

Date: 16/03/2023



Question Paper Code

57/5/3

Corporate Office : Aakash Tower, 8, Pusa Road, New Delhi-110005 | Ph.: 011-47623456

Time: 3 hrs.

Max. Marks: 70

Class-XII

BIOLOGY (Theory)

(CBSE 2023)

GENERAL INSTRUCTIONS

Read the following instructions very carefully and strictly follow them:

- (i) This question paper contains **33** questions. **All** questions are compulsory.
- (ii) Question paper is divided into **FIVE** sections – Section **A, B, C, D** and **E**.
- (iii) **In Section – A** : Question No. **1** to **16** are Multiple Choice (MCQ) type questions, carrying **1** mark each.
- (iv) **In Section – B** : Question No. **17** to **21** are Very Short Answer (VSA) type questions, carrying **2** marks each.
- (v) **In Section – C** : Question No. **22** to **28** are Short Answer (SA) type questions, carrying **3** marks each.
- (vi) **In Section – D** : Question No. **29** to **30** are **Case-Based** questions, carrying **4** marks each. Each question has subparts with internal choice in one subpart.
- (vii) **In Section – E** : Question No. **31** to **33** are Long Answer (LA) type questions, carrying **5** marks each.
- (viii) There is no overall choice. However, an internal choice has been provided in **1** question in **Section-B**, **1** question in **Section-C**, **2** questions in **Section-D** and **1** question in **Section-E**. A candidate has to attempt only **one** of the alternatives in such questions.
- (ix) Wherever necessary, neat and properly labelled diagrams should be drawn.

SECTION-A

1. Select the pathogen mismatched with the symptoms of disease caused by it from the list given below: [1]
- Entamoeba histolytica* : Constipation, abdominal pain.
 - Epidermophyton* : Dry scaly lesions on nail.
 - Wuchereria bancrofti* : Chronic inflammation of lymphatic vessels of lower limb.
 - Haemophilus influenzae* : Blockage of the intestinal passage.

Answer (d)

Sol. Option (d) is a mismatch because bacteria like *Streptococcus pneumoniae* and *Haemophilus influenzae* are responsible for the disease pneumonia in humans which infects the alveoli [air-filled sacs] of the lungs.

Option (a) is not the answer because, amoebiasis is caused by *Entamoeba histolytica*. Its symptoms include constipation, abdominal pain and cramps, stool with excess mucus and blood clots.

Option (b) is not the answer because *Epidermophyton* are responsible for ringworms, which is one of the most common fungal infections in man. Appearance of dry, scaly lesions on various parts of body such as skin, nails and scalp are the main symptoms of this disease.

Option (c) is not the answer because a slowly developing chronic inflammation of lymphatic vessels of the lower limbs are the symptoms of elephantiasis or filariasis which is caused by *Wuchereria* (*W. bancrofti* and *W. malayi*).

2. Important attributes belonging to a population but not to an individual are: [1]
- Birth rate and death rate
 - Male and female
 - Birth and death
 - Sex-ratio

Select the correct option from the given options:

- (i) only
- (ii) only
- (ii) and (iii)
- (i) and (iv)

Answer (d)

- Sol.**
- A population has certain attributes whereas an individual organism does not. A population has birth rates (per capita births) and death rates (per capita deaths). Another attribute of a population is sex ratio. Thus, (i) and (iv) describe the population attributes. This makes option (d) correct.
 - An individual may have birth and death. Thus, (iii) is incorrect. Therefore, option (c) is incorrect as it includes (iii).
 - An individual is either a male or a female. Thus, (ii) is incorrect. Therefore, option (b) is incorrect.
 - Option (a) is incorrect as it only considers birth rate and death rate but not the sex ratio as a population attribute.

Hence, the correct option is (d).

3. Many copepods live on the body surface of marine fish. This relationship is an example of: [1]
- Commensalism
 - Parasitism
 - Amensalism
 - Mutualism

Answer (b)

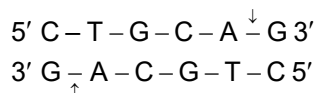
Sol. Copepods live on the body surface of marine fish show the relationship of parasitism. Here, copepods are ectoparasites.

Many marine fishes are infested with ectoparasitic copepods and show +, – interaction.

- The interaction where one species is benefitted and the other is neither benefitted nor harmed is called commensalism.
- In amensalism, one species is harmed whereas the other is unaffected.
- Mutualism interaction confers benefits on both the interacting species.

Hence option (b) is correct.

4. Given below is the restriction site of a restriction endonuclease *Pst*-I and the cleavage sites on a DNA molecule. [1]



Choose the option that gives the correct resultant fragments by the action of the enzyme *Pst*-I.

