

# Solved Paper 2023

## BIOLOGY

Time : 3 Hours

Class-XII

Max. Marks : 70

### 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 number 1 to 16 are Multiple Choice (MCQ) type questions carrying 1 mark each.
- (iv) In Section-B question number 17 to 21 are Very Short Answer (VSA) type questions carrying 2 marks each.
- (v) In Section-C question number 22 to 28 are Short Answer (SA) type questions carrying 3 marks each.
- (vi) In Section-D question number 29 and 30 are case-based questions carrying 4 marks each. Each question has subparts with internal choice in one subpart.
- (vii) In Section-E question number 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.

Delhi Set-I

57/5/1

### SECTION - A

1. 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*

Ans. Option (b) is correct.

*Explanation:* Neanderthal man used hides to protect their body and buried their dead. They lived in near east and central Asia between 1, 00,000 - 40,000 years back.

2. Given below are Column A with a list of certain Assisted Reproductive. Technologies (ART) and in Column B the procedures followed during ART: [1]

Column A		Column B	
S. No.	Names of ART	S. No.	Procedures
(A)	GIFT	(i)	Transfer of ovum from a donor into the fallopian tube of another female.
(B)	ICSI	(ii)	Transfer of semen from the donor into the vagina of the female.
(C)	ZIFT	(iii)	Injecting sperms directly into the ovum.
(D)	IUI	(iv)	Transfer of early embryos into the fallopian tube.

Choose the option where ART correctly matches with the procedure.

- (a) (A)-(i), (B)-(ii), (C)-(iii), (D)-(iv)                      (b) (A)-(iv), (B)-(i), (C)-(ii), (D)-(iii)  
 (c) (A)-(iv), (B)-(iii), (C)-(i), (D)-(ii)                      (d) (A)-(i), (B)-(iii), (C)-(iv), (D)-(ii)

Ans. Option (d) is correct.

**Explanation:** Gamete Intra Fallopian tube (GIFT) is the transfer of an ovum from a donor into the fallopian tube of another female.

- Intra Cytoplasmic Sperm Injection (ICSI) is a procedure to form an embryo in the laboratory in which a sperm is directly injected into the ovum.
- Zygote Intra Fallopian Transfer (ZIFT) is the technique where the zygote or early embryos are transferred into the fallopian tube.
- Intra uterine insemination (IUI) is the technique in which the semen is collected either from the husband or a healthy donor and is artificially introduced either into the vagina or into the uterus of the female. **1**

3. The decrease in the T-lymphocytes count in human blood will result in: [1]

- (a) Decrease in antigens  
 (b) Decrease in antibodies  
 (c) Increase in antibodies  
 (d) Increase in antigens

Ans. Option (b) is correct.

**Explanation:** T-lymphocytes help B cells to secrete antibodies. Hence, the decrease in the T-lymphocytes count in human body will result in decrease in antibodies.

4. 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]  
 3' AUCAGGUUUGUGAUGGUACGA 5'

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

Ans. Option (a) is correct.

**Explanation:** The codon UUU specifically represent the amino acid phenylalanine and AUG represents the methionine.

5. A Tight one-to-one relationship between many species of fig tree and certain wasps is an example of – [1]

- (a) Commensalism                      (b) Parasitism  
 (c) Amensalism                      (d) mutualism

Ans. Option (d) is correct.

**Explanation:** The relationship between the fig tree and wasp is mutualism, where both species benefit. Wasp pollinates fig tree and the female uses the ovary of the flower for oviposition and larvae uses seeds for nutrition.

6. Select the pathogen mismatched with the symptoms of disease caused by it from the list given below: [1]

- (a) *Entamoeba histolytica*: Constipation, abdominal pain.  
 (b) *Epidermophyton*: Dry scaly lesions on nail.  
 (c) *Wuchereria bancrofti*: Chronic inflammation of lymphatic vessels of lower limb.

(d) *Haemophilus influenzae*: Blockage of the intestinal passage.

Ans. Option (d) is correct.

**Explanation:** Pneumonia is a bacterial disease caused by *Streptococcus pneumonia* and *Haemophilus influenzae*. The disease pneumonia is characterised by the accumulation of fluid in the lungs.

7. 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)  $\text{kcal m}^{-2}$

Ans. Option (a) is correct.

**Explanation:** The primary productivity in an ecosystem is expressed in terms of  $\text{gm}^{-2}\text{yr}^{-1}$ . The rate of biomass production is called productivity.

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

5' C—T—G—C—A ↓ G 3'

3' G—A—C—G—T ↓ C 5'

↑

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

- (a) 5' C—T—G                      C—A—G 3'  
       3'—G—A—C—G—T'        C 5'  
 (b) 5' C—T                      G—C—A—G 3'  
       3' G—A—G—C                      T—C 5'  
 (c) 5' C—T—G—C                      A—G 3'  
       3' G—A—C—G                      T'—C 5'  
 (d) 5' C—T—G—C—A                      3' G  
       3' G                      A—C—G—T—C 5'

Ans. Option (d) is correct.

**Explanation:** The correct resultant fragments by the action of the enzyme Pst I is as follows:

5' C—T—G—C—A ↓ G 3'

3' G—A—C—G—T ↓ C 5'

↑

↓

5' C—T—G—C—A

G—3'

3'—G

A—C—G—T—C 5'

9. The IUCN Red Data List (2004) in the last 500 years documents the extinction of nearly 784 species including: [1]

- (a) 330 invertebrates (b) 338 invertebrates  
(c) 359 invertebrates (d) 362 invertebrates

Ans. Option (c) is correct.

**Explanation:** The IUCN Red Data List (2004) in the last 500 years documents the extinction of nearly 784 species including 359 invertebrates.

