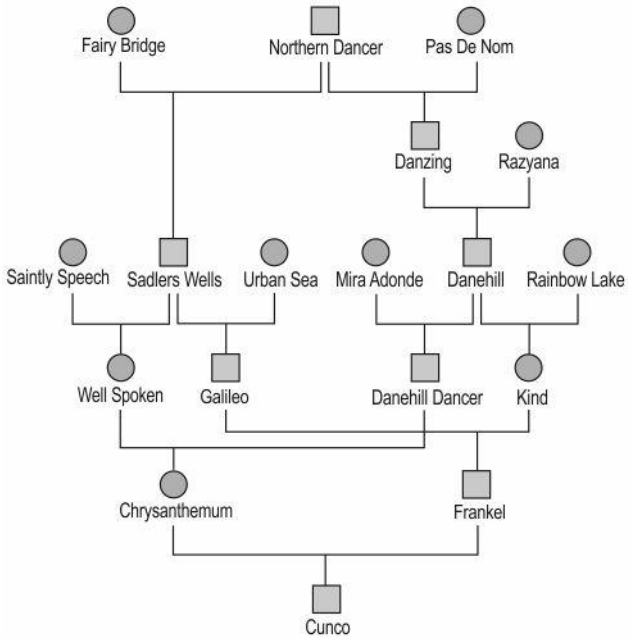
9. CHAPTER: STRATEGIES FOR ENHANCEMENT IN FOOD PRODUCTION

Q.No	Question	Marks
	Multiple Choice Question	
Q.154	Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): Single cell proteins have the potential to meet the growing demand for food and eliminate hunger. Reasoning (R): The yield of proteins from conventional agriculture is more than the yield of proteins from microbes. Which of the following is correct? A. Both A and R are true, and R is a correct explanation for A. B. Both A and R are true, and R is not a correct explanation for A. C. A is true, but R is false. D. A is false, but R is true.	1
Q.155	Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): The micropropagation of the plants does not depend on reproductive structures. Reason (R): Some plant parts have the property of totipotency. Which of the following is correct? 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.	1
Q.156	Four students are artificially propagating a tomato plant using tissue culture. Shown below is a representation of the parent plant and particular parts from which the students isolated cells.	1

	 After 10 days, the parent plant exhibited curling and yellowing of leaves which are symptoms of tobacco mosaic virus. The incubation period of the virus is approximately 1-3 weeks. Which of the following student's tissue culture experiment will give rise to diseased plants? A. David B. Firoz C. Sneha D. Tejas	
Q.157	There are about 450 globally recognised dog breeds. One such breed is the Goldador formed by a cross between two commonly known dog breeds - the Golden Retriever and the Labrador Retriever. Which of the following statements describes the parents of the first Goldador dog correctly? A. They belong to different genus and species. B. They belong to the same genus and species. C. They belong to same genus but different species. D. (Cannot say without knowing their common ancestor.)	1
Q.158	Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): The progeny of cross-hybridisation must undergo selection and testing.	1

	Reason (R): Some hybrids lack the desired combination of their parents' characteristics. Which of the following is correct? 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.	
Free Response Questions/Subjective Questions		
Q.159	The image below shows the milestones of tomato crop.  In which of the four milestones will the presence of beehives containing *Apis indica* be most beneficial? Provide a reason.	2
Q.160	Read the following scenario and answer the questions that follow. Parent 1: *Brandywine* tomato variety known for its large size and excellent flavor. Parent 2: *Sun Gold* tomato variety known for its small size, sweet taste, and disease resistance. (a) Rectify the statement given below by rewriting it. "Crossbreeding of parent 1 and parent 2 will always yield better progeny than inbreeding parent 2 with its offspring." (b) Support your answer to (a) by clearly stating the purpose and outcome of both methods of plant breeding.	3
Q.161	Mark the following statements as true or false and provide a reason.	2

	(a) Artificial insemination has a higher rate of success than normal mating concerned with animal breeding. (b) In herd improvement experiments, artificial insemination is performed first followed by super-ovulation.	
Q.162	Consider two fields having the same number of plants. Field A contains plants of the *Cavendish* banana variety known for firm texture, high yield, and resistance to fungus but sensitivity to other biotic stresses. In field B, seeds produced from a cross between two different banana varieties (*Gros Michel* and *Manzano*) were sown. Gros Michel is known for its excellent flavor and creamy texture but lacks disease resistance. *Manzano* is known for its small size and resistance to biological stresses. (a) The plants of which field will yield bananas with (i) varied characteristics (ii) uniform characteristics (b) If both fields are attacked by aphids, which field will likely have most number of affected plants? Provide reason. (c) In the event of a fungal attack, which field which field will likely have most number of affected plants? Provide reason.	3
Q.163	Controlled breeding experiments are carried out by performing artificial insemination. (a) State TWO advantages of artificial insemination that overcome problems of natural insemination. (b) Semen is mainly made of protein. State why semen needs to be transported in a frozen manner before artificial insemination is performed.	3
Q.164	Shown below is the family tree of a horse, Cunco, who was bred to participate in racing. His ancestor, Northern Dancer, was a champion horse who won 14 out of 18 races in his lifetime and fathered many horses for breeding future champions. Answer the questions that follow based on the tree shown below.	3

	 (a) How many inbred horses are there? (b) Name all the inbred horses identified in (a). (c) If Well Spoken and Galileo are bred, name one risk that the offspring would possess. (d) Cunco is a descendant of Northern Dancer, however, he performed poorly in all the races. What kind of mating will be fruitful to restore racing champion characteristics in the next generation?	
Q.165	Black rot disease is caused by the bacteria, *Xanthomonas campestris* which affects cauliflower. A plant laboratory is focussed on developing a cauliflower variety that is resistant to black rot infection. (a) Name two sources from which the laboratory can obtain resistant genes. (b) The laboratory attempts were unsuccessful as they used conventional breeding techniques. Highlight any one aspect of (a) that could have caused failure. (c) Name two alternative breeding techniques that the laboratory can use to develop the desired variety of cauliflower.	3
Q.166	(a) The Rotolactor is an automatic machine used for milking a large number of cows successively on a rotating platform. State one advantage of the Rotolactor over manual milking of cows. (b) List two practices for maintaining a dairy farm that uses machines for milking cows.	3
Q.167	As a beekeeper, which of the three options would you pick to set up a bee farm and why? (i) an agricultural land surrounded by an orchard (ii) a barren patch of land next to a chemical factory	2

	(iii) a grassy piece of land behind an under-construction residential building	
Q.168	The first successful wheat-rye somatic hybrid was created in 1968 by using protoplast fusion. The hybrid combined desirable traits from both wheat and rye, such as resistance to disease and cold temperatures. (a) Which part of the cell protected the integrity of the protoplasts from the wheat and rye plant? (b) The wheat and rye protoplasts each had one nuclei. How many nucleus/nuclei would the hybrid have? (c) A scientist is attempting the above experiment. He isolated pollen grains from the wheat plant and egg cell from the rye plant. The cells were subjected to a chemical treatment that turned them into protoplasts. The fusion of protoplast from wheat plant and rye plant will yield a somatic hybrid. Is the statement true or false? Give reason. (d) Name the artificial process by which the single-cell somatic hybrid would develop into a plant? (e) (i) Will the plants produced from the single hybrid cell be identical to each other? (ii) Will the hybrid plants be identical to the parents?	3
Q.169	Mark the following statements as true or false and provide a reason for each. (a) Mutation breeding involves the insertion of specific genes into the plant genome. (b) Micropropagation increases the vulnerability of plant population already vulnerable to environmental stresses.	2

Answer key and Marking Scheme

Q.No	Answers	Marks
Q.154	C. A is true, but R is false.	1
Q.155	A. Both A and R are true, and R is a correct explanation for A.	1
Q.156	C. Sneha	1
Q.157	B. They belong to the same genus and species.	1
Q.158	A. Both A and R are true, and R is a correct explanation for A.	1
Q.159	October - December Flower buds develop during October to December. The flowers will be pollinated by bees and yield better crop and honey.	2
Q.160	(a) 1 mark for any of the following: - Crossbreeding of parent 1 and parent 2 will not always yield better progeny than inbreeding parent 2 with its offspring. OR - Neither crossbreeding nor inbreeding will always yield better progeny. [Accept any other relevant answer that does not side with one method of animal breeding.] (b) 1 mark for each of the following: - Crossbreeding produces hybrids and increases the genetic diversity/heterozygosity of population - Inbreeding produces purebreds and preserves specific superior traits/ increases homozygosity of population [Accept any other relevant answer.]	3
Q.161	(a) 0.5 mark for each of the following: - true - Artificial insemination maintains safer mating conditions	2

	OR Artificial insemination helps overcome geographical barriers in uniting the male and female. [Accept any other relevant reason.] (b) 0.5 mark for each of the following: - false - Super-ovulation is done first followed by artificial insemination.	
Q.162	(a) 0.5 mark for each of the following: (i) field B (ii) field A (b) 0.5 mark for each of the following: - field A - All plants are genetically identical or somaclones of the parent who lacks resistance to aphids. (c) 0.5 mark for each of the following: - field B - The parents do not carry fungal resistance.	3
Q.163	(a) 1 mark for each of the following: - Spread of diseases/infections is low as artificial insemination is performed in controlled sterile conditions. - Desired traits can be obtained in the offspring of animals that are inseminated artificially. *[Accept any other valid answer.]* (b) Proteins get denatured at room temperature and stress conditions and so need to be frozen so as to preserve their condition.	3
Q.164	(a) 3 (b) 0.5 marks for each of the following: - Chrysanthemum - Frankel	3

	- Cunco (c) 0.5 marks for any of the following: - reduced fertility - reduced productivity - build-up of harmful recessive genes [Award any other relevant answer.] (d) out-breeding/out-crossing OR crossing with unrelated racing horses from the same breed	
Q.165	(a) 0.5 marks each for any two of the following: - cultivated varieties of cauliflower - germplasm collection of cauliflower crop - germplasm collection of wild species related to cauliflower plant (b) lack of or limited disease-resistant varieties in the germplasm [Award any other relevant response.] (c) 0.5 marks for each of the following: - somaclonal variation - mutation breeding [Award any other relevant response.]	3
Q.166	(a) 1 mark for any of the following: - reduced chance of contamination from the handler - handler is available for other tasks associated with the management of dairy farm [Accept any other relevant answer.] (b) 1 mark each for any two of the following: - stringent cleanliness and hygiene of the milking machine and dairy farm - regular inspection and record keeping of the milking machine - regular visits by a veterinary doctor	3

	[Accept any other relevant answer.]	
Q.167	1 mark each for selecting correct option and giving reason - option (i) - reason - Bees will pollinate the orchard trees and honey yield will be high	2
Q.168	(a) plasma membrane or cell membrane (b) two (c) 0.5 mark for each of the following: - False - Gametes cannot be used for somatic hybridisation. (d) tissue culture (e) 0.5 mark for both of the following: - yes - no	3
Q.169	(a) 0.5 mark for each of the following: - false - Mutation breeding involves the induction of random or spontaneous mutations in the plant's genome, artificially through use of chemicals or radiations. (b) 0.5 mark for each of the following: - true - Plants produced by micropropagation will be genetically identical to the original plant from which they were grown.	2

10. CHAPTER: MICROBES IN HUMAN WELFARE

Q.No	Question	Marks
	Multiple Choice Question	
Q.170	Industrial production of which of these products can be negatively affected by the presence of *Saccharomyces cerevisiae*? A. Beer B. Wine C. Fruit juice D. Wheat bread	1
Q.171	A pharmaceutical industry aims to develop a chemical that can induce immune system modulation in patients with autoimmune diseases and help in alleviating symptoms. Which of the following microbes should they consider utilizing? A. *Aspergillus niger* B. *Staphylococcus aureus* C. *Trichoderma polysporum* D. *Saccharomyces cerevisiae*	1
Q.172	A pharmaceutical company is working on a drug based on statin and is searching for appropriate candidates for clinical tests so as to evaluate its safety, efficacy, and potential therapeutic benefits in a controlled and monitored setting and obtain potential regulatory approval. Which of the following would serve as suitable candidates to obtain samples? A. A professional swimmer. B. A person who recently recovered from dengue. C. A gym trainer who consumes protein in higher quantities. D. A person who consumes saturated fats in higher quantities.	1
Q.173	An industry aims to transition from a small-scale experimental bioreactor to a large bioreactor for the production of an enzyme. Which of the following parameters would be CONSTANT during the scaling-up process? P) pH profile Q) Reactor capacity	1

	R) Volume of inoculum S) Temperature profile T) Initial nutrient concentration A. Only P, R and S B. Only P, Q and R C. Only Q, T and R D. Only P, S and T	
Q.174	Certain micro-organisms such as *Pseudomonas, Bacillus,* and *Burkholderia* species are administered in regions in the oceans where accidental oil spills occur. Which of the following enzymes could the above micro-organisms be producing for them to be helpful in the scenario? A. Streptokinases B. Proteases C. Amylases D. Lipases	1
Q.175	Read the following statements: (A) BOD and polluting potential are inversely related. (B) BOD and polluting potential are directly related. (C) More the BOD, the easier it is to treat the water. (D) More the BOD, more will the harm if released in a water body. Which of these is true? A. (A) and (C) are true and (C) is the reason for (A) B. (B) and (C) are true and (C) is not related to (B) C. (A) and (D) are true and (D) is not related to (A) D. (B) and (D) are true and (D) is the reason for (B)	1
Q.176	'Some groups of microbes release secondary metabolites that are harmful to other groups of organisms and not to the groups releasing it.' For which of the following applications of human welfare is this microbial feature significant? P) Biopesticides Q) Fertilizers	1

R) Fermentation

S) Antibiotics

T) Sewage treatment

A. only P and Q
B. only P and S
C. only P, S and T
D. only Q, R, S and T

Q.177 A biologist inoculated bacteria A, fungus B, and both bacteria A and fungus B on 3 different sterile petri dishes 1,2 and 3 respectively. After 24 hours, he observed growth in all 3. These are his observations: 1

Plate	Organisms	Observation
1	bacteria A	46 small round colonies
2	fungus B	9 medium round colonies
3	bacteria A + fungus B	4 small round colonies + 10 medium round colonies

What can the biologist conclude from this?