- (a) $\begin{array}{l} 5' \text{ C - T - G} \\ 3' \text{ G - A - C - G - T} \end{array} \quad \begin{array}{l} \text{C - A - G } 3' \\ \text{C } 5' \end{array}$
- (b) $\begin{array}{l} 5' \text{ C - T} \\ 3' \text{ G - A - G - C} \end{array} \quad \begin{array}{l} \text{G - C - A - G } 3' \\ \text{T - C } 5' \end{array}$
- (c) $\begin{array}{l} 5' \text{ C - T - G - C} \\ 3' \text{ G - A - C G} \end{array} \quad \begin{array}{l} \text{A - G } 3' \\ \text{T - C } 5' \end{array}$
- (d) $\begin{array}{l} 5' \text{ C - T - G - C - A} \\ 3' \text{ G} \end{array} \quad \begin{array}{l} \text{G } 3' \\ \text{A - C - G - T - C } 5' \end{array}$

Answer (d)

Sol. Option (d) is the correct answer because *Pst*-I cuts the DNA between bases A and G only when the sequence CTGCA is present in the DNA generating sticky ends.



5. Given below is a sequence of bases in mRNA of a bacterial cell. Identify the amino acid that would be incorporated at codon position 3 and codon position 5 during the process of its translation. [1]



- (a) Phenylalanine, Methionine (b) Cysteine, Glycine
(c) Alanine, Proline (d) Serine, Valine

Answer (a)*

Sol.

- From 3' end of mRNA, codon position 3 is constituted of UUU which codes for phenylalanine. Codon position 5 is constituted of AUG which codes for methionine. In this way, option (a) is correct.
- Cysteine is coded by UGU and UGC and glycine is coded by GGU, GGC GGA and GGG. Thus, option (b) is incorrect.
- Alanine is coded by GCU, GCC, GCA and GCG and Proline is coded by CCU, CCC, CCA and CCG. Thus, option (c) is incorrect.
- Serine is coded by UCU, UCC, UCA and UCG and Valine is coded by GUU, GUC, GUA and GUG. Thus, option (d) is incorrect.

Hence, the correct answer is option (a).

* However, mRNA sequence is read from 5' → 3'. There is no option available in the question if we read the mRNA sequence from 5' → 3'.

6. Given below are structural details of a human mammary gland : [1]
- The glandular tissue in the breast has 15-20 clusters of cells called alveoli.
 - The milk is stored in the lumen of alveoli
 - The alveoli join to form the mammary ducts.
 - Mammary ampulla is connected to lactiferous ducts.
- Choose the option that gives the correct detail of human mammary gland.
- (i) and (ii)
 - (ii) and (iii)
 - (ii) and (iv)
 - (i) and (iii)

Answer (c)

- Sol.** • Option (c) is the correct answer because the cells of alveoli secrete milk, which is stored in the cavities [lumens] of alveoli. Several mammary ducts join to form a wider mammary ampulla which is connected to lactiferous duct through which milk is sucked out.
- Option (a) is not the correct answer because the glandular tissue of each breast is divided into 15-20 mammary lobes containing clusters of cells called alveoli.
 - Options (b) and (c) are not the answer because the milk-secreting alveoli opens into mammary tubules. The tubules of each lobe join to form a mammary duct.
7. Given below are the list of the commercially important products and their source organisms. Select the option that gives the correct matches. [1]

	List A		List B
	Bioactive Products		Microbes (Source Organism)
(A)	Cyclosporin A	(i)	<u>Streptococcus</u>
(B)	Statins	(ii)	<u>Trichoderma polysporum</u>
(C)	Streptokinase	(iii)	<u>Penicillium notatum</u>
(D)	Penicillin	(iv)	<u>Monascus purpureus</u>

- (A)(i), (B)(ii), (C)(iii), (D)(iv)
- (A)(iii), (B)(iv), (C)(ii), (D)(i)
- (A)(iv), (B)(iii), (C)(ii), (D)(i)
- (A)(ii), (B)(iv), (C)(i), (D)(iii)

Answer (d)

- Sol.** Cyclosporin A is used as an immunosuppressive agent in organ transplant patients and it is produced by fungus *Trichoderma polysporum*.
- Statins are produced by the yeast *Monascus purpureus*.
- Streptokinase is produced by bacterium *Streptococcus*.
- Penicillin antibiotic was named after the mould *Penicillium notatum*.
- Hence option (d) is correct

8. Tetanus antitoxin (Tetanus toxoid) when injected into the human body is immediately provides: [1]
- Innate immunity
 - Passive immunity
 - Auto immunity
 - Active immunity

Answer (b)

Sol. Option 'b' is the answer because Tetanus antitoxins contain pre-formed antibodies against the pathogen of tetanus.

Option 'a' is not the answer because, innate immunity is non-specific type of defence, that is present at the time of birth.

Option 'c' is not the answer because, auto immunity is the immune response of an organism against its own healthy cells or tissues.

Option 'd' is not the answer because, active immunity develops when a host is exposed to antigens, which may be in the living form or dead and antibodies are produced against antigens.