10. 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	
S. No.	Bioactive Product	S. No.	Microbes (Source Organism)
(A)	Cyclosporin A	(i)	<i>Streptococcus</i>
(B)	Statins	(ii)	<i>Trichoderma Polysporum</i>
(C)	Streptokinase	(iii)	<i>Penicillium notatum</i>
(D)	Penicillin	(iv)	<i>Monascus purpureus</i>

Options:

- (a) (A)-(i), (B)-(ii), (C)-(iii), (D)-(iv) (b) (A)-(iii), (B)-(iv), (C)-(ii), (D)-(i)  
(c) (A)-(iv), (B)-(iii), (C)-(ii), (D)-(i) (d) (A)-(ii), (B)-(iv), (C)-(i), (D)-(iii)

Ans. Option (d) is correct.

**Explanation:** Cyclosporin A, a bioactive molecule is produced by the fungus *Trichoderma polysporum*. Statins are produced by the yeast *Monascus purpureus*, Streptokinase is produced by the bacterium *Streptococcus* and Penicillin, an antibiotic is produced by *Penicillium notatum*.

11. Important attributes belonging to a population but not to an individual are: [1]

- (i) Birth rate and death rate  
(ii) Male and female  
(iii) Birth and death  
(iv) Sex-ratio

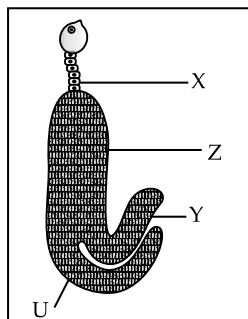
Select the correct option from the given options:

- (a) (i) only (b) (ii) only  
(c) (ii) and (iii) (d) (i) and (iv)

Ans. Option (d) is correct.

**Explanation:** Birth rate, death rate, age distribution pattern, sex ratio and population density are attributes of a population but not of an individual.

12. 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).

Ans. Option (c) is correct.

**Explanation:** The part labeled as X is suspensor, Y is Cotyledon, Z is radicle and part U is Plumule.

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): Determining the sex of an unborn child followed by MTP is an illegal practice. [1]

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

Ans. Option (b) is correct.

**Explanation:** Medical Termination of pregnancy (MTP) is a procedure of intentional or voluntary termination of pregnancy before full term. Many people in India opt for MTP to avoid the birth of a female child which is an illegal practice in India. Amniocentesis, on the other hand, is a practice to test the presence of genetic diseases like Down's syndrome, Haemophilia, etc.

14. Assertion (A): Synthetic oligonucleotide polymers are used during Annealing in a PCR. [1]

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

Ans. Option (a) is correct.

**Explanation:** In polymerase chain reaction (PCR), during annealing, synthetic oligonucleotides

polymers called primers are used that are complementary to the regions of the DNA.

15. **Assertion (A):** Decomposition process is slower if detritus is rich in lignin and chitin. [1]

**Reason (R):** Decomposition is largely an oxygen requiring process.

**Ans.** Option (b) is correct.

**Explanation:** Decomposition is largely an oxygen requiring process. The process of decomposition is slower if detritus is rich in lignin and chitin and quicker if detritus is rich in nitrogen and water soluble substances like sugars.

16. **Assertion (A):** In **Thalassemia** an abnormal myoglobin chain is synthesized due to a gene defect. [1]

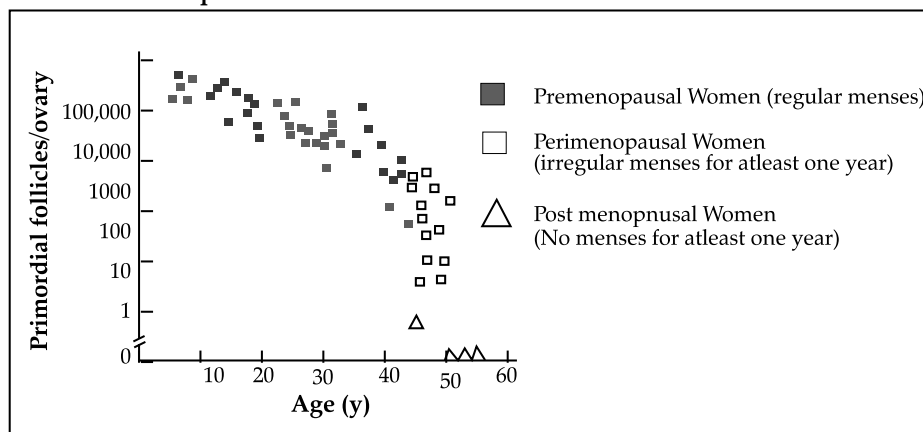
**Reason (R):**  $\alpha$ -Thalassemia is controlled by genes HBA1 and HBA2 on chromosome 16.

**Ans.** Option (d) is correct.

**Explanation:** Thalassemia is a genetic defect that occurs due to the reduced rate of synthesis of one of the globin chains that make up the haemoglobin.  $\alpha$ -Thalassemia is controlled by genes HbA1 and HbA2 on chromosome 16, while  $\beta$ -Thalassemia is controlled by the gene HBB of chromosome 11.

### SECTION - B

17. 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. [2]



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

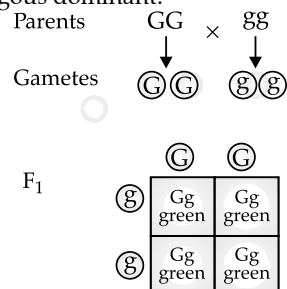
**Ans.** (a) The average age of women at the onset of menopause is 45 years.  
 (b) According to the given graph, at the age of 10, maximum primordial follicles are present in the ovary.

18. "Cattle and goats do not browse the *Calotropis* plant." Justify the statement giving reasons. [2]

**Ans.** *Calotropis* plant produces highly poisonous cardiac glycosides that affect the heart of cattle and goats. This is the reason why cattle and goats avoid browsing this plant.