Y) The fungus inhibits the growth of the bacteria.

Z) The bacterium causes the fungus to grow better.

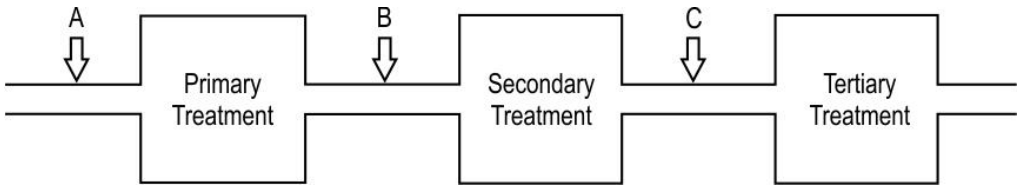
A. only Y
B. only Z
C. both Y and Z
D. neither Y nor Z

Free Response Questions/Subjective Questions

Q.178 To understand the effectiveness of the broad-spectrum antibiotics produced by *Acremonium* fungi, a group of scientists grow it on nutrient media plates along with various disease-causing microbes. The observations related to their growth patterns is tabulated as follows - 5

Micro-organism	Growth pattern with *Acremonium* fungi
Staphylococcus aureus	Both the fungi and bacterial colonies appear.
Enterococcus faecalis	Only the fungi grows.

	Klebsiella pneumoniae	Both the fungi and bacterial colonies appear.
	Pseudomonas aeruginosa	Only the fungi grow.
	(a) Antibiotics produced by the *Acremonium* fungi can be used to treat the diseases caused by which of the above microorganisms? (b) Mention any THREE advantages of using microbes for large-scale antibiotic production compared to chemical synthesis.	
Q.179	Pectinases are used in the textile industry as well as in wastewater treatment. Identify how pectinase can help in each of these industries.	2
Q.180	A patient who has been undergoing chemotherapy is suffering from blood coagulations around central venous catheters that have been used to administer the related drugs. (a) Suggest one possible enzyme that could be considered for administration, with the aim of potentially restoring proper blood flow. (b) Based on (a), mention the micro-organism that it is produced from.	2
Q.181	A water treatment plant primarily receives wastewater from an industry that discharges fungicides as a waste byproduct. Mention any THREE ways the above situation might influence the water treatment procedure.	3
Q.182	While both biological pesticides and chemical pesticides are designed to protect plants and control pests, mention any FIVE advantages that biological pesticides offer over their chemical counterparts.	5
Q.183	Two farmers A and B primarily grow rice. Farmer A practices crop rotation with legumes and rice, and farmer B does not rotate crops. If crops are not rotated, replenishment of nutrients does not occur which degrades soil fertility. Justify your answer	2
Q.184	Given below are three chemical equations. Suggest specific microorganisms that can be used as inoculants for synthesizing the desired products. (a) $C_6H_{12}O_6 \rightarrow 2\ C_2H_5OH + 2\ CO_2$ (b) $N_2 + 3\ H_2 \rightarrow 2\ NH_3$ (c) $(C_6H_{10}O_5)n + H_2O \rightarrow CO_2 + H_2 + CH_4$	3
Q.185	A wastewater sample containing a higher concentration of calcium chloride, potassium chloride, aluminium and copper will always have a higher BOD value. Mark the above statement as true or false and justify your answer.	2

Q.186	Correct the wrong information (in bold) in the steps of the sewage treatment plant and then arrange the sentences in chronological order. 1. Agitation in the aeration tank leads to the **formation of suspended organic waste matters called flocs.** 2. During primary treatment, **aerobic bacteria degrade waste matter in the sewage.** 3. When the BOD is significantly reduced, the effluent is passed from the aeration tank to the settling tank. 4. **The primary sludge** is taken for secondary treatment. 5. Anaerobic sludge digesters degrade **bacteria and fungi in the sludge and produce oxygen.**	3
Q.187	Explain any THREE reasons behind using cow dung for biogas production.	3
Q.188	In a wastewater treatment plant, sampling was done thrice at various stages in the treatment process indicated by A, B and C in the following diagram -  Each time the sample was taken, its BOD was measured, resulting in the following recorded values: 30 mg/L, 300 mg/L, 250 mg/L (a) Define BOD and determine which of these BOD values correspond to stages A, B, and C in the treatment process. (b) Based on (a), justify your answer for each value.	5
Q.189	Alex, Ross and Jane are trying to standardise and identify the best way to make curd. They followed different methods as follows: - Alex took a bowl of lukewarm milk and rested it overnight at room temperature. - Ross took boiling milk, added some curd to it and maintained the temperature high overnight. - Jane took a bowl of lukewarm milk, added some curd to it and rested it overnight at room temperature. (a) What are the possible end products that each one of them will obtain? (b) Based on (a), whose method will yield the best quality curd? Give reasons to support your answer.	3
Q.190	A scientific group aims to compare the quality of water from various water bodies. They collected samples from 3 water bodies and calculated their BOD amongst other parameters and tabulated them as follows.	3

<table>
<tr>
<td></td>
<td>
<table>
<tr><th>Sample Name</th><th>BOD Value (ppm)</th></tr>
<tr><td>A</td><td>100</td></tr>
<tr><td>B</td><td>2</td></tr>
<tr><td>C</td><td>11</td></tr>
</table>

(a) Arrange the sample names with respect to their level of pollution (highest to lowest).

(b) Explain how BOD can indicate the level of pollution in water and hence the water quality.
</td>
<td></td>
</tr>
<tr>
<td>Q.191</td>
<td>Some bacteria such as Lactobacillus aids in the conversion of milk to curd.
How does the pH of the system change during this conversion? Justify your answer.</td>
<td>2</td>
</tr>
<tr>
<td>Q.192</td>
<td>Carbon dioxide is produced as a by-product during the fermentation process of various food items and beverages. Explain any two ways by which this can be beneficial.</td>
<td>2</td>
</tr>
</table>

Answer key and Marking Scheme

Q.No	Answers	Marks
Q.170	C. Fruit juice	1
Q.171	C. *Trichoderma polysporum*	1
Q.172	D. A person who consumes saturated fats in higher quantities.	1
Q.173	D. Only P, S and T	1
Q.174	D. Lipases	1
Q.175	D. (B) and (D) are true and (D) is the reason for (B)	1
Q.176	B. only P and S	1
Q.177	A. only Y	1
Q.178	(a) *Enterococcus faecalis* and *Pseudomonas aeruginosa* *[1 mark each for each organism]* (b) *[1 mark each for any THREE of the following points]* Large-scale antibiotic production by microbes offers the following advantages as compared to the chemical synthesis - follows pathways that are biologically relevant and efficient. - involves less hazardous chemical reactions compared to traditional chemical synthesis and results in a smaller environmental footprint and reduced use of harsh chemicals. - renewable and sustainable due to usage of previous inoculum. - cost-effective. - less energy-intensive and faster. - a vast array of secondary metabolites can also be obtained. *[Accept any other valid answers]*	5
Q.179	Textiles made from plant sources, such as cotton, will contain plant material such as pectin which will need to be degraded.	2

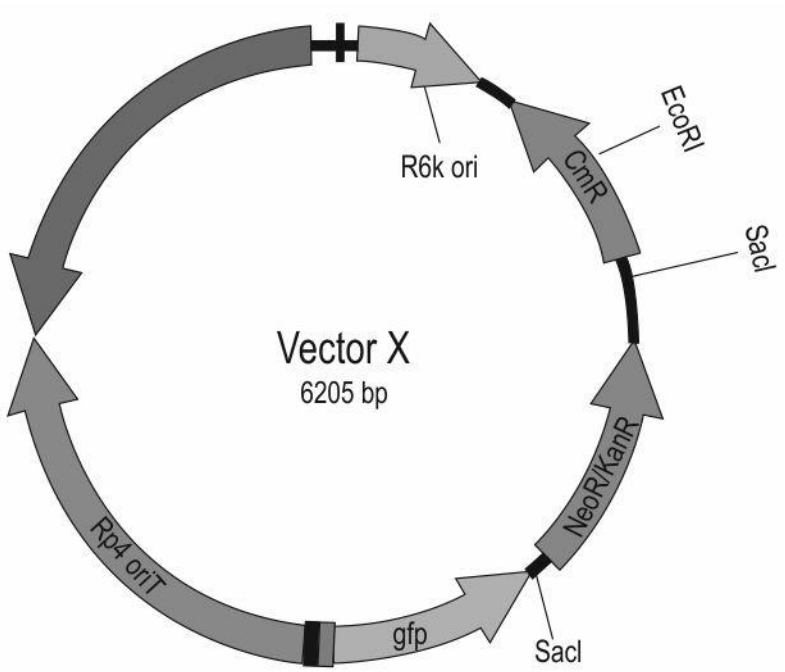
	Waste water will also contain pectinaceous material where pectinase can act to clarify water reducing plant wastes.	
Q.180	(a) Streptokinase (b) *Streptococcus* spp.	2
Q.181	*[1 mark each for the following THREE points]* - fungicides can interfere with the formation and stability of activated sludge flocs and might result in slower settling, and reduced solid-liquid separation. - they can be toxic to other microorganisms such as bacteria, which are essential for the breakdown of organic matter in wastewater. - they could form harmful byproducts in combination with other chemicals during treatment. *[Accept any other valid answer]*	3
Q.182	*[1 mark each for any FIVE of the following]* Unlike chemical pesticides, biological pesticides - are derived from living organisms or natural substances, making them relatively less environmentally harmful - degrade faster and leads to lower residual levels in food and water - target specific pests or groups of pests. This precision reduces the impact on beneficial insects, pollinators, and other non-target organisms, helping to maintain a more balanced ecosystem. - pose fewer risks of acute toxicity or long-term health effects associated with exposure for the farmers and farm animals. - play a key role in IPM strategies, which aim to balance pest control and ecosystem health. - make less impact on crop and non-crop plants. - cause reduced aquatic and soil pollution *[Accept any other valid answers]*	5
Q.183	[1 mark each for each of the following points] - Farmer A - Legumes with nitrogen-fixing bacteria called Rhizobia that reside in nodules on roots and convert atmospheric nitrogen (N_2) into a form that plants can utilize,	2