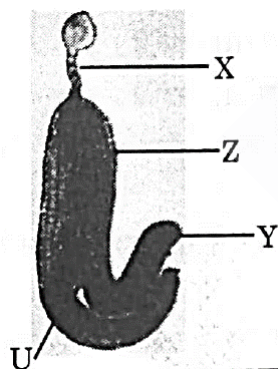
9. The primary productivity in an ecosystem is expressed as: [1]

- | | |
|--|--------------------------------|
| (a) $\text{gm}^{-2} \text{yr}^{-1}$ | (b) $\text{gm}^{-2} \text{yr}$ |
| (c) $\text{K cal m}^{-2} \text{yr}^{-1}$ | (d) K cal m^{-2} |

Answer (a) and (c)*

- Sol.**
- The rate of biomass production is called productivity. It is expressed in terms of $\text{gm}^{-2} \text{yr}^{-1}$ or $\text{Kcal m}^{-2} \text{yr}^{-1}$.
 - Primary production is defined as the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis. It is expressed in terms of weight (gm^{-2}) or energy (Kcal m^{-2}). Thus, option (d) is incorrect.
 - Thus, both option (a) and (c) are correct.

10. Select the option that shows the correctly identified 'U', 'X', 'Y' and 'Z' in a developing dicot embryo. [1]



- (a) X – Plumule (2n), Y – Suspensor (n), Z – Cotyledon (2n), U – Radicle (2n).
 (b) X – Plumule (2n), Y – Suspensor (2n), Z – Radicle (2n), U – Cotyledon (2n).
 (c) X – Suspensor (2n), Y – Cotyledon (2n), Z – Radicle (2n), U – Plumule (2n).
 (d) X – Cotyledon (2n), Y – Radicle (n), Z – Plumule (n), U – Suspensor (n).

Answer (c)

Sol. In the given figure of mature embryo of dicot plant.

Label X is suspensor

Y is cotyledon

Z is radicle

and U is plumule

All the given parts are diploid (2n).

Hence, option (c) is correct.

11. The sixth extinction in progress currently is different from all previous extinctions on earth as it is : [1]
- (a) 10-100 times faster (b) 100-1000 times faster
 (c) 100-10000 times faster (d) 1000-10000 times faster

Answer (b)

Sol. The 'sixth extinction' presently in progress is different from the previous episodes of extinction as the current species extinction rates are estimated to be 100 to 1000 times faster than in the pre-human times and our activities are responsible for the faster rates. Thus, option (b) is correct.

12. At which stage during evolution did human use hides to protect their bodies and buried their dead? [1]
- (a) Homo habilis (b) Neanderthal man
 (c) Java man (d) Homo erectus

Answer (b)

Sol. Option 'b' is correct because, the Neanderthal man with a brain size of 1400 cc first used hides to protect their bodies and buried their dead.

Note: Question Nos. 13 to 16 consists of two statements Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:

- (a) Both (A) and (R) are true and (R) is the correct explanation of (A).
 (b) Both (A) and (R) are true, but (R) is not the correct explanation of (A).
 (c) (A) is true, but (R) is false.
 (d) (A) is false, but (R) is true.
13. **Assertion (A):** Decomposition process is slower if detritus is rich in lignin and cutin.

Reason (R): Decomposition is largely an oxygen requiring process. [1]

Answer (b)

Sol. Decomposition is slower if detritus is rich in lignin and chitin because lignin and cutin polymers are highly resistant to chemical and biological degradation due to its molecular architecture.

Decomposition is largely an oxygen requiring process.

The rate of decomposition is controlled by chemical composition of detritus and climatic factors.

Hence, both Assertion and Reason are true but Reason is not correct explanation of Assertion.

Therefore, option (b) is correct.

14. **Assertion (A):** Determining the sex of an unborn child followed by MTP is an illegal practice.

Reason (R): Amniocentesis is a practice to test the presence of genetic disorders also. [1]

Answer (b)

Sol. Option (b) is the answer because:

Both (A) and (R) are true, but (R) is not the correct explanation of (A).

Amniocentesis is a foetal sex and disorder determination test based on the chromosomal pattern of the embryo's cells in the amniotic fluid surrounding the developing foetus. It is being misused to know the sex of unborn child followed by the termination of foetus in case its a female. So this is why, determining the sex of an unborn child followed by MTP is banned and considered as an illegal practice.

15. **Assertion (A) :** In Thalassemia an abnormal myoglobin chain is synthesized due to a gene defect.

Reason (R) : α -Thalassemia is controlled by genes HBA1 and HBA2 on chromosome 16. [1]

Answer (d)

Sol. Thalassemia could be due to either mutation or deletion which ultimately results in reduced rate of synthesis of one of the globin chains (α and β chains) that make up haemoglobin. This causes the formation of abnormal haemoglobin molecules resulting into anaemia which is characteristic of the disease. Thus, assertion is a false statement.

α -Thalassemia is controlled by two closely linked genes HBA1 and HBA2 on chromosome 16 of each parent and it is observed due to mutation or deletion of one or more of the four genes. Thus, reason is a true statement.

Therefore, the correct option is (d).

16. **Assertion (A)** : Synthetic oligonucleotide polymers are used during Annealing in a PCR.

Reason (R) : The primers bind to the double stranded DNA at their complementary regions.

[1]

Answer (c)

Sol. Option 'c' is the correct answer because during the PCR, the primers bind to their complementary sequences on the single-stranded templates.