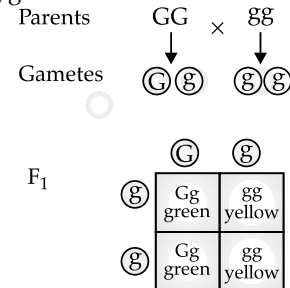
19. By using Punnett square depict the genotypes and phenotypes of test crosses (where green pod colour (G) is dominant over yellow pod colour (g) in Garden pea with unknown genotype. [2]

**Ans.** **Case I:** When the parent with unknown genotype is homozygous dominant.



All progeny are bearing green pods

**Case II:** When the parent with unknown genotype is heterozygous dominant.



50% progeny bear green pods  
 50% progeny bear yellow pods

This means, if all the F<sub>1</sub> progeny are showing dominant phenotype, the tested parents is homozygous dominant.

If 50% F<sub>1</sub> show dominant phenotype and 50% show recessive phenotype then tested parent is heterozygous dominant.

20. (a) (i) Give an example of a genus of virus used as narrow spectrum insecticidal biocontrol agent. [2]

(ii) How does its use serve as an aid in overall integrated pest management programme? [2]

OR

(b) Why a malignant tumour considered to be more damaging than a benign tumour? Explain.

Ans. (a) (i) Baculoviruses are used as narrow spectrum insecticidal biological control agents in the genus *Nucleopolyhedrovirus*.

(ii) These viruses are excellent candidate for species –specific, narrow spectrum insecticidal applications.

They have shown to have no negative impact on plants, mammals, birds, fish or even on non-target insects. This is especially desirable when beneficial insects are being conserved to aid in an overall integrated pest management (IPM) programme or when an ecologically sensitive area is being treated.

OR

(b) Benign tumors are the tumors that remain confined to their original location and do not spread to other parts of the body whereas malignant tumors are a mass of proliferating cells that grow very rapidly, are invading and damages the surrounding normal tissues. These cells divide uncontrollably, forming a mass of cells called tumor. From the tumor, some cells get sloughed off and enter into the blood stream. From the blood stream, these cells reach distant parts of the body and therefore, initiate the formation of new tumors by dividing actively. This property is called metastasis, which makes the malignant tumors more damaging than a benign tumour.

21. (a) Write the scientific name of the source organism of the them a stable DNA polymerase used in PCR. [2]

(b) State the advantage of using Thermostable DNA polymerase.

Ans. (a) The thermostable DNA polymerase is isolated from a bacterium called *Thermus aquaticus*.

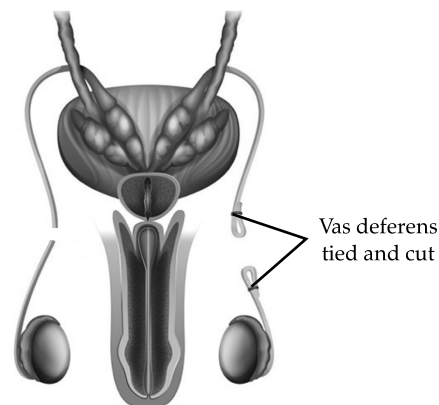
(b) *Thermus aquaticus* remain active during the high temperature for the denaturation step in PCR and remain enzymatically active after each cycle.

### SECTION - C

22. Name and explain a surgical contraceptive method that can be adopted by the male partner of a couple. [3]

Ans. Vasectomy is the surgical contraceptive method in the males.

In this, a small part of the vas deferens is removed or tied up through a small incision on the scrotum. This blocks the gamete transport and thereby prevents fusion of sperm with ovum.



23. Human Genome Project (HGP) was a mega project launched in the year 1990 with some important goals. [3]

(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]

Ans. (a) Prime goals of HGP are:

(i) Identify all the approximately 20,000 -25,000 genes in the human DNA.

(ii) Determining the sequences of the 3 billion chemical base pairs that make up human DNA.

(iii) Store this information in databases.

(iv) Improve tools for data analysis.

(b) *Drosophila*

24. Industrial melanism in England after 1850 is an excellent example of Natural selection. Explain how? [3]

Ans. Natural selection is the process by which the organisms that are best suited for their environment survive and reproduce.

The classical example of natural selection can be explained by the response of a peppered moth *Biston betularia* due to industrial melanism in England.

Before industrialization (1850s), it was observed that there were more white winged moths (*Biston betularia*) on trees than dark winged or melanised moths (*Biston carbonaria*). The reason behind this was more white coloured lichens that covered the trees. Hence, white winged moths were able to camouflage themselves and survived. But the dark coloured moths were picked out by predators.

However, after industrialization (1920), there were more dark winged moths and less white winged moths. This was because; the tree trunks became dark due to industrial smoke and soot. Under this condition the white winged moth did not survive as the predators could identify them easily. However, dark winged moth survived because of suitable dark background.

Therefore, before the industrial revolution, white moths have advantageous features and got selected by nature but post industrial revolution, the melanised moths were better adapted to their environment and hence survived more.

25. 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 pollinate the stigma of a bisexual flower by a plant breeder. [3]

**Ans.** Artificial hybridization is one of the major approaches of crop improvement programme to improve crop yield. In this method, desired pollen grains are used for pollination. This is achieved by emasculation and bagging techniques.

(a) **Emasculation:** Emasculation is the process of removal of anthers (using forceps) from the bisexual flower bud without affecting the female reproductive part i.e. pistil.

(b) **Bagging:** Emasculated flowers are then covered with a suitable bag (made up of butter paper) to prevent contamination of its stigma with unwanted pollen. This is called bagging.