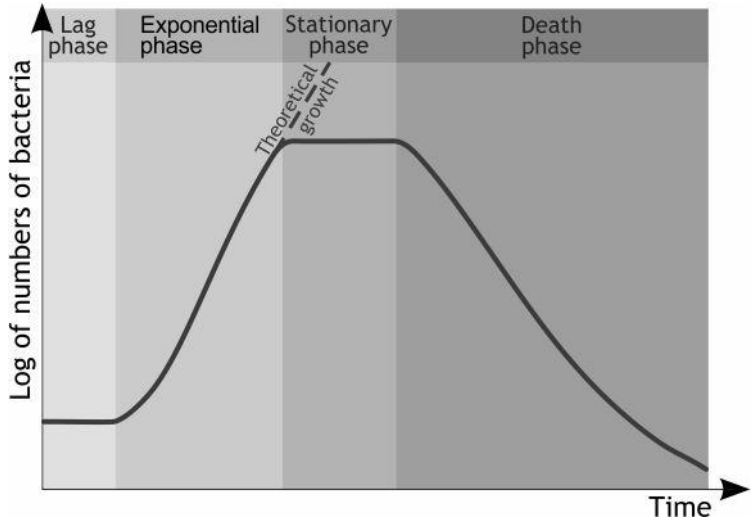
	such as ammonia (NH_3) and nitrates (NO_3^-) and aid in better yield when crops are rotated. **OR** No crop rotation does not replenish nutrients in the soil degrading soil fertility.	
Q.184	(a) *Saccharomyces cerevisiae* *[Accept any other valid answers]* (b) *Rhizobium spp.* *[Accept any other valid answers]* (c) *Methanobacterium spp.* *[Accept any other valid answers]*	3
Q.185	- False - BOD is influenced by the presence of organic compounds that microbes need to break down and not by inorganic compounds and metals such as calcium chloride, potassium chloride, aluminium and copper.	2
Q.186	1. Agitation in the aeration tank leads to the formation of mesh-like structures of bacteria associated with fungal filaments called flocs. 2. During primary treatment, filtration and sedimentation are used for the physical removal of particles like debris and grit. 3. The primary effluent is taken for secondary treatment. 4. Anaerobic sludge digesters degrade bacteria and fungi in the sludge and produce methane, hydrogen sulphide, and carbon dioxide. *[0.5 mark each for each of the above corrected statements]* Correct order: 2, 4, 1, 3, 5	3
Q.187	*[1 mark each for any THREE of the following points]* - cow dung contains a significant amount of methane-producing bacteria (methanogens) due to their presence in the cow's digestive system and aids in the production of methane which is a major component of biogas. - it is rich in organic matter such as cellulose, other carbohydrates, and proteins, that serves as a food source for the microorganisms responsible for anaerobic digestion.	3

	- easily accessible in rural areas and is a waste product on farms that needs recycling and proper disposal. - biogas derived from cow dung is a renewable energy source, contributing to reducing reliance on non-renewable fossil fuels. - the leftover material post-production of biogas can be used as an organic nutrient-rich fertilizer that helps in recycling nutrients back into the soil, improving soil fertility and agricultural productivity. *[Accept any other valid answers]*	
Q.188	(a) - BOD or Biological Oxygen Demand, is a measure of the amount of dissolved oxygen consumed by microorganisms while breaking down organic matter in water, indicating its pollution level. - A: 300 mg/L - B: 250 mg/L - C: 30 mg/L *[0.5 marks for each of the above points]* (b) A - Influent will have the highest organic pollutants and hence the highest BOD. (300 mg/L) B - Primary treatment will reduce the organic matter and hence the BOD to some extent with sedimentation and screening. (250 mg/L) C - Secondary treatment involves biological processes like activated sludge or trickling filters, which reduce BOD levels to the largest extent. (30 mg/L) *[1 mark for each of the above points]*	5
Q.189	(a) 0.5 marks each for the following: - The milk in Alex's bowl might not have gotten converted into curd. - The milk in Ross's bowl may not turn into curd completely or may get spoilt. - The milk in Jane's bowl would turn into curd. *[Accept any other valid answer]* (b) 0.5 marks each for the following:	3

	- Jane would have made the best quality curd. - For proper curd formation, she added the **necessary *Lactobacilli* inoculum** into the milk. - Along with the above, she maintained the milk at the **ambient temperature needed for the growth** of the *Lactobacilli*. *[Appropriate marks to be deducted for missing any one of the reasons]*	
Q.190	(a) The level of pollution in these samples - Sample A > Sample C > Sample B. *[Appropriate marks to be deducted even if any one is incorrect]* (b) BOD (Biological Oxygen Demand) measures the amount of oxygen consumed by microorganisms for oxidizing the organic matter present in water. *[1 mark]* Microorganisms need more oxygen to break down organic matter in the polluted water, hence increasing the value of BOD, and indicating the poor quality of water. *[1 mark]*	3
Q.191	During the process of curd formation, a decrease in the pH occurs in the system. *0.5 marks each for the following:* - The Lactic acid bacteria present in the curd inoculum, when added to milk, converts the lactose of the milk to lactic acid. - This acid formation lowers the pH of the milk, thereby coagulating the milk proteins and forming curd.	2
Q.192	1 mark each for mentioning any two of the following: - It increases the shelf life of some products by inhibiting the growth of spoilage organisms along with preventing the oxidation of certain compounds. - It enhances the taste and aroma of some products. - It enhances the texture of some products by making them fluffy. *[Accept any other valid answer and provide marks for the same]*	2

11. CHAPTER: BIOTECHNOLOGY: PRINCIPLES AND PROCESSES

Q.No	Question	Marks
	Multiple Choice Question	
Q.193	Nihal said that bacteria are never used as a host to clone recombinant DNA for antibiotic production. Is his statement correct and why? A. Yes, because antibiotics kill host bacterial cells. B. No, because antibiotics only kill cells other than bacterial cells. C. No, because the foreign DNA or the host bacterial cell is resistant to the antibiotic being produced. D. Yes, because host bacterial cells do not have the machinery to allow the growth of an antibiotic obtained from other microbes.	1
	Free Response Questions/Subjective Questions	
Q.194	A researcher used a vector X to insert a foreign gene to create a recombinant vector. The image of vector X is shown below.  It has sites for two restriction enzymes - SacI and EcoRI. The foreign gene can be cut using either of these two enzymes. The vector also has a green fluorescent protein (gfp) gene that can be used as a selectable marker, and two genes - chloramphenicol resistance (CmR) and neomycin resistance (NeoR) that provide antibiotic resistance. Chloramphenicol and neomycin are two different antibiotics.	5

	(a) What is/are the possible end product(s) that will be obtained post-ligation if the researcher uses the following enzyme to insert the foreign gene: (i) SacI (ii) EcoRI (b) Based on (a), which enzyme will be better to use to ensure that the foreign gene has been inserted in the vector? Why? (c) If the well of an agarose gel is filled with a solution of the intact vector and the foreign gene, what will the DNA band closer to the well contain? Why?	
Q.195	The large-scale production of an organism is generally done in a bio-processor unit. Given below is the growth curve of a bacteria that is being used for the production of a recombinant molecule. Maintaining sterile conditions is of utmost importance in a bio-processor unit.  (a) In which phase are the cells likely to be producing a larger concentration of the recombinant molecule? Why? (b) In cases where the culture in the bio-processor unit reaches the death phase, identify ONE strategy that can help revive the bio-processing to restart production of the recombinant molecule. (c) What does a sterile condition mean? (d) State ONE reason why the bacteria that are producing the recombinant molecule are not harmed during the process of sterilisation.	5
Q.196	Bacterial cells offer certain advantages over plant or animal cells that make them an easy choice for the production of many recombinant molecules. State THREE such advantages.	3
Q.197	Give TWO reasons why it is important to introduce the gene/s of interest in a vector and then into the host cell or insert it directly into the host chromosomal genome.	2
Q.198	pBR322 was a plasmid that was constructed artificially using genetic material from three sources:	2

	i) the tetracycline resistance gene of pSC101 ii) the ampicillin resistance gene of RSF 2124 iii) the replication elements of pMB1, a close relative of the ColE1 plasmid. Describe the TWO enzymatic steps that would have occurred in the construction of pBR322.	
Q.199	In the process of DNA replication, RNA primers are used to initiate replication where a free nucleotide can start forming a bond with the RNA primer as per the leading strand base sequence. Later, this RNA primer needs to be removed. What type of a nuclease can help with this activity? Why?	2
Q.200	The basis of rDNA technology is to alter the genetic material of an organism to obtain enhanced and desired characteristics in an organism. (a) Preferably, the gene of interest and the vector are cut with the same restriction enzyme. Is this statement true? Give a reason to support your answer. (b) What is/are ALL the possible outcomes after the gene of interest and the vectors are ligated? (c) If a vector contains an ampicillin resistance gene as the selectable marker, state TWO situations in which the host cell will grow in a medium that contains ampicillin.	5
Q.201	State whether each of these statements given below is/are true or false. Justify your answer. (a) Plasmids with a single restriction site are preferred over those with multiple sites for the same enzyme during the cloning process. (b) The tumour-inducing (Ti) plasmid can be extracted from *Agrobacterium tumifaciens* cells and used as it is for cloning a foreign gene.	3
Q.202	Vectors containing the foreign DNA have to be forced into host cells that are made competent to do so. A common method is to first treat host cells with calcium chloride and then incubate these cells on ice. This is followed by briefly placing them at 42 °C and then putting them back on ice. This enables the host cells to take up recombinant DNA and is called the heat shock treatment. (a) Explain why DNA vectors CANNOT pass through the cell membrane like other molecules such as oxygen. (b) Calcium from a $CaCl_2$ solution binds to DNA making it easier for them to enter a cell. Why? (c) Why does the heat shock treatment make the membrane porous allowing for easy uptake of DNA?	5
Q.203	Polymerase chain reaction (PCR) is an in-vitro technique used to amplify nucleic acid sequences. The conditions and duration of each step in PCR are as follows: - Step 1 at 94 °C for 2 min	5

	- Step 2 at 50-65 °C for 30 seconds - Step 3 at 72 °C for 5 min (a) Give TWO reasons why amplification using PCR can be better than amplification in-vivo using plasmids. (b) At which step does the denaturation of DNA take place? How does this occur? (c) What would be the result of the PCR reaction if step 2 does not occur? (d) At what step would PCR be important in rDNA technology?	
Q.204	Insulin is commonly prepared in bio-processing units for patients suffering from insulin-dependent diabetes. Explain THREE steps that would be a part of the downstream processing for insulin.	3

Answer key and Marking Scheme

Q.No	Answers	Marks
Q.193	D. Yes, because host bacterial cells do not have the machinery to allow the growth of an antibiotic obtained from other microbes.	1
Q.194	(a) 0.5 marks each for the following: (i) *[2 marks]* - self-ligated vectors/vectors without the foreign gene inserted - vectors with the foreign gene ligated at any of the two positions - self-ligated vectors without the foreign gene and the neoR gene - self-ligated vectors with the foreign gene but without the neoR gene (ii) *[1 mark]* - self-ligated vectors/vectors without the foreign gene inserted - vectors with the foreign gene inserted inside the CmR gene. *[Award marks if the end products are drawn]* (b) 0.5 marks each for the following: - EcoRI is a better enzyme to use. - Use of EcoRI will ensure the foreign gene insertion because apart from the presence of gfp, it will also be susceptible to chloramphenicol. So only colonies that do not grow on the chloramphenicol-containing medium will have the foreign gene inserted. (c) 0.5 marks each for the following: - intact vector - DNA fragments in an agarose gel move depending on their size where larger fragments stay close to the well while smaller fragments move further away. *[Accept any other valid answer]*	5
Q.195	(a) 1 mark each for the following: - exponential growth phase	5

	- that is the phase where biomass is highest and so each cell produces the recombinant molecule causing its overall concentration to be the highest in the unit (b) 1 mark for any ONE of the following: - addition of more microbes in the growth phase - adding fresh medium while removing the used-up medium *[Accept any other valid answer]* (c) A sterile condition refers to the absence of contaminating organisms in a system. *[Accept any other valid answer]* (d) 1 mark for any one of the following: - bacterial culture of interest is added after the sterilisation process - if the bacteria of interest is thermophilic/die at higher temperature than that used for sterilisation *[Accept any other valid answer]*	
Q.196	1 mark each for the following: - Bacterial cells replicate much faster than plant or animal cells. - Bacterial cells naturally possess extrachromosomal DNA which can act as carriers for the recombinant DNA. - Absence of the nuclear membrane in bacterial cells makes it easy to introduce the recombinant plasmid to the replication, transcription and translation machinery of the cell. *[Accept any other valid answers]*	3
Q.197	1 mark each for the following: - An alien piece of DNA in the cytoplasm is likely to get degraded. - A piece of DNA will not get replicated without the origin of replication and so will not get inherited.	2
Q.198	1 mark each for the following: - The DNA sequences coding for the antibiotic resistance genes and the replication elements would have been cut from the original plasmid using appropriate **restriction enzymes**.	2