SECTION-B

17. (a) Name (i) a GM cereal crop having enhanced nutritional value, (ii) the nutrient it is rich in.

(b) State any two benefits of Genetically modified crops.

[2]

Sol. (a) (i) A genetically modified cereal crop having enhanced nutritional value is golden rice.

[1/2]

(ii) It is rich in vitamin A.

[1/2]

(b) Benefits of Genetically modified crops are:

(Any two) [1/2 × 2]

(1) GM crops are more tolerant to abiotic stresses.

(2) There is increased efficiency of mineral usage by GM plants.

(3) Genetic modification has enhanced the nutritional value of food.

(4) GM crops has reduced reliance on chemical pesticides.

18. By using Punnett square depict the genotypes and phenotypes of test crosses (where green pod colour (G) is dominant over yellow pod colour (g) in Garden pea with unknown genotype.

[2]

Sol. • Homozygous recessive (Yellow pod colour) → Genotype (gg).

• Dominant phenotype (Green pod colour) → Genotype can be (heterozygous Gg) or (homozygous GG).

(i) $Gg \times gg$

If offsprings obtained are in phenotypic ratio of 1 : 1 then, unknown genotype is heterozygous i.e., Gg

[1]

	g	g
G	Gg	Gg
g	gg	gg

(ii) $GG \times gg$

If all offsprings obtained show dominant phenotype then, unknown genotype is homozygous i.e., GG

[1]

	g	g
G	Gg	Gg
G	Gg	Gg

19. (a) Certain specific bacterial spores are mixed in water and sprayed over *Brassica* crop to control butterfly caterpillars.

Name this bacterium and its mode of action on the butterfly caterpillars.

[2]

OR

- (b) Immunotherapy these days is one of the most efficient ways of treatment of cancer. The therapy involved activates the immune system and destroys the tumour.

- Write an example of one such biological response modifier used in immunotherapy.
- Why do patients need such substances if immune system is already working in body?
- State what is 'Contact inhibition'.

[2]

- Sol.** (a) The dried spores of bacteria *Bacillus thuringiensis* (Bt) are available in sachets which are mixed with water and sprayed over *Brassica* crop to control butterfly caterpillars.

[1]

Spores are eaten by the insect larvae and in the gut of the larvae, toxin is released and the larvae get killed.

It is a type of biocontrol agent.

[1]

OR

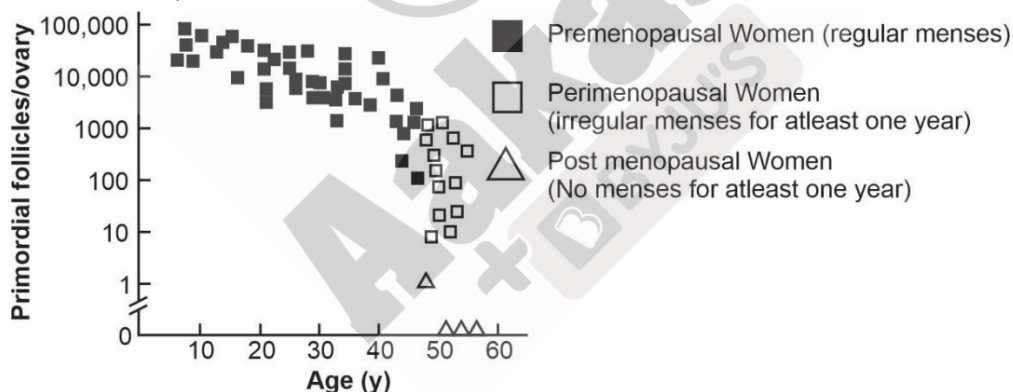
- A biological response modifier used in immunotherapy is α -interferon.
- Biological response modifiers activate the immune system of the body and help in destroying the tumour.
- Contact inhibition is a property of normal cells by virtue of which contact with other cells inhibit their uncontrolled growth.

[1/2]

[1/2]

[1]

20. The graph given below shows the number of primordial follicles per ovary in women at different ages. Study the graph and answer the questions that follow.



- What is the average age of the women at the onset of menopause?
- At what age are maximum primordial follicles present in the ovary, according to the given graph?

[1 + 1 = 2]

- Sol.** (a) According to the given graph, the average age of the women at the onset of menopause

$$= \frac{45 + 55}{2} = \frac{100}{2} = 50 \text{ years}$$

[1]

- (b) According to the given graph, the maximum primordial follicles ($> 1,00,000$) are present in the ovary at the age of 7 years.

[1]

21. "Some species of insects and frogs have evolved with various specific features that help them from being detected."

[2]

- Justify the statement giving reasons.
- Mention any two such features.