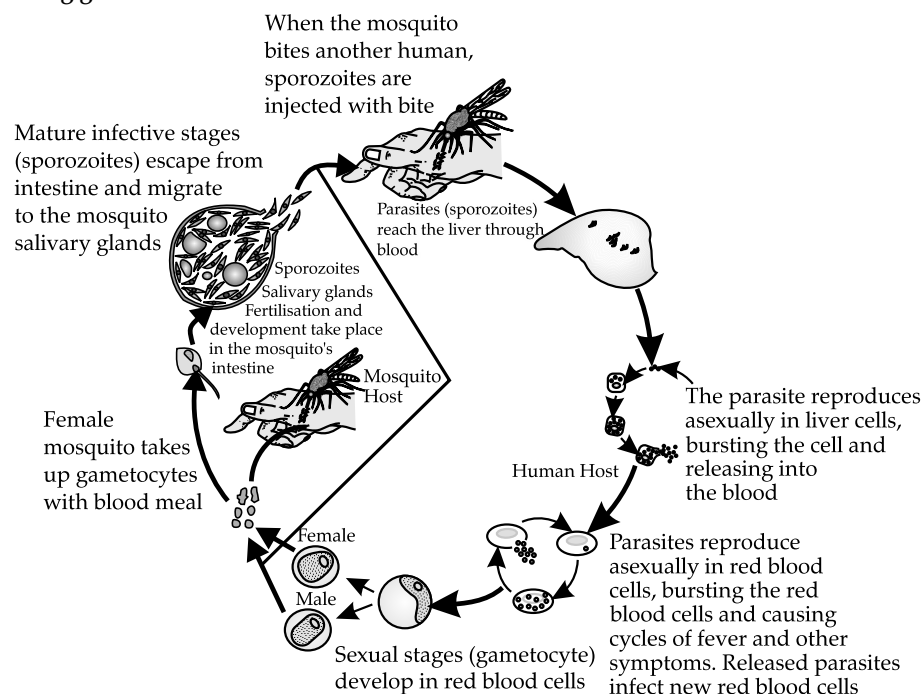
When the stigma of the bagged flower attains receptivity, mature pollen grains collected from anthers of the male parent are dusted on the stigma. Then the flowers are rebagged and allowed to develop the fruits.

26. (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.

- Ans.** (a) (i) The malarial parasite, *Plasmodium*, requires two hosts – Human and Anopheles, to complete their life cycle.
- (ii) Life cycle of plasmodium starts with inoculation of sporozoites (infective stage) through the bite of infected female *Anopheles* mosquitoes.
- (iii) The parasite initially multiplied within the liver cells and then attack the red blood cells (RBCs) resulting in their rupture.
- (iv) There is release of a toxic substance called hemozoin from the ruptured RBCs which responsible for the chill and high fever.
- (v) From the infected human the parasite enters into the body of *Anopheles* mosquito during biting and sucking blood.
- (vi) Further development takes place in the body of *Anopheles* mosquitoes.
- (vii) The female mosquito takes up gametocytes with the blood meal.
- (viii) Formation of gametes and fertilization takes place in the intestine of mosquito.
- (ix) The zygote develops further and forms thousands of sporozoites which migrated into the salivary gland of mosquito.
- (x) When the mosquito bites another human, sporozoites are injected.



#### Life Cycle of Plasmodium

OR

(b) Health is a state of complete physical, mental and social well-being. It increases the productivity and ensures longevity. One can achieve the good health through following ways:

(i) Balanced diet

- (ii) Personal hygiene
- (iii) Exercise
- (iv) Awareness about prevention and control of diseases
- (v) Proper waste disposal and control of vectors
- (vi) Vaccination

27. On spraying *Bacillus thuringiensis* on an infected cotton crop field the pests are killed by the toxin, however the toxin although produced by the bacteria does not affect it. Explain giving reason.

[3]

Ans. *Bacillus thuringiensis* forms protein crystals during a particular phase of their growth. These crystals contain a toxic **insecticidal protein**.

These proteins are present in inactive *protoxin* form, but become active toxin in the alkaline pH of insect gut.

The activated toxin binds to the surface of midgut epithelial cells and creates pores that cause cell swelling and lysis and eventually cause death of the insect. Hence, BT toxin does not kill the bacterium that produces it, but kills the insect that ingests it.

28. "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.

Ans. (a) The broad utilitarian argument says that biodiversity plays an important role in maintaining and sustaining supply of goods and services. It means biodiversity has many ecosystem services. *e.g.,*

(i) Amazon forest ('lung of the planet') produces 20% of total oxygen in the earth's atmosphere.

(ii) Pollination through bees, bumblebees, birds and bats.

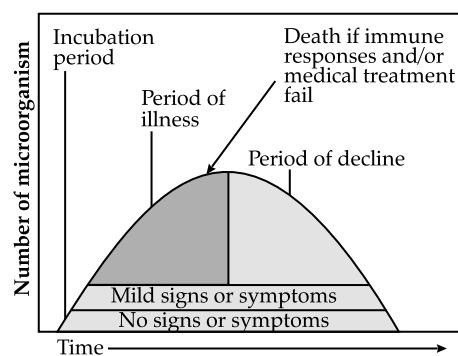
(iii) Aesthetic pleasures. (Any two)

(b) The ethical argument for conserving biodiversity states that there are thousands of plants, animals and microbes on this earth which are not useless. Each one has some intrinsic value even if it is not of any economic value to us. It is therefore our moral duty to ensure well-being of all the living creatures' for the utilization.

### SECTION - D

Q. Nos, 29 and 30 are case based questions. Each question has sub parts with internal choice in one subpart.

29. When a microorganism invades a host, a definite sequence of events usually occur leading to infection and disease, causing suffering to the host. This process is called **pathogenesis**. Once a microorganism overcomes the defence 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: [4]



(a) In which period, according to the graph there are maximum chances of a person transmitting a disease/infection and why?

(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.

(c) Draw a schematic labelled diagram of an antibody.

(d) In which period, the number of immune cells forming antibodies will be the highest in a person suffering from pneumonia? Name the immune cells that produce antibodies.

Ans. (a) There are maximum chances of a person transmitting a disease/infection during period of illness because the number of micro-organisms in the body is very high at that time.