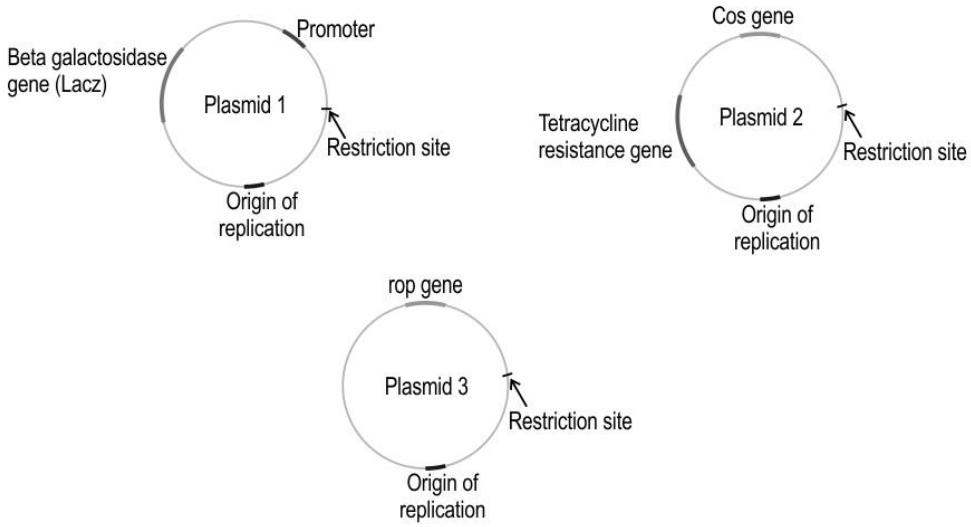
	- The fragments created after restriction digestion would need to be ligated using **DNA ligase** to construct the vector.	
Q.199	1 mark each for the following: - exonuclease - Since the nucleotides from the end of the DNA strand need to be removed exonucleases can help with the activity. *[Accept any other valid answer]*	2
Q.200	(a) - True *[0.5 marks]* - If the gene of interest and vector are cut with the same restriction enzyme they will produce the same sticky ends that are complementary to each other, making ligation easier. *[1 mark]* (b) 0.5 marks for each of the following: - self-ligated vector/s - two of more genes of interest self-ligate - gene of interest and vector ligate (c) 1 mark each for the following: - If the gene of interest ligates into the vector and gets transformed into the host cell. - If the vector self-ligates and gets transformed into the host cell.	5
Q.201	(a) - True *[0.5 marks]* - Plasmids with a single restriction site get cut at only one site increasing the possibility of obtaining a cloned vector rather than those with multiple cleaving sites for the same enzyme. *[1 mark]* *[Accept any other valid answer]* (b) - False *[0.5 marks]* - Plasmids extracted from the bacteria cannot be used as it is as the pathogenic genes need to be removed before it can be used as a vector. *[1 mark]*	3

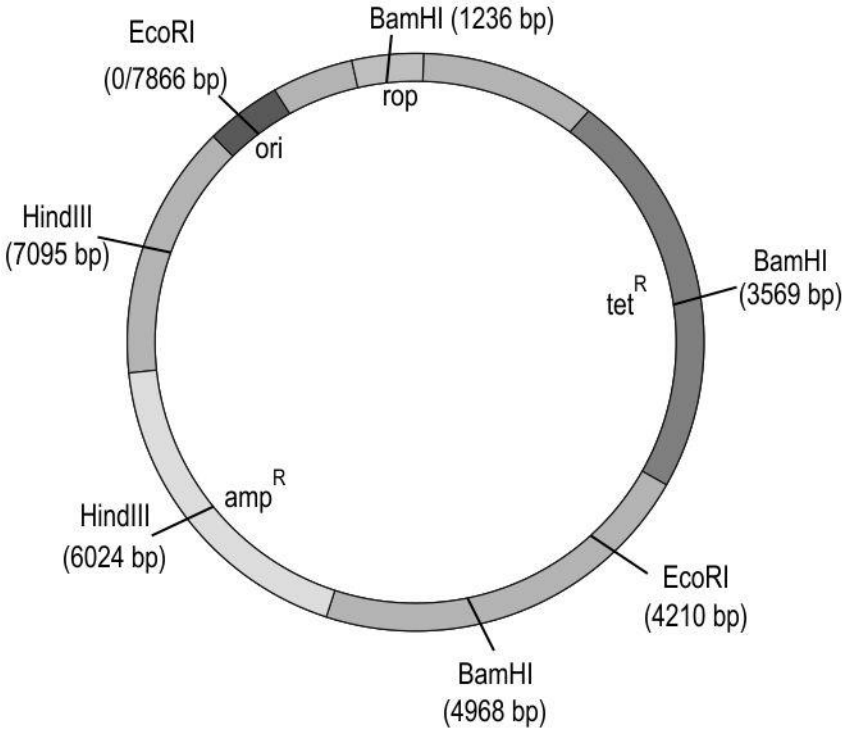
	[Accept any other valid answer]	
Q.202	(a) 1 mark each for the following: - The cell membrane is an amphipathic structure whose **outer ends are hydrophobic or non-polar** in nature. - Oxygen being a non-polar molecule can enter the cell easily but **DNA is highly polar/hydrophilic** in nature which is repelled by the cell membrane. *[Accept any other valid answer. Marks to be awarded to mentioning the highlighted points.]* (b) 1 mark each for the following: - DNA is a negatively charged molecule and this makes it highly polar in nature. - Calcium are divalent cations which bind to DNA making it non-polar and so easier to cross the cell membrane. *[Accept any other valid answer.]* (c) An increase in temperature results in greater kinetic energy of molecules making the membrane more fluid/porous.	5
Q.203	(a) 1 mark each for the following: - PCR is faster than the generation time of many microbes. - An origin of replication is not required for PCR as is required in plasmids. *[Accept any other valid answer]* (b) 0.5 marks each for the following: - Step 1 - Heat causes denaturation of DNA. (c) No DNA would be amplified OR the reaction would stop. (d) PCR would be an important step just before the process of ligation, done before transformation into the required host.	5
Q.204	1 mark for each of the following: - The first step would be **extraction** of the protein from the cells in which it is produced. - The second step would be to **purify** only insulin from the other cell contents that would get mixed in the process of extraction.	3

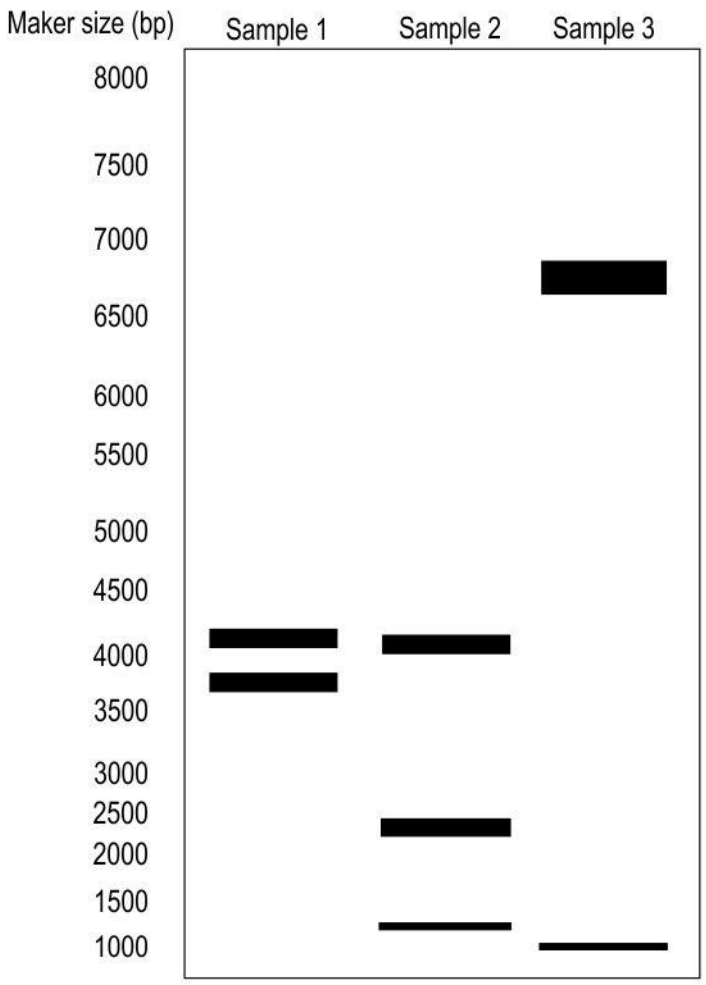
	- The third step would be to **store insulin at low temperatures** to prevent denaturation of the hormone. *[Accept any other valid answer]*	

12. CHAPTER: BIOTECHNOLOGY AND ITS APPLICATIONS

Q.No	Question	Marks
	Multiple Choice Question	
Q.205	Transgenic mice are being developed to replace the use of monkeys for laboratory testing of vaccines or drugs meant for humans. Which of the following is/are POSSIBLE reasons for this move? P) Mice and humans have similar physiology. Q) The reproduction rate is faster in mice. A. only P B. only Q C. both P and Q D. neither P nor Q	1
Q.206	There are two statements given below marked as Assertion (A) and Reason (R). Read the statements and choose the correct option. Assertion (A): A single-stranded DNA probe tagged with a radioactive molecule does not appear in an autoradiogram. Reason (R): Complementarity with DNA obtained from cloned cells forms the basis of probing using tagged DNA molecules in autoradiography. A. Both A and R are true, but R is not the correct explanation for A. B. Both A and R are true, and R is the correct explanation for A. C. A is true, but R is false. D. A is false, but R is true.	1
	Questions 207 and 208 are based on the following information. Meera wanted to study a cytoskeletal protein called MAP2. To do so, she needed to clone the gene to obtain a recombinant MAP2 protein. She had identified the gene for this specific protein and had the cloned DNA sequence ready for further processing.	
Q.207	Which of the following is crucial for getting E. coli cells to produce the recombinant MAP2 protein from the cloned DNA? A. inserting the DNA sequence directly into the E. coli cells B. cutting the DNA sequence using restriction enzymes like EcoRI C. inserting the DNA into a plasmid that can be expressed in the host E. coli cells	1

	D. isolating the DNA sequence from the host E. coli cells and performing a polymerase chain reaction	
Q.208	In the sequence of producing recombinant MAP2 protein, Meera had to perform gel electrophoresis immediately after a PCR (Polymerase Chain Reaction). What could have been Meera's primary goal for performing gel electrophoresis? A. Separating the positively and negatively charged MAP2 DNA fragments. B. Separating the cloned MAP2 DNA from other DNA fragments. C. Separating recombinant MAP2 protein from other proteins. D. Separating cloned MAP2 DNA from MAP2 protein.	1
Q.209	Shown below are three plasmids.  *Cos* gene initiated packaging of virus particles and *rop* gene keeps a check on the copy number of the plasmid in a bacterial cell. Which of these is ideal to be used for rDNA technology? A. only plasmid 1 B. only plasmids 1 and 2 C. only plasmids 2 and 3 D. all - plasmids 1, 2 and 3	1
Q.210	There are two statements given below marked as Assertion (A) and Reason (R). Read the statements and choose the correct option. Assertion (A): Transposons cause insertional mutations that can be treated using gene silencing.	1

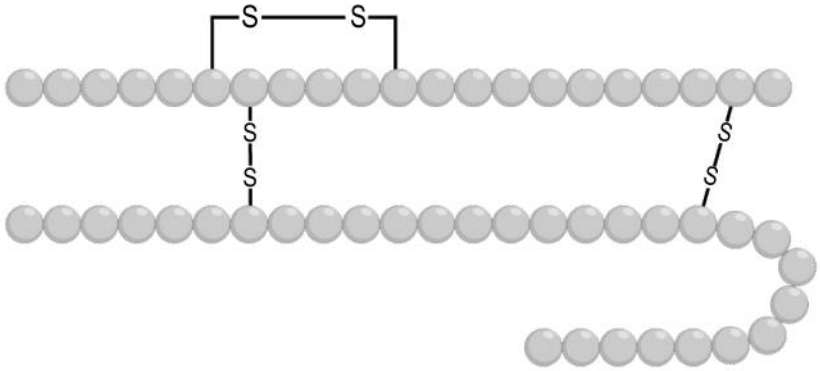
	Reason (R): Transposons are mobile genetic elements that self-replicate via an RNA intermediate. A. Both A and R are true, and R is the correct explanation for A. B. Both A and R are true, but R is not the correct explanation for A. C. A is true, but R is false. D. A is false, but R is true.	
Free Response Questions/Subjective Questions		
Q.211	(a) How is the model organism modified before being used for chemical safety testing? (b) What is the benefit of the modification identified in (a)?	2
Q.212	The plasmid shown below is 7866 base pairs in length and contains genes that confer resistance to antibiotics tetracycline and ampicillin. The bp at which the restriction site is present is also shown.  (a) While working in the lab, Reema took three individual samples of the plasmid. She added different restriction enzymes, EcoRI, HindIII, and BamHI, separately in each of the samples. But she forgot to label the samples in a hurry. She ran the three digested samples on an agarose gel electrophoresis to see the fragments. The results are shown below:	5



Considering complete restriction digestion had happened, help her identify which sample is digested by what enzyme.