Sol. Some species of insects (prey) and frogs (predator) have evolved various special features that help them from being detected. [1]

- (a) Prey species have evolved various defenses to lessen the impact of predation.
- (b) (i) Camouflage – Some species are cryptically coloured to avoid being detected easily by the predator.
(ii) Some are poisonous and therefore, avoided by the predators. [1]
(iii) The Monarch butterfly is highly distasteful to its predator (bird) because of a special chemical present in its body. (any two)

SECTION-C

22. (a) "Plasmodium protozoan needs both a mosquito and a human host for its continuity." Explain. [3]

OR

(b) We all must work towards maintaining good health because 'health is wealth'. Enlist any six ways of achieving good health. [3]

- Sol.** (a) • The malarial parasite (*Plasmodium*) requires two hosts—human and mosquitoes to complete its life cycle; the female *Anopheles* mosquito is the vector (transmitting agent) too.
• *Plasmodium* enters the human body as sporozoites through the bite of infected female *Anopheles* mosquito.
• The parasites initially multiply within the liver cells and then attack the red blood cells resulting in their rupture to release haemozoin, which is responsible for chill and high fever recurring every three to four days.
• When a female *Anopheles* bites an infected person, these parasites (gametocytes) enter the mosquito's body, perform multiplication within them to form sporozoites.
• Sporozoites are stored in salivary glands of mosquito and infect humans during biting. [3]

OR

- (b) A good health can be achieved by:
- (1) A good life style including hygienic food and water.
 - (2) Awareness about diseases and their effect on different bodily functions.
 - (3) Vaccination against infectious diseases
 - (4) Balanced diet, personal hygiene and regular exercise.
 - (5) Yoga can be practiced to achieve physical and mental health.

Proper disposal of wastes and control of vectors.

23. "Biodiversity plays a major role in many ecosystem services that nature provides." [3]

- (a) Describe any two broadly utilitarian arguments to justify the given statement.
- (b) State one ethical reason of conserving biodiversity.

Sol. (a) The broadly utilitarian argument says that biodiversity plays a major role in many ecosystem services that nature provides.

For instance,

- (1) **Oxygen:** About 20 percent of the total oxygen is produced by Amazon Forest which is essential for our survival.
- (2) **Pollination:** Without which plants cannot give us fruits or seeds. [1 + 1]
- (b) **Ethical reason of conserving biodiversity:** We should realise that every species has an intrinsic value and we have moral duty to care for their well-being. [1]

Biology (Class XII)

24. Name and explain a surgical contraceptive method that can be adopted by the male partner of a couple. [3]
- Sol.** A surgical contraceptive method that can be adopted by the male partner of a couple is called vasectomy. [1]
 In vasectomy, a small part of the vas deferens is removed or tied up through a small incision on the scrotum. [1]
 This technique is highly effective but their reversibility is very poor. This method is generally advised for the male partner as a terminal method to prevent any more pregnancies. [1]
25. Human Genome Project (HGP) was a mega project launched in the year 1990 with some important goals.
 (a) Enlist any four prime goals of HGP.
 (b) Name any one common non-human animal model organism which has also been sequenced thereafter. [3]
- Sol.** (a) Human Genome Project (HGP) was a mega project launched in the year 1990. [2]
 Prime goals of HGP were as follows:
 (1) Identify all the approximately 20,000 – 25,000 genes in human DNA.
 (2) Determine the sequences of the 3 billion chemical base pairs that make up human DNA.
 (3) Store this information in databases.
 (4) Address the ethical, legal and social issues (ELSI) that may arise from the project.
 (5) Improve tools for data analysis.
 (6) Transfer related technologies to other sectors, such as industries. (Any Four)
 (b) *Drosophila*, the fruit fly, is one of the non-human animal model organisms whose genome has been sequenced. [1]
26. One of the major approaches of crop improvement programme is Artificial Hybridisation. Explain the steps involved in making sure that only the desired pollen grain pollinates the stigma of a bisexual flower by a plant breeder. [3]
- Sol.** Artificial hybridisation is one of the major approaches of crop improvement programme. In such crossing experiments it is important to make sure that only the desired pollen grains are used for pollination and the stigma is protected from contamination. This can be achieved by following step:
 (1) **Emasculation** – If the female parent bears bisexual flowers, anthers are removed from the floral bud before the anther dehisces using a pair of forceps. [1]
 (2) **Bagging** – Emasculated flowers have to be covered with a bag of suitable size, generally made up of butter paper, to prevent contamination of its stigma with unwanted pollen. [1]
 (3) When the stigma of bagged flower attains receptivity, mature pollen grains collected from anthers of the male parent are dusted on the stigma, and the flowers are rebagged, and the fruits are allowed to develop. [1]
27. Mention Darwin's observations made on finches during his visit to Galapagos Islands. Write the explanation given by Darwin on his observations. [3]
- Sol.** During his visit to Galapagos Island, Darwin observed that there were many varieties of small black birds in these islands which differed mainly in the beak shape and feeding habits. [1]
 After analysing them, he realised that they were evolved on the same island itself. He conjectured that from the original seed-eating birds, other forms with altered beaks arose, enabling them to become insectivorous and vegetarian finches. [1]
 This process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography is called adaptive radiation. [1]

28. "RNA interference has been used to produce transgenic tobacco plants to protect them from the infestation by specific nematodes." Explain the novel strategy exploited by the biotechnologists. [3]