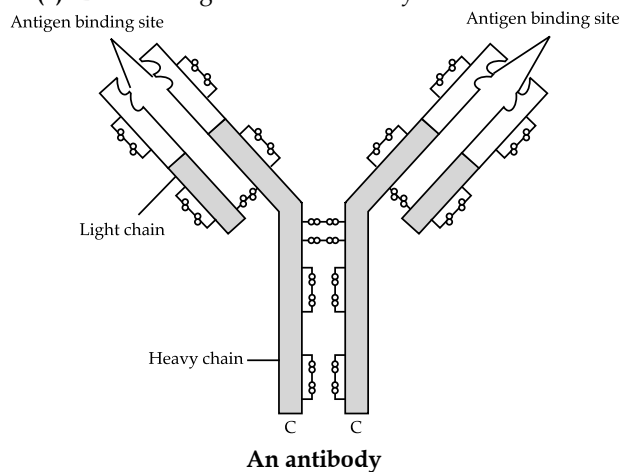
(b) Incubation period refers to the period between exposure to an infection and the appearance of the first symptoms.

AIDS is the sexually transmitted disease that can be easily transmitted during this period.

T helper cells are specific type of lymphocytes that are attacked by the pathogen of this disease.

OR

(c) Labeled diagram of an antibody:



An antibody

(d) During 'Period of decline', the infected person will have maximum number of cells producing antibodies

Immune cell that produce antibodies is B lymphocytes.

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 neg 44 + XX' Thus the human male is heterogametic, other words produces two different types of gametes one with 22 + X' chromosomes and the other with 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. [4]

- (a) State what is aneuploidy?  
 (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.  
 (c) A normal human sperm (22 + Y) fertilizes an ovum with karyotype 22 + XX' Name the disorder the offspring thus produced would suffer from and write any two symptoms of the disorder.

OR

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

- Ans. (a) Aneuploidy is a type of chromosomal aberration, where there is one extra chromosome or one missing chromosome.  
 (b) Due to non-disjunction of chromatids during spermatogenesis, some sperms will carry both sex chromosomes and some sperms will not carry any sex chromosome.  
 (c) If a normal human sperm (22 + Y) fertilizes an ovum with karyotype 22 + XX, the zygote will have the karyotype 44 + XXY. This is trisomy of X-chromosome. It results in the disorder called Klinefelter syndrome.

**Features of affected individual:** Overall masculine development, however, the feminine development is also expressed. e.g.,

- (i) Development of breast (Gynaecomastia).  
 (ii) Sterile.  
 (iii) Mentally retarded. (Any two)

OR

Down's syndrome is the best known and most common autosomal aneuploid abnormality.

**Features of affected individual:**

- (i) They are short statured with small round head.  
 (ii) Broad flat face.

- (iii) Furrowed big tongue and partially open mouth.  
 (iv) Many "loops" on finger tips.  
 (v) Palm is broad with characteristic palm crease.  
 (vi) Retarded physical, psychomotor and mental development.  
 (vii) Congenital heart disease. (Any two)

### SECTION - E

31. (a) (i) Explain the monosporic development of embryo sac in the ovule of an angiosperm.  
 (ii) Draw a diagram of the mature embryo sac of an angiospermic ovule and label any four parts in it. [5]

OR

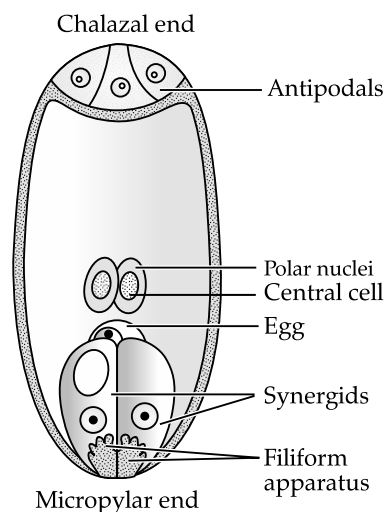
- (b) (i) Explain the formation of placenta after the implantation in a human female.  
 (ii) Draw a diagram showing human foetus within the uterus and label any four parts in it.

- Ans. (a) (i) In a majority of flowering plants, only one megaspore is functional while the other three degenerate. The single functional megaspore develops into the female gametophyte. This method of embryo sac formation from a single megaspore is termed monosporic development.

Formation of the embryo sac:

- The female gametophyte develops from a single functional megaspore. This megaspore undergoes three successive mitotic divisions to form 8-nucleated embryo sac.
  - The first mitotic division in the nucleus of the functional megaspore forms two nuclei. One nucleus move towards the micropylar end, while the other nucleus move towards the chalazal end. This result into 2-nucleate embryo sac.
  - Two more sequential mitotic nuclear divisions at their respective ends i.e. at the micropylar and chalazal end of the embryo sac result in the formation of the 4-nucleate and later the 8-nucleate stages of the embryo sac.
  - These divisions are strictly free nuclear, i.e. nuclear divisions are not followed immediately by cell wall formation.
  - After the 8-nucleate stage, cell walls are laid down leading to the organization of the typical female gametophyte or embryo sac.
  - Six of the 8 nuclei get surrounded by the cell wall and remaining two nuclei called polar nuclei are situated below the egg apparatus in the large central cell.
- (ii) A diagrammatic representation of the mature embryo sac is:





Mature embryo sac

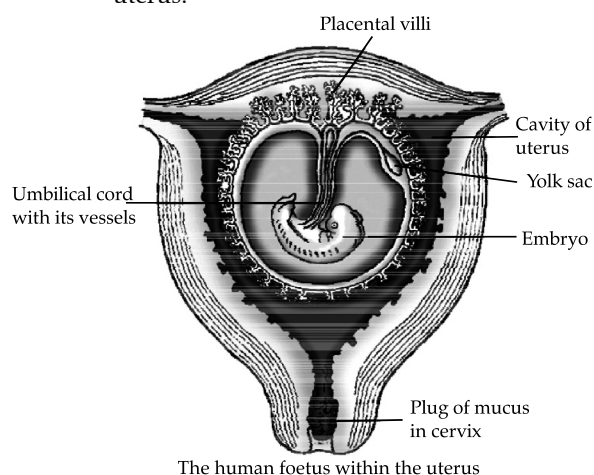
(Any four labels)

OR

- (b) (i) **Placenta formation:** After implantation, the trophoblast forms finger-like projections called chorionic villi, surrounded by the uterine tissue and maternal blood.