(b) Next, Seema digested a target DNA with HindIII, and ligated it with plasmids digested with the same enzyme and transferred them into a bacterial cell. How will she distinguish the transformant with recombinant plasmid from non-transformant? Give a reason to support your answer.

Q.213 Given below is an image of a hormone which is required for the treatment of a disease. 5



(a) Identify the hormone and the disease that is caused due to its insufficient secretion.

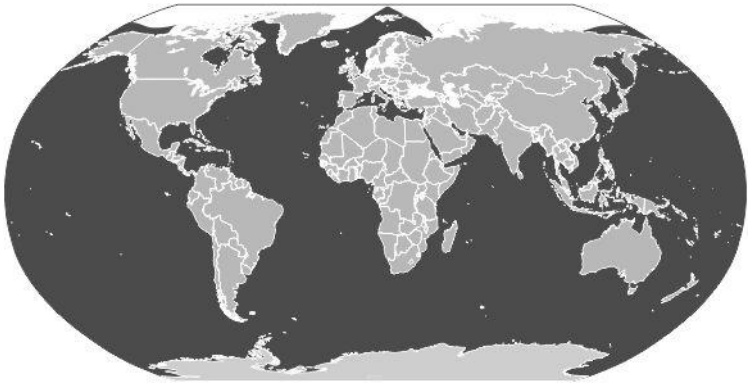
	(b) State whether the following statement about this hormone is true or false. Justify if true, correct if false. 'The structure in the image is a protein and is the precursor form of the hormone.' (c) Which characteristic helped you arrive at your answer in (b)? (d) Describe the challenge in large scale production of this hormone using rDNA techniques and how it was overcome.	
Q.214	(a) What are genetically modified organisms? (b) Transgenic mice models are preferred over human models to study several human diseases such as Alzheimer's. Is this statement TRUE? Give a reason to support your answer.	3
Q.215	According to recent reports, MIT engineers have embedded genes from fireflies into watercress plants inducing them to give dim light for nearly four hours. To create these plants, the MIT team turned to luciferase, the enzyme that gives fireflies their glow. Luciferase acts on a molecule called luciferin, causing it to emit light. Another molecule called co-enzyme A helps the process by enhancing luciferase activity. None of these molecules are naturally produced by plants. *[Sourced and edited from: https://www.dailymail.co.uk/sciencetech/article-5178531/MIT-creates-bioluminescent-trees-glow-like-fireflies.html]* (a) Describe briefly, the step-by-step process that should be followed in creating these plants. (b) Draw a diagram of the possible vector used in (a).	5

Answer key and Marking Scheme

Q.No	Answers	Marks
Q.205	C. both P and Q	1
Q.206	B. Both A and R are true, and R is the correct explanation for A.	1
Q.207	C. inserting the DNA into a plasmid that can be expressed in the host E. coli cells	1
Q.208	B. Separating the cloned MAP2 DNA from other DNA fragments.	1
Q.209	B. only plasmids 1 and 2	1
Q.210	A. Both A and R are true, and R is the correct explanation for A.	1
Q.211	(a) Genes that make the model organism more sensitive to the chemical being tested are introduced in them creating transgenic model organisms. (b) Since the organism is more sensitive it helps to study the effect of the chemical in a shorter duration as compared to a non-transgenic organism.	2
Q.212	(a) 1 mark for correctly identifying: Sample 1: EcoRI Sample 2: BamHI Sample 3: Hind III (b) 1 mark for each of the following: - She can grow the culture on a media plate containing ampicillin and tetracycline. - Since cutting with HindIII will disrupt the ampicillin resistance gene and not the tetracycline resistance gene, only cells containing the plasmid ligated with the target DNA will grow.	5
Q.213	(a) 0.5 marks each for the following: Hormone - insulin Disease - diabetes (b) False *[0.5 marks]* Correct statement - The structure in the image is a protein and is the final/active/mature form of the hormone. *[0.5 marks]* (c) The c-peptide which is part of the precursor form is missing in the structure shown, indicating that it is the final form. (d) Challenge - getting insulin assembled into a mature form without c-peptide sequence. *[1 mark]*	5

	Overcome - chains A and B were produced separately by rDNA technology in *E.coli* cells, extracted and combined by creating disulphide bonds to form human insulin. *[1 mark]*	
Q.214	(a) Plants, bacteria, fungi and animals whose genes have been altered by manipulation are called Genetically Modified Organisms. (b) 1 mark for each of the following: - The statement is true. - Transgenic mice allow for studying the progression of diseases in a shorter time than in humans due to the short life span of the mice. *[Accept any other valid answer]*	3
Q.215	(a) 0.5 marks each for the following: - DNA from the fireflies needs to be isolated. - This DNA and a suitable vector need to be digested by a restriction enzyme, electrophoresed and eluted from the gel. - The required gene sequences for the three genes need to be amplified using PCR. - The vector and the genes of interest need to be ligated together to create recombinant vectors and cells containing the recombinant vector can be selected using the appropriate marker. - These vectors can be transformed into a plant embryo through the use of micro-particles. (b) Marks to be awarded for a neatly labelled diagram with the following parts shown: - the origin of replication [0.5 marks] - restriction site/cloning site [0.5 marks] - selectable marker [0.5 marks] - three genes of interest coding for luciferase enzyme, luciferin, co-enzyme A [1 mark]	5

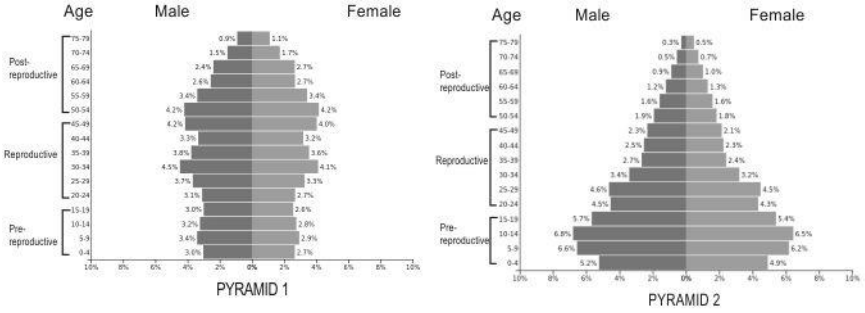
13. CHAPTER: ORGANISMS AND POPULATIONS

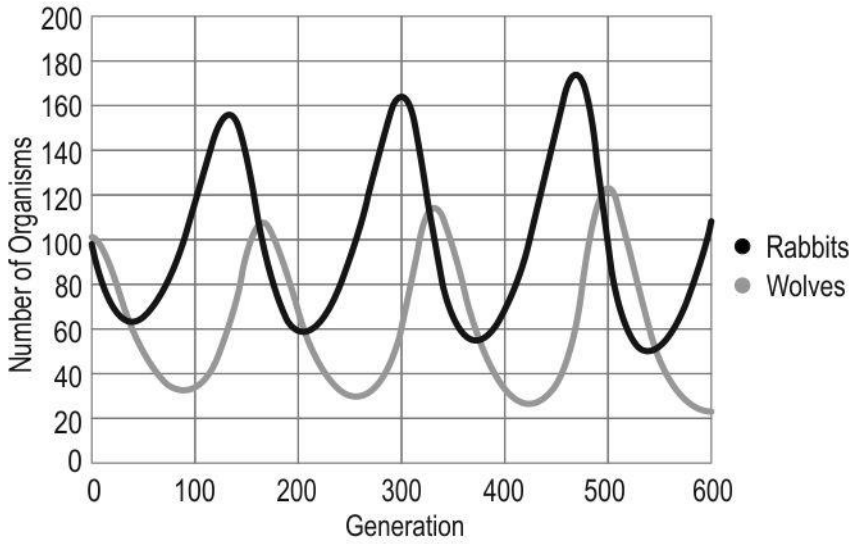
Q.No	Question	Marks
	Multiple Choice Question	
Q.216	In the image shown below, the dark grey part depicts the geographical distribution of the killer whale.  Which of these statements describes the killer whale and its habitat CORRECTLY? A. Low thermal tolerance and narrow geographical distribution B. High thermal tolerance and narrow geographical distribution C. Low thermal tolerance and widespread geographical distribution D. High thermal tolerance and widespread geographical distribution	1
Q.217	Two statements are given below - one labelled Assertion (A) and the other labelled Reasoning (R). Assertion (A): Only stenohaline fish can survive in freshwater. Reasoning (R): Stenohaline fish can tolerate a narrow range of salinity. Which of the following is correct? 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.	1
Q.218	The Atlantic salmon is a fish that can tolerate a salinity of 0 to 33 ppt (parts per thousand). Which of the following is it likely to be classified as and why?	1

	A. Stenohaline, because it can survive only in freshwater. B. Euryhaline, because it can survive only in marine water. C. Euryhaline, because it can survive major variation in salt concentration. D. Stenohaline, because it can survive only a narrow variation in salt concentration.	
Q.219	Every year, millions of monarch butterflies fly from the United States and Canada to Mexico to escape the cold weather. Which response to abiotic stress does the statement depict? A. Migration B. Regulation C. Suspension D. Conformation	1
Q.220	Tilapia is a fish found in a variety of freshwater environments and is capable of adjusting its internal salt concentrations to match the salinity of the water. Which response to abiotic stress does the statement depict? A. Migration B. Regulation C. Suspension D. Conformation	1
Q.221	The adaptations in which of the following animals enables it to satisfy the following conditions: 1. Allen's rule 2. Loses body heat slowly	1

	 A  B  C  D A. A B. B C. C D. D	
Q.222	The population of sparrows inhabiting a garden decreased dramatically. It was found that the mortality was equal to natality for the given population. Which of the following is TRUE for the population of sparrows? A. The number of emigrants was equal to immigrants. B. The number of emigrants was less than immigrants. C. The number of emigrants was more than immigrants. D. The population of sparrows was unaffected by emigrants and immigrants.	1
Q.223	The black walnut plant secretes juglone, a chemical substance that destroys other plants like pepper growing within its root zone. Which type of population interaction does the above statement represent? A. Predation B. Competition C. Mutualism D. Amensalism	1
Free Response Questions/Subjective Questions		
Q.224	A forest can accommodate a maximum of 500 deer (i.e., its carrying capacity). If the initial population size is 100 deer and the maximum per capita growth rate	2

<table>
<tr><td></td><td>is 0.05 per year, calculate the rate of change of the population size of deer for given time period.</td><td></td></tr>
<tr><td>Q.225</td><td>Read the news clipping shown below and answer the questions that follow.
 