Sol. RNAi involves silencing of a specific mRNA due to a complementary dsRNA molecule that binds to and prevents translation of the mRNA. The source of this complementary RNA could be from an infection by viruses having RNA genomes or transposons that replicate *via* an RNA intermediate. [1]

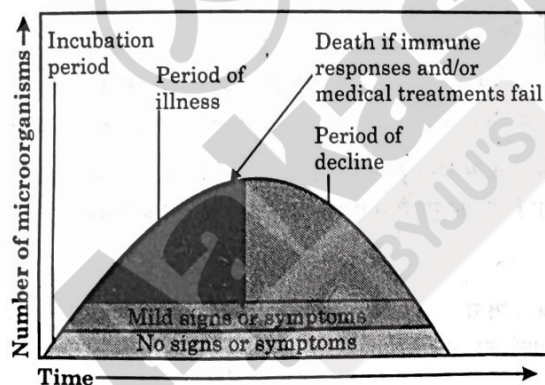
Using *Agrobacterium* vectors, nematode-specific genes were introduced into the host plant. The introduction of DNA was such that it produced both sense and anti-sense RNA in the host cells. These two RNA's being complementary to each other formed a dsRNA that initiated RNAi and thus, silenced the specific mRNA of the nematode. [1]

The consequence was that the parasite could not survive in a transgenic host expressing specific interfering RNA. The transgenic plant therefore got itself protected from the parasite. [1]

SECTION-D

Note : Question numbers 29 and 30 are **Case-Based** questions. Each question has subparts with internal choice in one subpart.

29. When a microorganism invades a host, a definite sequence of events usually occurs leading to infection and disease, causing suffering to the host. This process is called pathogenesis. Once a microorganism overcomes the defense system of the host, development of the disease follows a certain sequence of events as shown in the graph. Study the graph given below for the sequence of events leading to appearance of a disease and answer the questions that follow :



- (a) In which period, according to the graph there are maximum chances of a person transmitting a disease/infection and why? [1]
 (b) Study the graph and write what is an incubation period. Name a sexually transmitted disease that can be easily transmitted during this period. Name the specific type of lymphocytes that are attacked by the pathogen of this disease. [2]

OR

- (b) Draw a schematic labelled diagram of an antibody. [2]
 (c) In which period, the number of immune cells forming antibodies will be the highest in a person suffering from pneumonia? [1]

Name the immune cells that produce antibodies.

Sol. (a) According to the given graph, during the period of mild signs or symptoms, there is maximum chance of a person transmitting disease.

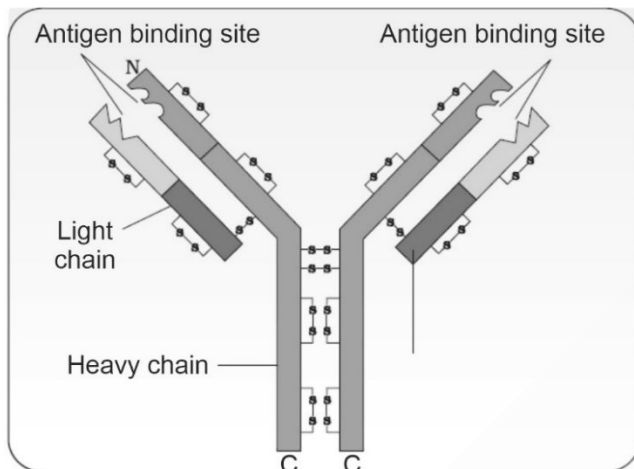
It is because, during this period the number of microorganisms are more as they continue replicating themselves due to low titre of antibodies. [1]

- (b) The time period between infection and appearance of symptoms of a disease is called incubation period. [1]

HIV can be easily transmitted during incubation period. HIV, the pathogen of AIDS, attacks helper T-lymphocytes. [1]

OR

- (b) [2]



- (c) Period of decline. [½]
- Antibodies are produced by B-lymphocytes. [½]

30. The chromosome number is fixed for all normal organisms leading to species specification whereas any abnormality in the chromosome number of an organism results into abnormal individuals. For example, in humans 46 is the fixed number of chromosomes both in male and female. In male it is ' $44 + XY$ ' and in female it is ' $44 + XX$ '. Thus, the human male is heterogametic, in other words produces two different types of gametes one with ' $22 + X$ ' chromosomes and the other with ' $22 + Y$ ' chromosomes respectively. Human female, on the other hand is homogametic i.e., produces only one type of gamete with ' $22 + X$ ' chromosomes only.

Sometimes an error may occur during meiosis of cell cycle, where the sister chromatids fail to segregate called nondisjunction, leading to the production of abnormal gametes with altered chromosome number. On fertilisation such gametes develop into abnormal individuals.