The chorionic villi and uterine tissue gets interdigitated with each other to form a structural and functional unit between embryo (foetus) and the maternal body called placenta. Placenta is connected to the embryo by an umbilical cord. It transports substances to and from the embryo.

- (ii) Diagram showing human foetus within the uterus:



The human foetus within the uterus

(Any four labels)

32. (a) Name and describe the steps involved in the technique widely used in forensics that serves as the basis of paternity testing in case of disputes.
- (b) It is sometimes observed that the  $F_1$  progeny has a phenotype that does not resemble either of the two parents and has intermediate phenotype. Explain by taking a suitable example and working out the cross upto  $F_2$  progeny. [5]

**Ans. (a)** DNA fingerprinting is the technique widely used in forensics that serves as the basis of paternity testing in case of disputes. It involves identifying differences in some specific regions in DNA called **repetitive DNA** variable number tandem repeats (VNTR)), because in these sequences, a small stretch of DNA is repeated many times.

**Steps of DNA fingerprinting are:**

- (i) Isolation of DNA from the cells of child, father, and mother involved in paternity disputes.
  - (ii) Make copies (amplification) of DNA by polymerase chain reaction (PCR).
  - (iii) Digestion of DNA by restriction endonucleases.
  - (iv) Separation of DNA fragments by gel electrophoresis.
  - (v) Transferring (blotting) of separated DNA fragments to synthetic membranes, such as nitrocellulose or nylon and then baked in a vacuum oven at  $80^\circ\text{C}$  for 3-5 hours (to fix the DNA fragment on the membrane).
  - (vi) Double stranded DNA made single stranded.
  - (vii) Hybridization using labeled VNTR probe.
  - (viii) Detection of hybridized DNA fragments by autoradiography. After hybridization with VNTR probe the autoradiogram gives many bands of different sizes. These bands give a characteristic pattern for an individual DNA.
- (b) The phenomenon involved in this  $F_1$  progeny is incomplete dominance. For e.g. Flower colour in snapdragon (dog flower or *Antirrhinum sp.*) and *Mirabilis jalapa* (4'O clock plant).

A monohybrid cross between the plants having red flowers and white flowers in *Antirrhinum* species will result in all pink colour flowers in the  $F_1$  generation.

The progeny obtained in  $F_1$  generation does not resemble either of the parents and exhibit intermediate characteristics. This is because, the dominant allele R, is partially dominant over the other allele, r.

Therefore, the recessive allele, r, also gets expressed in the  $F_1$  generation resulting, in the production of intermediate pink flowering progenies with Rr genotypes.

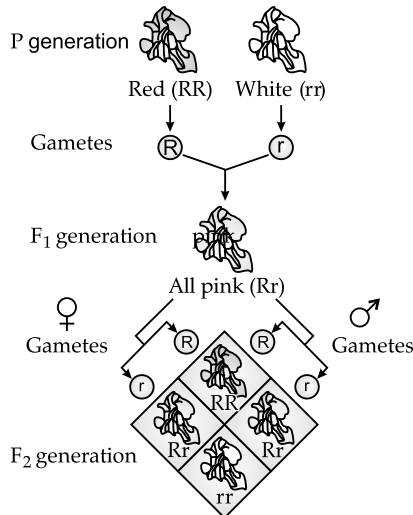
When the  $F_1$  individuals were self pollinated, the  $F_2$  resulted in the following ratio as 1 (RR) Red: 2 (Rr) Pink : 1 (rr) White.

Here, phenotypic and genotypic ratios are same.

Phenotypic ratio = 1 Red : 2 Pink : 1 White

Genotypic ratio = 1 (RR) : 2 (Rr) : 1 (rr)

This means that **R** was not completely dominant over **r**.



Phenotypic ratio : red : pink : white  
1 : 2 : 1

Genotypic ratio : RR : Rr : rr  
1 : 2 : 1

33. (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.

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

- List the operational guidelines that must be adhered to so as to achieve optimisation of the bioreactor system. Enlist any four.
- Mention the phase of the growth we refer to in the statement "Optimisation of growth and metabolic activity of the cells".
- Is the biological product formed in the bioreactor suitable for the intended use immediate? Give reason in support of your answer. [5]

OR

- (b) (i) 'EcoRI' has played very significant role in r-DNA technology.  
(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. [5]

Ans. (a) (i) The operational guidelines to be adhered to as to achieve maximum optimization of the bioreactor system are :

- Sterile fermentations
- Surface treatment and cleanliness.
- Temperature and pH control
- Oxygen availability throughout the bioreactor.

- (ii) "Optimisation of growth and metabolic activity of the cells" refers to the log or exponential phase.

- (iii) After completion of the biosynthetic stage in the bioreactor, the product is subjected to various processes in order to separate and purify the product before it is ready for marketing as a finished product. The product is formulated with suitable preservatives and is passed through various clinical trials for quality control and other tests.

OR

- (b) (i) (I) EcoRI comes from *Escherichia coli* RY 13

- E *Escherichia* (Genus)
- co *coli* (Species)
- R RY13 (Strain)
- I First identified order (Id) in Bacteria

(II) Recognition and cleavage site of EcoRI is:

5' GAATTC... 3'  
3' CTATTC... 5'

- (ii) Restriction enzymes cut the strand a little away from the centre of the palindrome sites, but between the same two bases on the opposite strands. This leaves single stranded overhanging stretches at the ends. They are called sticky ends. This stickiness facilitates action of the enzyme **DNA ligase**.