China plans to increase retirement age as population of elderly people rises
China is planning to raise its retirement age gradually and in phases to deal with the ageing population in the country, its state media reported. "People nearing retirement age will only have to delay retirement for several months," Chinese government expert said. Currently, China's retirement age is 60 for men, 55 for white-collar women and 50 for female factory workers.
(a) Draw an age pyramid for the above data clearly labelling the post-reproductive, reproductive, and pre-reproductive parts.
(b) Name the type of the age pyramid drawn in (a).</td><td>3</td></tr>
<tr><td>Q.226</td><td>The surface area and volume of the bodies of two organisms (X and Y) are compiled in the table below.
<table><tr><th>Organism</th><th>Surface Area (cm^2)</th><th>Volume (cm^3)</th></tr><tr><td>X</td><td>3800</td><td>1900</td></tr><tr><td>Y</td><td>6.3</td><td>0.03</td></tr></table>
Based on the above table, answer the questions that follow:
(a) Calculate the surface area to volume ratio of organisms X and Y.
(b) Which of the two organisms is more suited to survive in a cold environment?
(c) State your reason for (b) in terms of heat loss.</td><td>3</td></tr>
<tr><td>Q.227</td><td>A small town has a population of 10,000 people. In the past year, there were 250 births and 970 deaths in the town.
(a) Calculate the birth rate per thousand for the given population.
(b) Calculate the death rate per thousand for the given population.
(c) Complete the following statement.
The state of population in the town is _____ (stable/declining/increasing) because the birth rate is _____ (equal to/greater than/lesser than) the death rate.
(d) Name two other factors that would influence the density of the given population.</td><td>5</td></tr>
<tr><td>Q.228</td><td>A patch of grassland was inhabited by 100 goats in August 2022. Between August 2022 and December 2022, it was found that the average natality was 10, average mortality 8, average immigration 5, and average emigration 3.</td><td>2</td></tr>
</table>

	At the end of December 2022, (a) what was the population density of goats in the same patch of grassland? (b) was there a net increase or net decrease in the population of goats? (c) what was the value by which there was a net increase or decrease in (b)?	
Q.229	A country introduced the one-child policy in order to curb the population growth. Shown below are two age pyramids of the country, one from 1980 and the other from 2020.  (a) Identify the pyramids from 1980 and 2020. (b) State one characteristic each of pyramid 1 and pyramid 2 that helped you in answering (a).	3
Q.230	The following table contains values of the population of bacteria growing over time. **Time (in days)** | **Population ($\times 10^6$ cells/mL)** 0 | 0.5 2 | 0.6 4 | 1.0 7 | 3.2 9 | 5.2 11 | 5.3 14 | 5.3 Based on the values in the table above, (a) Construct a population growth curve. (b) Indicate the carrying capacity in the graph. (c) Give reason for the position of the carrying capacity.	3

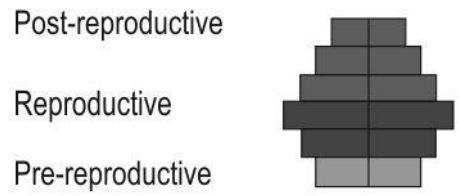
Q.231	Show below is a graph representing the predator-prey relationship. Answer the questions that follow:  (a) Give one evidence that the ecosystem is stable. (b) What will be effect of migration of rabbits on the population of wolves and why? (c) Name and describe one adaptation that helps preys escape predation. (d) In a hypothetical scenario, all wolves vanish from the ecosystem. (i) What will be the consequence on the vegetation present in the ecosystem and why? (ii) It is found that the population of rabbits does not increase dramatically. State the ecological phenomenon responsible for keeping the population of rabbits in check.	5
Q.232	Mistletoe is a plant that grows on the branches of oak trees. It takes nutrients from the oak tree and can weaken or kill it over time. (a) Identify the host and the parasite. (b) Give one point of similarity and difference between the above scenario and predation.	3
Q.233	Population density is calculated by the following formula: $N_{t+1} = N_t + [(B+I)-(D+E)]$ Imagine a population of fish in an artificial lake which acts as a closed system. (a) Which quantity or quantities of the above formula will NOT be used in calculating the population of fish? (b) Give reason for (a).	2
Q.234	The following table contains values of the population of seals inhabiting Alaska.	3

	<table><tr><th>Year</th><th>Number of seals</th></tr><tr><td>1975</td><td>1500</td></tr><tr><td>1980</td><td>3000</td></tr><tr><td>1985</td><td>5500</td></tr><tr><td>1990</td><td>7400</td></tr><tr><td>1995</td><td>7200</td></tr><tr><td>2000</td><td>7100</td></tr><tr><td>2005</td><td>7050</td></tr><tr><td>2010</td><td>7100</td></tr></table> (a) Based on the values in the table above, construct a population growth curve. (b) Name and describe the type of growth as seen in the curve plotted.	
Q.235	Read the scenario below and answer the questions that follow. In the Caribbean, there are several species of Anolis lizards that live in the same habitats and feed on similar prey. However, research has shown that when two species have nearly identical body size and feeding habits, one species will outcompete the other for resources, leading to the exclusion of the other species. (a) For the above example of competition to satisfy Gause's Competitive Exclusion Principle, name two conditions that MUST be met. (b) State two ways by which the two species could co-exist in the same habitat.	2
Q.236	Read the scenario below about interference competition and answer the questions that follow. Red squirrels and gray squirrels both live in forests and compete for food and nesting sites. Red squirrels are known to be more aggressive than gray squirrels, and they will often chase gray squirrels away from food sources and nesting sites. (a) The resources present in the habitat above must be limiting. Is this statement true or false? Justify your answer. (b) Which species' r-value is likely to drop and why?	2

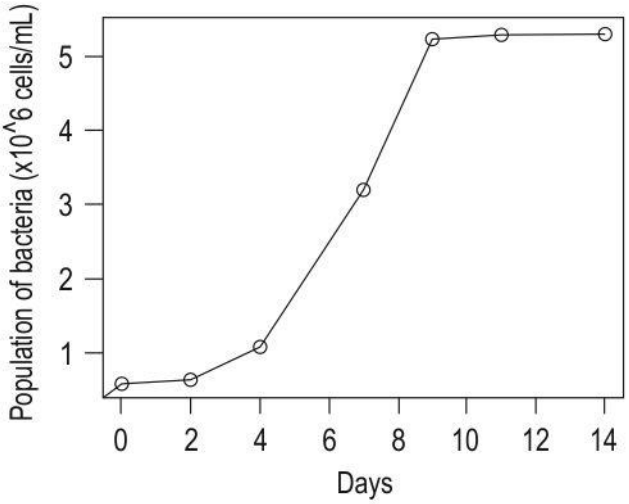
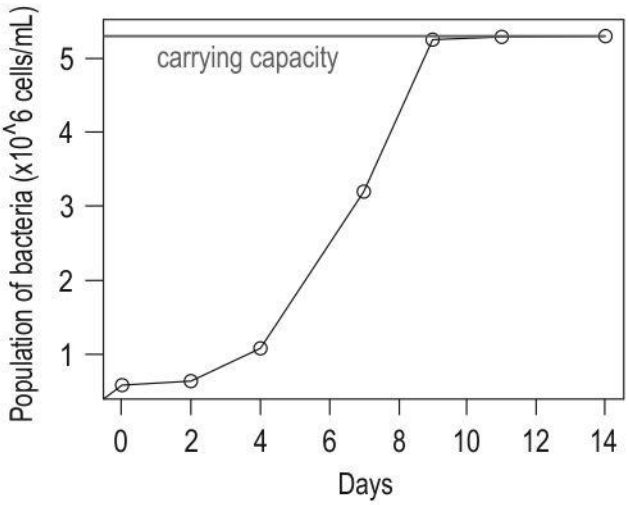
Q.237	Mark the following statements as TRUE or FALSE and give a reason to support your answer. (a) Competition happens only between closely-related species. (b) Competition always leads to the elimination of one species. (c) Two species compete only when the resources are limited.	3
Q.238	Which one of the following examples can be classified as mutualism? Justify. (i) Male fireflies use flashing lights to attract females. However, some females will mimic the flash pattern of another species to attract and consume males of that species. (ii) The pitcher plant produces a scent that mimics the scent of ripe fruit, which attracts insects that feed on fruit. When the insects land on the plant, they slip on the slippery surface of the pitcher and fall into the digestive fluid inside. (iii) The night-blooming flowers of senita cacti are visited by tiny senita moths that transfer pollen. The female moth lays eggs on a flower petal and eventually, the larva feeds on the seeds and fruit tissue.	2

Answer key and Marking Scheme

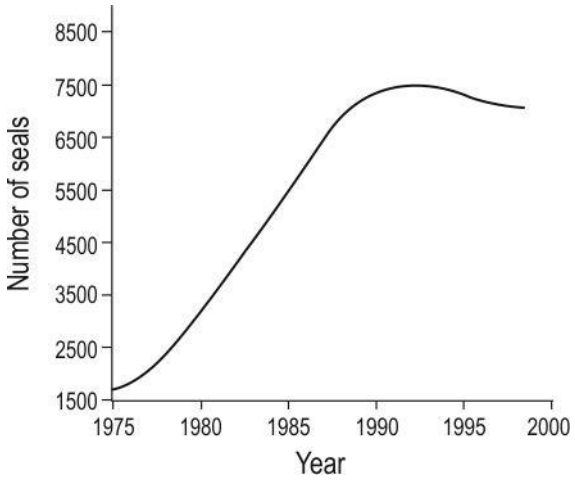
Q.No	Answers	Marks
Q.216	D. High thermal tolerance and widespread geographical distribution	1
Q.217	D. A is false, but R is true.	1
Q.218	C. Euryhaline, because it can survive major variation in salt concentration.	1
Q.219	A. Migration	1
Q.220	D. Conformation	1
Q.221	C. C	1
Q.222	C. The number of emigrants was more than immigrants.	1
Q.223	D. Amensalism	1
Q.224	Possible complete answer: $\frac{dN}{dT} = rN(\frac{K-N}{K})$ $= 0.05 \times 100(\frac{500-100}{500})$ = 0.05 × 100 × 0.8 = 4 deer per year 0.5 marks each for the following: - writing the correct formula - substitution - calculation - correct answer	2
Q.225	(a) - 1 mark for drawing the correct shape of age pyramid. - 0.5 marks each for indicating post-reproductive, reproductive, and pre-reproductive	3

	 (b) Declining	
Q.226	(a) 1 mark each for calculating the following: Organism X = 3800/1900 = 2:1 Organism Y = 6.3/0.03 = 210:1 (b) Organism X (c) A low surface area to volume ratio means that the organism will lose less heat/retain heat better in a cold environment.	3
Q.227	(a) 0.5 mark each for writing the correct formula and arriving at the correct answer: **Birth rate = (Number of births / Total population) x 1000** = (250/10000) x 1000 = 0.025 x 1000 = **25 births per 1000 people** (b) 0.5 mark each for writing the correct formula and arriving at the correct answer: **Death rate = (Number of deaths / Total population) x 1000** = (970/10000) x 1000 = 0.097 x 1000 = **97 deaths per 1000 people** (c) 0.5 mark for each blank: - declining - lesser than (d) 1 mark for each of the following: - immigration/entry of individuals of the same species into the habitat	5

	- emigration/exit of individuals of the same species from the habitat *[Accept any other valid answer.]*	
Q.228	(a) 0.5 mark each for writing the formula and the correct answer Population density is calculated by the following formula: **$N_{t+1} = N_t + [(B+I)-(D+E)]$** = 100 + [(10+5)-(8+3)] = **104** (b) net increase (c) 4	2
Q.229	(a) 0.5 marks for each of the following: Pyramid 1 - 2020 Pyramid 2 - 1980 (b) 1 mark for any one of the following for pyramid 1: - More population is in the post-reproductive stage - Pyramid 1 is in the declining phase. 1 mark for any one of the following for pyramid 2: - More population is in the pre-reproductive and reproductive stage - Pyramid 2 is in the expanding phase. [Accept any other valid answer.]	3
Q.230	(a) 0.5 mark for each of the following: - marking X axis as time - marking Y axis as population - plotting all values correctly - connecting all the points with a line	3

	 (b) 0.5 mark for indicating carrying capacity.  (c) 0.5 mark for reasoning. The population of bacteria is not growing after day 9. [Accept any other valid reason.]	
Q.231	(a) The number of predators and prey cycle over generations. (b) 0.5 mark each for writing the effect and reason. - The number of wolves will increase. - As the population of rabbits increases, there will be plenty of food for the wolves to eat and consequently reproduce. (c) 0.5 mark each for naming and describing any of the following: - camouflage	5

	- Some organisms blend in with their surroundings because of their colour. OR - poisonous - Some organisms are highly distasteful to their predators because of special chemicals present in their body. (d) 0.5 mark each for writing the effect and reason. - The vegetation will decline. - In the absence of predator, the population of rabbits will no longer be in check. As the population of rabbits increases, the vegetation will reduce. (e) competition with another species	
Q.232	(a) 0.5 mark for each of the following: - Host - oak tree - Parasite - mistletoe (b) 1 mark for any one of the following similarities: - The parasite and predator benefit from the relationship. - The host and prey are harmed in the relationship. - One species always benefits and the other is always harmed. 1 mark for any one of the following differences: - The parasite lives inside or on the host whereas the predator does not. - The parasite may or may not kill the host but the predator always kills the host. *[Accept any other relevant answer.]*	3
Q.233	(a) 0.5 mark for each of the following: - I (immigration) - E (emigration) (b) A closed system will not have any individual entering it from inside or leaving it by going outside.	2
Q.234	(a) 0.5 mark for each of the following:	3

	- marking X axis as time - marking Y axis as population or number of seals - plotting all values correctly - connecting all the points with a line  (b) 0.5 mark for each of the following: - logistic growth - population size increases rapidly at first, then slows down as it approaches the carrying capacity of the environment [Accept any other valid response.]	
Q.235	(a) 0.5 mark for each of the following: - resources are limited - competition is between closely-related species (b) 0.5 mark for each of the following: - feeding at different times of the day - feeding on different parts of the same resource [Accept any other valid answer.]	2
Q.236	(a) 0.5 mark for each of the following: - Statement is FALSE. - Reason - The feeding efficiency of one species could reduce due to the interfering and inhibitory presence of the other species, even if resources are abundant.	2

	(b) 0.5 mark for each of the following: - gray squirrel - Because of the red squirrels aggression, the gray squirrels have limited access to the resources.	
Q.237	(a) 0.5 mark for each of the following: - False - Unrelated species can also compete for the same resource. (b) 0.5 mark for each of the following: - False - Some species in a competitive relationship might co-exist by resource partitioning. [Accept any other valid reason.] (c) 0.5 mark for each of the following: - False - Species can also compete when resources are abundant where one species interferes with the feeding patterns of another species.	3
Q.238	1 mark each for identifying the correct example and giving reason. - (iii) - Reason: Only in (iii), both species are being benefitted. OR In (i) and (ii), one species is being killed. [Accept any other valid reason.]	2

14. CHAPTER: ECOSYSTEM

<table>
<tr><th>Q.No</th><th>Question</th><th>Marks</th></tr>
<tr><td colspan="3">Multiple Choice Question</td></tr>
<tr><td>Q.239</td><td>Stratification in ecology refers to the vertical layering of habitat. This layering is dependent on several factors. For example, in an aquatic ecosystem, layers are formed based on the temperature required by organisms.