- (a) State what is aneuploidy. [1]
(b) If during spermatogenesis, the chromatids of sex chromosomes fail to segregate during meiosis, write only the different types of gametes with altered chromosome number that could possibly be produced. [1]
(c) A normal human sperm ($22 + Y$) fertilises an ovum with karyotype ' $22 + XX$ '. Name the disorder the offspring thus produced would suffer from and write any two symptoms of the disorder. [2]

OR

- (c) Name a best known and most common autosomal aneuploid abnormality in human and write any two symptoms. [2]

Sol. (a) **Aneuploidy:** Failure of segregation of chromatids during cell division cycle results in the gain or loss of a chromosome (s), called aneuploidy. [1]

- (b) If during spermatogenesis, the chromatids of sex chromosomes fail to segregate during meiosis, different types of gametes with altered chromosome produced will be- [1]

- (i) $22 + XY$
(ii) $22 + O$

(c) Sperm + Ovum
(22 + Y) (22 + XX)

↓
Fertilization

↓

44 + XXY

Person with 44 + XXY karyotype would suffer from Klinefelter's syndrome. Symptoms of Klinefelter's syndrome include –

- (i) Tall stature
- (ii) Feminine development, e.g., development of breast i.e., Gynaecomastia
- (iii) Sterility

[any two] [2]

OR

(c) Down's syndrome is a best known and most common autosomal aneuploid abnormality in human.

Symptoms of Down's Syndrome include -

- (i) Short stature
- (ii) Small round head
- (iii) Furrowed tongue/big and wrinkled tongue
- (iv) Partially open mouth
- (v) Retarded physical, psychomotor and mental development
- (vi) Flat back of head
- (vii) Many 'loops' on finger tips
- (viii) Palm crease
- (ix) Broad flat face
- (x) Congenital heart disease

[any two] [2]

SECTION-E

31. (a) (i) How and why is charging of tRNA essential in the process of translation?
(ii) State the function of ribosome as a catalyst in bacteria during the process of translation.
(iii) Explain the process of binding of ribosomal units to mRNA during protein synthesis.

[5]

OR

- (b) Describe the dihybrid cross upto F₂ generation as conducted by Gregor Mendel using pure lines of Garden Pea for characters seed shape and seed colour.

[5]

- Sol.** (a) (i) During translation, amino acids are joined by a bond which is known as a peptide bond. Formation of a peptide bond requires energy. Therefore, in the first phase itself amino acids are activated in the presence of ATP and linked to their cognate tRNA, a process commonly called as charging of tRNA. If two such charged tRNAs are brought close enough, the formation of peptide bond between them would be favoured energetically. [2]
(ii) 23S rRNA of ribosome of bacteria acts as a catalyst for the formation of peptide bond. The presence of a catalyst enhances the rate of peptide bond formation. [1]
(iii) When the small subunit of ribosome encounters an mRNA, the process of translation of the mRNA to proteins begins. There are two sites in the large subunit, for subsequent amino acids to bind and thus, be close enough to each other for the formation of a peptide bond. [2]

OR

(b)

Character	Dominant trait	Recessive trait
Seed shape	Round (R)	Wrinkled (r)
Seed colour	Yellow (Y)	Green (y)

Parental Generation

Phenotype : Round and yellow seed Wrinkled and green seed

Genotype : RRYYY rryy

↓

↓

Gametes : RY ry

F₁ Generation

Genotype : RrYy

Phenotype : Round and yellow seed

[2]

F₁ × F₁ (Selfing) :

	RrYy		×		RrYy			
	↓	↓	↓	↓	↓	↓	↓	
Gametes :	RY	Ry	rY	ry	RY	Ry	rY	ry

[1]

F₂ Generation

	RY	Ry	rY	ry
RY	RRYY Round and yellow	RRYy Round and yellow	RrYY Round and yellow	RrYy Round and yellow
Ry	RRYy Round and yellow	RRyy Round and green	RrYy Round and yellow	Rryy Round and green
rY	RrYY Round and yellow	RrYy Round and yellow	rrYY Wrinkled and yellow	rrYy Wrinkled and yellow
ry	RrYy Round and yellow	Rryy Round and green	rrYy Wrinkled and yellow	rryy Wrinkled and green

Genotypic ratio : RRYYY : RRyy : RRYy : RrYY : RrYy : rrYY : Rryy : rrYY : rryy
 1 : 1 : 2 : 2 : 4 : 2 : 2 : 1 : 1

Phenotypic ratio : Round and yellow : Round and green : Wrinkled and yellow : Wrinkled and green
 9 : 3 : 3 : 1

[2]

32. (a) Bioreactors are the containment vehicles of any biotechnology-based production process. For large scale production and for economic reasons the final success of biotechnological process depends on the efficiency of the bioreactor.

[5]

Answer the following questions w.r.t. the given paragraph:

- (i) List the operational guidelines that must be adhered to so as to achieve optimisation of the bioreactor system. Enlist any four.
- (ii) Mention the phase of the growth we refer to in the statement "Optimisation of growth and metabolic activity of the cells".
- (iii) Is the biological product formed in the bioreactor suitable for the intended use immediate? Give reason in support of your answer.