When foreign DNA and the host DNA are cut by the same restriction enzyme, the resultant DNA fragments have the same kind of sticky-ends and these are joined together by DNA ligases.

## Delhi Set-II

57/5/2

Note: Except these, all other questions are from Delhi/Outside Delhi Set-I.

### SECTION - A

1. Interferons are proteins. In humans they are secreted by: [1]

- (a) Thymus gland      (b) B-lymphocytes  
(c) Viral infected cells      (d) Tonsils

Ans. Option (c) is correct.

Explanation: Viral infected cells secrete proteins called interferon. Interferon protects non-infected cells from further viral infection.

5. Given below are four aspects of Reproductive Health in Column A and related information in Column B: [1]

Column A		Column B	
S. No.	Names of ART	S. No.	Significant information
(A)	MTP	(i)	Analysing fetal cells from amniotic fluid of the foetus.
(B)	Amniocentesis	(ii)	Legalised in 1971.
(C)	Saheli	(iii)	Programme initiated in 1951
(D)	Family Planning	(iv)	Non-steroidal oral contraceptive

Select the correct match from the following options:

- (a) (A)-(iv), (B)-(ii), (C)-(iii), (D)-(i)      (b) (A)-(ii), (B)-(i), (C)-(iv), (D)-(iii)  
 (c) (A)-(i), (B)-(iii), (C)-(ii), (D)-(iv)      (d) (A)-(ii), (B)-(v), (C)-(iii), (D)-(iv)

Ans. Option (b) is correct.

**Explanation:** The Government of India legalized MTP (Medical Termination of Pregnancy) in 1971.

In amniocentesis, some of the amniotic fluid of the developing foetus is taken to analyse the fetal cells for the presence of certain genetic disorders.

Saheli is the non-steroidal contraceptives for the females.

India introduced a number of programmes to ensure reproductive health to all in 1951. e.g., reproductive health programmes and family planning.

8. Interaction between clown fish living among the stinging tentacles of sea anemone is an example of- [1]

- (a) Amensalism      (b) Parasitism  
 (c) Mutualism      (d) Commensalism

Ans. Option (d) is correct.

**Explanation:** The interaction between clown fish living among the stinging tentacles of *sea anemone* is an example of commensalism. This is the interaction in which one species and the other is neither benefited nor harmed. The fish gets protection from predators with the help of stinging tentacles of *sea anemone*. The anemone has no any benefit.

10. Which one of the following groups faces maximum threat of extinction ? [1]

- (a) Gymnosperms      (b) Birds  
 (c) Amphibian      (d) Mammals

Ans. Option (c) is correct.

**Explanation:** Amphibians appear to be more vulnerable to extinction. Presently, 12% of all bird species, 23% of all mammal species, 32 % of all amphibian species and 31% of all gymnosperms species in the world face the threat of extinction.

### SECTION - B

17. (a) State the principle involved in separation of DNA fragments using gel electrophoresis. [2]

(b) How are DNA fragments visualized once they are separated by gel electrophoresis ?

Ans. (a) Gel electrophoresis is a technique of separating mixtures of large molecules (such as DNA fragments or proteins) on the basis of molecular size and charge. Since, DNA fragments are negatively charged; they can be separated by forcing them to move towards the anode under an electric field through a medium/matrix. Most commonly used matrix is agarose. Agarose is a natural polymer

extracted from sea weeds. The DNA fragments separate (resolve) according to their size through sieving effect provided by the agarose gel. Hence, the smaller sized fragment move farther.

(b) Ethidium bromide is used as stain for DNA, which on exposure to UV-light appear as orange coloured bands.

18. (a) (i) Give an example of a genus of fungi that forms mycorrhizal association with plants. [2]  
 (ii) How does the plant derive benefits from this association?

OR

(b) Name any two techniques used to detect the cancer of internal organs and write about any one of them.

Ans. (a) (i) *Glomus*

(ii) Benefits of mycorrhiza to plants are:

- (a) Mycorrhiza fungi allow plants to draw more nutrients and water from the soil.  
 (b) They also increase plant tolerance to different environmental stresses.  
 (c) Mycorrhizal plants are more resistant to disease and drought. (Any two)

OR

(b) Techniques to detect the cancer of internal organs are:

- (i) Radiography (use of X-rays)  
 (ii) CT (Computerized tomography) scan  
 (iii) MRI (Magnetic Resonance Imaging).

(Any two)

**Explanation:**

- (i) Radiography is a diagnostic imaging technique that uses radiation to produce images of internal organs.  
 (ii) Computed tomography uses X-rays to generate a three dimensional image of the internals of an object.

- (iii) MRI uses strong magnetic fields and ionizing radiations to accurately detect pathological and physiological changes in the living tissue.

(Explanation of any one) 1

20. Abingdon tortoise in Galapagos islands became extinct within a decade on introduction of goats in the island. "Explain giving reason. [2]

**Ans.** The Abingdon tortoise in Galapagos Islands became extinct within a decade after goats were introduced on the island, due to greater browsing efficiency of the goats.

This happened due to interference competition, where the feeding efficiency of one species gets reduced due to the interfering and inhibitory presence of the other species, even if resources are abundant.

### SECTION - C

22. Explain how did the experiment conducted by S.L. Miller substantiate that life evolved from pre-existing non-living organism molecules. [3]

**Ans.** S.L. Miller conducted an experiment to prove theory of chemical evolution.

- (a) He created a condition similar to that of primitive earth (i.e., high temperature, volcanic storms, reducing atmosphere containing CH<sub>4</sub>, NH<sub>3</sub>, H<sub>2</sub>O and H<sub>2</sub> etc.)
- (b) He operated electric discharge in a closed flask containing CH<sub>4</sub>, NH<sub>3</sub>, H<sub>2</sub> and water vapours at 800 °C.
- (c) As a result, some amino acids are formed.
- (d) In similar experiment, other observed compounds were sugars, nitrogen gas, pigments and fats.