Which of the following is TRUE about the need of organisms that live in the uppermost layer of an ocean ecosystem?

<table>
<tr><th></th><th>temperature requirement</th><th>oxygen requirement</th></tr>
<tr><td>P</td><td>warmer</td><td>high</td></tr>
<tr><td>Q</td><td>colder</td><td>high</td></tr>
<tr><td>R</td><td>warmer</td><td>low</td></tr>
<tr><td>S</td><td>colder</td><td>low</td></tr>
</table>

A. P
B. Q
C. R
D. S</td><td>1</td></tr>
<tr><td>Q.240</td><td>Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R).

Assertion (A): The energy utilised by an organism for growth is not transferred to the next trophic level.

Reason (R): Growth causes an increase in biomass.

Which of the following is correct?

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.</td><td>1</td></tr>
</table>

Q.241	Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): Humus is organic in nature. Reason (R): Steps occurring before humification ensure the removal of most inorganic substances from the detritus. Which of the following is correct? 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.	1
Q.242	Nitin was studying a graph where he studied the impact of some factors on the rate of decomposition. For which of the following factors will the rate of decomposition show a somewhat bell-curved graph? *[Note: A bell curve is a graph where the values on the y-axis increase steadily, reach a peak and decrease at the same rate as the increase, creating a curve shaped like a bell]* W) chitin content in detritus X) fructose content in detritus Y) moisture content in the soil Z) temperature of the environment A. only W B. only Z C. only Y and Z D. only X, Y and Z	1
Q.243	If X is the amount of energy produced by the producers, which of the following is the correct amount of energy received by humans from the producers in a food web? A. only 10% B. either 10% or 1% C. either 10%, 1% or 0.1% D. Humans are not part of a food web.	1

Q.244	Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): Plants do not constitute the first trophic level in all food chains. Reason (R): Dead plants or animals is the first trophic level for detritivores. Which of the following is correct? 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.	1
Q.245	If the energy produced by the producers of a food web is 20,810 kcal, what is the minimum amount of energy that will be available to snakes in this food web? A. 383 kcal B. 2081 kcal C. 10000 kcal D. Cannot say without knowing the level that is occupied by snakes in this chain.	1
Q.246	Which of the following statements is/are TRUE about lichens? X) They do not always depend on biotic factors for growth. Y) They come from rocks. Z) They are pioneer species in all environments. A. only X B. only Z C. only Y and Z D. all - X, Y and Z	1
Q.247	A carbon sink is any environment that can store carbon and remove it from the atmosphere. Which of the following will lead to a DECLINE in carbon sink? A. Deforestation B. Population growth C. Burning of fossil fuels D. Increase in industrial activity	1
Q.248	Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R).	1

<table>
<tr><td></td><td>Assertion (A): The phosphorus cycle starts in the Earth's crust.

Reason (R): Rocks are found in abundance in the Earth's crust.

Which of the following is correct?

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.</td><td></td></tr>
<tr><td colspan="3">Free Response Questions/Subjective Questions</td></tr>
<tr><td>Q.249</td><td>A pioneer species is a species that invades a bare area. Such bare areas are usually xerophytic. The pioneer species is gradually replaced by other species, till a climax species/ community remains stable in the environment.
(a) Why is the pioneer species replaced by the climax species/community?
(b) What is the environment type usually required by the climax species?</td><td>2</td></tr>
<tr><td>Q.250</td><td>State THREE points of difference between a natural terrestrial ecosystem and a man-made ecosystem such as zoo.</td><td>3</td></tr>
<tr><td>Q.251</td><td>The Tundra desert's gross primary productivity (GPP) is 800 kilocalories/m^2 and respiration losses are about 200 kilocalories.
(a) What is the net primary productivity of the desert? Show calculations.
(b) Why do deserts have the least NPP across most ecosystems?</td><td>2</td></tr>
<tr><td>Q.252</td><td>Fish farming involves the commercial breeding of fish either in fish tanks or in artificial enclosures such as fish ponds.
Is a fish farm an example of an ecosystem? Justify your answer.</td><td>2</td></tr>
<tr><td>Q.253</td><td>Give a reason why:
(a) Mass lost in faeces is considered available biomass for the next trophic level.
(b) Secondary productivity of herbivores is lower than primary productivity.
(c) The ocean is not a productive ecosystem.</td><td>3</td></tr>
<tr><td>Q.254</td><td>Given below is the approximate percentage content of cellulose, hemicellulose and lignin composition of the same mass of dried grass and coconut husks.
<table><tr><th></th><th>cellulose</th><th>hemicellulose</th><th>lignin</th></tr><tr><td>dried grass</td><td>40%</td><td>40%</td><td>20%</td></tr><tr><td>coconut husks</td><td>25%</td><td>20%</td><td>50%</td></tr></table></td><td>3</td></tr>
</table>

	(a) Considering ambient climatic conditions, which of these will take longer to decompose and why? (b) If these materials are found in marshy soils, would overall decomposition be faster? Justify.	
Q.255	The first law of thermodynamics states that energy can neither be created nor destroyed, only altered in form. Does the energy flow in an ecosystem follow this rule? Justify.	2
Q.256	Identify if the statements given below are true or false. Justify your answer. (a) In an inverted food pyramid, the energy is the lowest at the first trophic level. (b) The biomass of zooplankton is greater than phytoplankton as they reproduce fast and have a longer life span. (c) In the long run, an inverted food pyramid is unstable.	3
Q.257	Justify the following statements: (a) A xeric environment turns into a mesic environment over time. (b) A mesic environment is preferred over a hydric or xeric environment.	2

Answer key and Marking Scheme

Q.No	Answers	Marks
Q.239	A. P	1
Q.240	D. A is false, but R is true.	1
Q.241	A. Both A and R are true, and R is the correct explanation for A.	1
Q.242	C. only Y and Z	1
Q.243	C. either 10%, 1% or 0.1%	1
Q.244	A. Both A and R are true, and R is the correct explanation for A.	1
Q.245	A. 383 kcal	1
Q.246	A. only X	1
Q.247	A. Deforestation	1
Q.248	A. Both A and R are true, and R is the correct explanation for A.	1
Q.249	(a) because the climax species makes the environment non-conducive for the pioneer species (b) mesophytic	2
Q.250	1 mark each for any three of the following: - Natural ecosystems are self-sustaining whereas man-made ecosystems require the assistance of humans. - The nutrient cycle starts and ends in the same ecosystem in natural ecosystems whereas in man-made ecosystems the nutrient cycle may begin in one place and end in another. - Individuals of a species may be scattered throughout the geography in natural ecosystems whereas species are present in close proximity in man-made ecosystems. - Interactions are spontaneous in natural ecosystems whereas they are controlled by humans in man-made ecosystems. [Accept any other valid points.]	3
Q.251	(a) 0.5 marks for the correct formula and 0.5 marks for the correct answer: NPP = GPP - R NPP = 800 - 200 = 600 kilocalories/m2	2

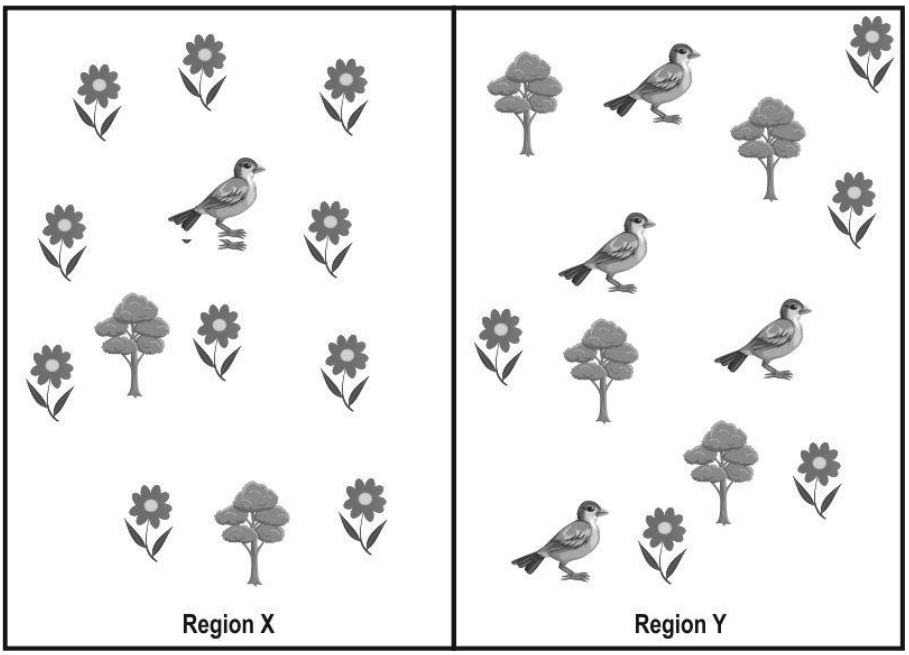
	(b) The low water availability and other conditions are not unfavourable for rapid photosynthesis.	
Q.252	1 mark for each of the following: - Yes, it is. - In a fish farm, fish interact with each other as well as the physical environment created for them making it an ecosystem. [No marks to be allotted if correct justification is not provided.]	2
Q.253	1 mark for each of the following: (a) Faeces are available to decomposers and so are not completely removed from the food web. (b) Not all biomass produced by producers is consumed by herbivores, a lot is lost and is available to decomposers. (c) Sunlight is a largely limiting factor, especially in deep ocean layers, making photosynthesis and therefore productivity low. [Accept any other valid answer.]	3
Q.254	(a) 0.5 marks for each of the following: - coconut husks - higher lignin content reduces the rate of decomposition (b) 1 mark for each of the following: - It would be slower. - Marshy soils tend to have less oxygen availability/anaerobic conditions exist which reduces the rate of decomposition.	3
Q.255	- Yes it does. - Energy from the Sun is converted to chemical energy by photosynthesis which is then transferred through various trophic levels as chemical energy or utilised to produce heat energy. [No marks to be awarded if justification is not provided.]	2
Q.256	0.5 marks for identifying if true or false and 0.5 marks for the justification: (a) - False. - Energy is always highest in the first trophic level and reduces as we move up the pyramid. (b) - True.	3

	- Since the biomass of zooplankton is greater it is likely that more individuals are present per unit area than phytoplankton which is possible when organisms do not die fast but reproduce fast. (c) - True. - Since a lower amount of food will be available to the higher trophic levels, it is likely to be unstable over time. [Accept any other valid justification. No marks are to be awarded for writing true/false if the correct justification is not provided.]	
Q.257	1 mark for each of the following: (a) As pioneer species and then seral plant communities grow in a xeric environment, they increase the moisture content in the environment as they perform their physiological processes making the environment mesic. (b) A mesic environment provides an ambient environment with the right moisture content for the growth of most species. [Accept any other valid justification.]	2

15. CHAPTER: BIODIVERSITY AND CONSERVATION

Q.No	Question	Marks
	Multiple Choice Question	
Q.258	Which of the following is/are example/s of biodiversity? (i) Animals and emigrants in an area. (ii) Microorganisms present in the intestine of an organism. (iii) Cell from the same tissue in different organisms. A. only (i) B. only (ii) C. only (ii) and (iii) D. all - (i), (ii) and (iii)	1
Q.259	Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): Biodiversity does not vary greatly across longitudes. Reasoning (R): Variations in climate that cause a difference in biodiversity largely depend on the latitudes. Which of the following is correct? A. Both A and R are true, but R is not the correct explanation for A. B. Both A and R are true, and R is the correct explanation for A. C. A is true, but R is false. D. A is false, but R is true.	1
Q.260	The slope in a species-area relationship (SAR) predicts the species richness of an area. Consider a mainland with several islands around it. Which of the following is MOST LIKELY to be true about the slope of regression as we move from islands closer to the mainland to those further away from it? A. It increases B. It decreases C. It remains the same D. Cannot say without knowing the location of the islands.	1