OR

- (b) (i) 'EcoRI' has played very significant role in r-DNA technology. [3]
 - (I) Explain the convention for naming *EcoRI*.
 - (II) Write the recognition site and the cleavage sites of this restriction endonuclease.
- (ii) What are the protruding and hanging stretches of DNA produced by these restriction enzymes called? Describe their role in formation of r-DNA. [2]

- Sol.** (a) (i) The operational guidelines that must be adhered to so as to achieve optimisation of the bioreactor system are:
- (I) It should have an agitator system, an oxygen delivery system and a foam control system. [½]
 - (II) Bioreactor must have a temperature control system to provide optimum growth conditions. [½]
 - (III) Bioreactor must have a pH control system. [½]
 - (IV) It should have sampling ports so that small volumes of the culture can be withdrawn periodically. [½]
- (ii) In log/exponential phase, these culturing method produces a larger biomass leading to higher yield of desired protein, this is due to optimisation of growth and metabolic activity of the cells. [1]
- (iii) The biological product formed in the bioreactor is not suitable for the intended use immediate because after completion of the biosynthetic stage, the product has to be subjected through a series of processes before it is ready for marketing as a finished product. The processes include separation and purification, which are collectively referred to as downstream processing. The product has to be formulated with suitable preservatives. Such formulation has to undergo through clinical trials as in case of drugs. Strict quality control testing for each product is also required. [2]

OR

- (b) (i) (I) The convention for naming *EcoRI* is as follows. [2]

E – *Escherichia*
co – *coli*
R – Derived from the name of strain
I – Order in which the enzyme was isolated from that strain of bacteria.

EcoRI comes from *Escherichia coli* RY13
- (II) *EcoRI* cuts the DNA between bases G and A only when the sequence GAATTC is present in the DNA. [1]
- (ii) The protruding and hanging stretches of DNA produced by restriction enzymes are called sticky ends. These are named so because they form hydrogen bonds with their complementary cut counterparts. This stickiness of the ends facilitates the action of the enzyme DNA ligase. [2]

33. (a) (i) Explain the monosporic development of embryo sac in the ovule of an angiosperm. [3]
- (ii) Draw a diagram of the mature embryo sac of an angiospermic ovule and label any four parts in it. [2]

OR

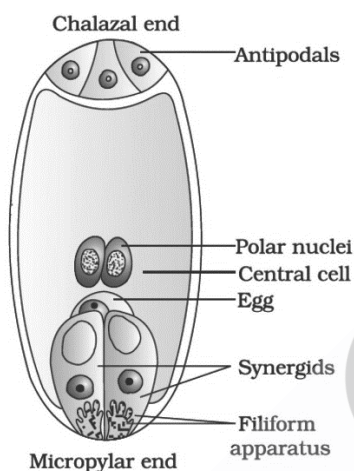
- (b) (i) Explain the formation of placenta after the implantation in a human female. [3]
- (ii) Draw a diagram showing human foetus within the uterus and label any four parts in it. [2]

Sol. (a) (i) The megaspore mother cell (MMC) in ovule undergoes meiotic division that results in the production of four megaspores. In majority of angiosperms, one of the megaspores is functional while the other three degenerate. Only the functional megaspore develops into the female gametophyte (embryo sac). This method of embryo sac development from a single megaspore is termed monosporic development.

The nucleus of the functional megaspore divides mitotically to form two nuclei which move to the opposite poles, forming the 2-nucleate embryo sac. Two more sequential mitotic nuclear divisions result in the formation of the 4-nucleate and later the 8-nucleate stages of the embryo sac. After the 8-nucleate stage, cell walls are laid down leading to the organisation of the typical female gametophyte or embryo sac.

(ii) Mature embryo sac

[3]



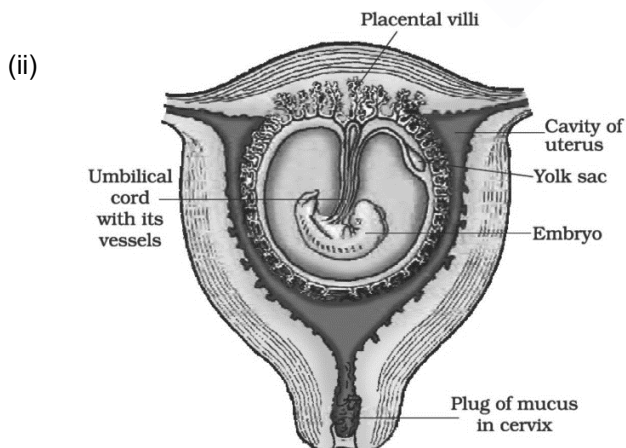
[Any 4 labels]

$$\left[4 \times \frac{1}{2} \right]$$

OR

(b) (i) Implantation is a process in which the blastocyst becomes embedded in the endometrium of the uterus. After implantation, the events which lead to the formation of placenta are as follows :

- (1) After implantation, finger-like projections appear on the trophoblast and are called chorionic villi. [1]
- (2) Chorionic villi are surrounded by the uterine tissue and maternal blood. [1]
- (3) The chorionic villi and uterine tissue become interdigitated with each other and jointly form placenta which is a structural and functional unit between developing embryo (foetus) and maternal body. [1]



[Any 4 labels]

$$\left[4 \times \frac{1}{2} \right]$$