Q.261	Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): Genetic diversity can be increased only by the occurrence of migration. Reasoning (R): Genetic diversity is the range of different inheritable traits within a species. Which of the following is correct? 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.	1
Q.262	Given below are two statements. Statement I: Plants are always more prone to extinction than animals. Statement II: Since plants can cross-pollinate, they can increase their genetic diversity more easily than animals. Which of the following is TRUE about these statements? A. Only statement I is true B. Only statement II is true C. Both statements are true D. Both statements are false	1
Q.263	Which of the following statements are CORRECT conclusions that can be derived from latitudinal gradients in biodiversity? X) Greater adaptability of organisms leads to better growth Y) Stability of the ecosystem plays a role in determining species diversity in the region Z) Presence of favourable conditions in a region enhances diversity A. Only X and Y B. Only Y and Z C. Only X and Z D. All - X, Y and Z	1
Q.264	Given below is the species distribution across two different regions - X and Y. The area used to count species was the same.	1

	 Which of the following is TRUE about the biodiversity in these regions? A. Region X is more diverse than region Y even though both regions have the same species richness. B. Region X is less diverse than region Y even though both regions have the same species richness. C. Region X and region Y have the same species richness and so the same diversity. D. Region X is more diverse as it has greater species richness than region Y.	
Q.265	The zebra mussel is a species that is native to Eastern Europe and Western Russia. It was unintentionally introduced into the lakes of the United States through the discharge of contaminated cargo from a ship. Which of the following is this statement an example of? A. Habitat loss B. Co-extinction C. Over-exploitation D. Alien species invasion	1
Q.266	Which of the following will DEFINITELY contribute to a steeper slope of regression in a species-area relationship graph? P) increase in the area for analysis Q) immigration of new species A. Only P B. Only Q C. Both P and Q	1

	D. Neither P nor Q	
Free Response Questions/Subjective Questions		
Q.267	Species richness and evenness are measures of species diversity in an area. Species richness refers to the number of groups of genetically related species, so the more species in an area greater the richness. Species evenness refers to the abundance of each species in an area. It is said that in two communities having equal species richness, the community with low evenness leads to lower biodiversity. Justify this statement.	2
Q.268	Biological invasion is the process by which an organism enters and establishes a sustainable population in a region that is beyond its native geography. High species diversity in a region ensures a decline in the biological invasion of that region. Justify this statement as true.	2
Q.269	Island biogeography studies the factors that affect the species richness and diversification of isolated natural communities, such as islands. (a) What is likely to happen to the rate of extinction in an island in the following situations? (i) it is close to a mainland (ii) area of the island is small Give a reason to support your answer (b) Describe ONE step that the government can take to improve stability in isolated natural communities.	3
Q.270	Producers are considered to be the most important members of the ecosystem. How does the rivet popper hypothesis explain the importance of producers in the stability of the ecosystem?	2
Q.271	Ecological relationships between organisms play an important role in the biodiversity of the region. In some cases, they benefit the diversity while in others cause a subsequent reduction in it. (a) A significant reduction in the predator population causes species abundance in the prey species. Is this statement TRUE? Give a reason to support your answer. (b) Barnacles, sticky crustaceans and the blue whale are in a commensal relationship where barnacles use blue whales for transport. How would the extinction of either species cause a change in biodiversity? (c) In which type of ecological relationship can the extinction of one species lead to the extinction of the other species?	5

	(d) What is the term used to describe the phenomenon describe in (c) called?	
Q.272	(a) The introduction of genetically modified organisms, such as golden rice, can lead to a significant reduction in the genetic diversity of the region. Justify this statement as true. (b) How does the impact identified in (a) affect the survival of the species?	3
Q.273	State THREE ADVANTAGES of in-situ conservation over ex-situ conservation of organisms.	3
Q.274	Cryopreservation is a technique used in the conservation of endemic species. (a) Explain how this method helps with the conservation of a species. (b) Which process that is carried out with humans is similar to cryopreservation and what is it used for?	3
Q.275	Describe TWO situations in which ex-situ conservation will be preferred over in-situ conservation.	2
Q.276	Fish were the first vertebrates to exist and are the most diverse group of vertebrates. Give TWO reasons to justify this statement as TRUE.	2

Answer key and Marking Scheme

Q.No	Answers	Marks
Q.258	D. all - (i), (ii) and (iii)	1
Q.259	B. Both A and R are true, and R is the correct explanation for A.	1
Q.260	B. It decreases	1
Q.261	D. A is false, but R is true.	1
Q.262	D. Both statements are false	1
Q.263	B. Only Y and Z	1
Q.264	B. Region X is less diverse than region Y even though both regions have the same species richness.	1
Q.265	D. Alien species invasion	1
Q.266	A. Only P	1
Q.267	1 mark each for the following: - Low evenness in a community basically means that a few species are present in greater abundance than the other species in the community. - Dominance of a few species leads to an unequal distribution of resources which eventually causes loss of biodiversity over time.	2
Q.268	1 mark for each of the following: - A high species diversity means that the resources in a region are being utilised by the existing species to survive leading to lower available resources. - Lower available resources, which are required by the invading species, may prevent invasion. *[Accept any other valid answer]*	2
Q.269	(a) (i) 0.5 marks each for the following: - The rate of extinction decreases. - Closeness to the mainland increases accessibility to resources thereby allowing species on the island to survive and reproduce.	3

	[Accept any other valid reason] (a) (ii) 0.5 marks each for the following: - The rate of extinction increases. - This is because, in smaller areas, there is greater competition for survival. *[Accept any other valid reason]* (b) 1 mark for any one of the following: - Improve disaster management systems so that in case of a disaster there is lesser loss of resources and life. - Improve infrastructure to ensure sustainability. *[Accept any other valid answer]*	
Q.270	1 mark each for the following: - According to the rivet popper hypothesis, the stability of an ecosystem is affected by the species that becomes extinct/is removed. - Since producers are the most important members that provide energy to the whole food chain, their loss means danger for the entire ecosystem, similar to the loss of rivets on the wings of an aeroplane. *[Accept any other valid answer]*	2
Q.271	(a) 1 mark for each of the following: - TRUE - Reduction of the predator population will allow the prey population to survive, grow and reproduce, thereby increasing their abundance. (b) 1 mark each for the following: - If the blue whale becomes extinct, the barnacles may slowly become extinct/population may decline significantly as they depend on the blue whale for transport in search of food and a stable living place. - If the barnacles become extinct, it may not impact the diversity of blue whales and they were not dependent on barnacles for survival. (c) mutualism (d) co-extinction	5
Q.272	(a) 1 mark for each of the following:	3

	- Genetically modified organisms have a greater advantage due to some **desirable characteristics added to them giving them dominance in competing** with related species. - This may cause these related species to be removed thereby **leading to a reduction in genetic diversity**. (b) Without genetic diversity a population may not be able to evolve in response to changing environmental conditions, leading to their eventual extinction *[Accept any other valid answer]*	
Q.273	1 mark for each of the following: - Conserving the natural habitat allows for the conservation of other organisms along with the endemic species. - Organisms staying safe and recovering in their natural state is greater than in simulated habitats. - It does not involve the removal of organisms from their natural habitat making it a more humane/ethical approach. *[Accept any other valid answer]*	3
Q.274	(a) 1 mark for each of the following: - Through cryopreservation, gametes of an endemic species can be preserved. - The gametes can be fertilised in-vitro and propagated using tissue culture and transferred to an animal that can carry the embryo to term allowing the endemic species count to increase. (b) 0.5 marks each for the following: - in-vitro fertilisation - used in case of couples that are unable to reproduce normally	3
Q.275	1 mark for any two of the following: - when the survival of an organism is low due to high predation - when harsh climatic conditions lead to the loss of organisms - in cases of habitat loss due to a calamity *[Accept any other valid answers]*	2
Q.276	1 mark each for the following:	2

	- They have good adaptability to aquatic conditions in different habitats. - Since they were the first vertebrates to exist they have had a lot of time to diversify. *[Accept any other valid answer]*	

16. CHAPTER: ENVIRONMENTAL ISSUES

Q.No	Question	Marks
	Multiple Choice Question	
Q.277	Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): Waste material from hospitals is hazardous and is incinerated. Reason (R): Incineration reduces the risk of the spread of pathogens by killing them. Which of the following is correct? 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.	1
Q.278	What happens to the BOD of a water body with REMOVAL of effluents from it? A. Increases B. Decreases C. Remains the same D. Increases and then stagnates	1
Q.279	A research group aims to study the adverse effects of aromatic poly hydrocarbons (PAHs), a class of unsaturated hydrocarbons, on organ systems of marine organisms. Which of the following is LIKELY to be the most suitable environment for the study? A. Middle of an ocean where vessels transfer oils between each other B. Region in the arctic ocean with minimal pollution C. River with frequent temperature fluctuations D. Lake in the middle of dense rainforest	1
Q.280	Two statements are given below- one labelled Assertion (A) and the other labelled Reason (R). Assertion (A): Nuclear waste is an extremely dangerous pollutant.	1

	Reason (R): Nuclear waste has the shortest half-life as compared to that of the other types of pollutants. Which of the following is correct? 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.	
Q.281	Which of the following statements are CORRECT about the process of eutrophication? (P) Increase in nutrient levels (Q) Increase in water clarity (R) Decrease in dissolved oxygen (S) Decrease in penetration of sunlight into water (T) Decrease in the growth of algae and aquatic plants A. Only (P) and (R) B. Only (P), (R), and (S) C. Only (Q), (R), and (T) D. All - (P), (Q), (R), (S), and (T)	1
Free Response Questions/Subjective Questions		
Q.282	The paper industry releases SO_2 as an effluent, resulting in air pollution in the city. (a) Mention any TWO potential negative effects of this SO_2 release. (b) Suggest an instrument that can be used to reduce this kind of pollution, and explain its working principle.	3
Q.283	Brominated Flame Retardants (BFRs) are extensively used in the manufacturing of electronics, furniture, textiles, vehicles, and other products. However, the release of these chemicals into water bodies is a known source of pollution. In water, BFRs are known to enter various food chains, and one such food chain is as follows: $Phytoplankton \rightarrow Zooplankton \rightarrow Herring \rightarrow Mackerel \rightarrow Humans$ (a) In this food chain, at which organismal level would you expect for the concentration of BFR to be the highest and why? (b) Which phenomenon is being exemplified in the above description?	2

Answer key and Marking Scheme

Q.No	Answers	Marks
Q.277	A. Both A and R are true, and R is the correct explanation for A.	1
Q.278	B. Decreases	1
Q.279	A. Middle of an ocean where vessels transfer oils between each other	1
Q.280	C. A is true, but R is false.	1
Q.281	B. Only (P), (R), and (S)	1
Q.282	(a) *1 mark each for mentioning any two of the following:* - SO_2 pollution can cause respiratory problems such as asthma, bronchitis, etc., in humans and animals. - SO_2 reacts with other components of air and causes acid rain that harms animals, plants, and infrastructure. - It can lead to the acidification of soil and water, and affect the survival of the resident organisms. - SO_2 adversely affects the ability of leaves to photosynthesize and results in reduced growth in plants. (b) *Marks to be awarded for any one instrument and its working principle:* - In order to control the SO_2 release, instruments called scrubbers can be used. *[0.5 marks]* - Working principle of scrubbers - Lime or water is sprayed onto an exhaust stream containing the pollutant, leading to the gaseous pollutant getting removed and collected as sludge. *[0.5 marks]* *OR* - In order to control the SO_2 release, instruments called electrostatic precipitators can be used. *[0.5 marks]* - Working principle of electrostatic precipitators - An external attachment of charge to the stream of pollutant molecules happens, leading to their movement toward one of the charged electrodes kept across the stream, thereby removing them from the stream. *[0.5 marks]* *OR*	3

	[Accept any other valid answer and provide marks for the same]	
Q.283	(a) 0.5 marks each for the following: - In this food chain, the highest concentration can be found at the 'humans' level. - Reason - The non-degradable pollutants accumulate and result in higher concentrations in organisms with each successive level in a food chain. (b) The above description is an example of a phenomenon called biomagnification.	2

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