27. Eli Lilly's contribution for diabetic patients through r-DNA technology has been overwhelmingly accepted. Explain how? [3]

**Ans.** Insulin used for diabetes was earlier extracted from pancreas of slaughtered cattle and pigs. This insulin from an animal source though caused some patients to develop allergy or other type of reactions to the foreign protein. Eli Lilly, an American company prepared human insulin using rDNA technology, which didn't cause any immune response in the patients and hence, their contribution was widely accepted. They prepared two DNA sequences corresponding to A and B chains of human insulin and introduced them in plasmids of *E. coli* to produce insulin chains. Chains A and B were produced separately, extracted and combined by creating disulphide bonds to form human insulin.

### SECTION - E

32. (a) "It is sometimes observed that the F<sub>1</sub> progeny shows a phenotype that resembles both the parents." Explain this type of inheritance using the example of A, B, O blood groups in human.

OR

- (b) (i) Explain the process of amino-acylation of tRNA and its role in the process of translation.
- (ii) How does initiation of the translation process occur in prokaryotes? Explain. [5]
- (iii) Where are the untranslated regions located on m-RNA and why?

**Ans.** (a) When two alleles of a gene are equally dominant and express themselves even when they are together, are known as co-dominance. e.g., ABO blood grouping in human.

ABO blood groups are controlled by the gene I. The plasma membrane of the RBC has sugar polymers that protrude from its surface and is controlled by the gene. The gene (I) has three alleles I<sup>A</sup>, I<sup>B</sup> and i. The alleles I<sup>A</sup> and I<sup>B</sup> produce a slightly different form of the sugar while allele i doesn't produce any sugar. Each person possesses any two of the three I gene alleles. I<sup>A</sup> and I<sup>B</sup> are completely dominant over i, but when I<sup>A</sup> and I<sup>B</sup> are present together they both express their own types of sugars, i.e. they are co-dominant. Hence, red blood cells have both A and B type sugars.

Alleles from parent I	Alleles from parent II	Genotype of offspring	Blood types (Phenotypes)
I <sup>A</sup>	I <sup>A</sup>	I <sup>A</sup> I <sup>A</sup>	A
I <sup>A</sup>	I <sup>B</sup>	I <sup>A</sup> I <sup>B</sup>	AB
I <sup>A</sup>	i	I <sup>A</sup> i	A
I <sup>B</sup>	I <sup>A</sup>	I <sup>A</sup> I <sup>B</sup>	AB
I <sup>B</sup>	I <sup>B</sup>	I <sup>B</sup> I <sup>B</sup>	B
I <sup>B</sup>	i	I <sup>B</sup> i	B
i	i	ii	O

OR

- (b) (i) Charging of tRNA (Aminoacylation of tRNA): Here, amino acids are activated (amino acid + ATP) and linked to their cognate tRNA in the presence of aminoacyl tRNA *synthetase*. This process is commonly known as charging of tRNA or aminoacylation of tRNA. If two such charged tRNAs are brought close enough, the formation of peptide bonds between them would be favoured energetically. This is an essential step as only activated amino acids are carried to the site of protein synthesis by their respective tRNA.
- (ii) Translation is initiated by formation of an initiation complex consisting of 30S ribosomal subunit, formyl-methionyl (fMet) tRNA, and mRNA.

It begins at the 5'-end of mRNA in the presence of an initiation factor.

The mRNA binds to the small subunit of ribosome. AUG is recognized by the initiator tRNA. Initiation codon for methionine is AUG. So methionyl tRNA complex would have UAC at the Anticodon site. Now the large subunit (50S) binds to the small subunit to complete the initiation complex. Large subunit (70S) has two binding sites to which tRNA-carrying amino acids can bind. One is called aminoacyl

tRNA binding site (A site) and the other is called peptidyl site (P site). There is also a third site called the exit or E site where tRNAs are released.

- (iii) An mRNA has additional sequences that are not translated (untranslated regions or UTR). UTRs are present at both 5'-end (before start codon) and 3'-end (after stop codon). They are required for efficient translation process.

**Delhi Set-III**

57/5/3

**Note:** Except these, all other questions are from Delhi/Outside Delhi Set-I & II.

**SECTION - A**

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

- (a) Commensalism (b) Parasitism  
(c) Amensalism (d) Mutualism

**Ans. Option (b) is correct.**

**Explanation:** Many marine fish are infested with ectoparasitic copepods. Hence, the relationship is an example of parasitism.

6. Given below are structural details of a human mammary gland: [1]

- (i) The glandular tissue in the breast has 15-20 clusters of cells called alveoli.  
(ii) The milk is stored in the lumen of alveoli.  
(iii) The alveoli join to form the mammary ducts.  
(iv) Mammary ampulla is connected to lactiferous ducts.

Choose the option that gives the correct detail of human mammary gland.

- (a) (i) and (ii) (b) (ii) and (iii)  
(c) (ii) and (iv) (d) (i) and (iii)

**Ans. Option (c) is correct.**

**Explanation:** Glandular tissue of each breast contains 15-20 mammary lobes with alveoli. The cells of alveoli secrete milk, which is stored in the cavities (lumen) of alveoli. The alveoli open into mammary tubules. The tubules of each lobe join to form a mammary duct, which unite to form a wider mammary ampulla which is connected to lactiferous duct through which milk is sucked out.

8. Tetanus antitoxin (Tetanus toxoid) when injected into the human body it immediately provides: [1]

- (a) Innate immunity (b) Passive immunity  
(c) Auto immunity (d) Active immunity

**Ans. Option (b) is correct.**

**Explanation:** Tetanus antitoxin when injected into the human body it immediately provides passive immunity. Passive immunization is the direct injection of pre-formed antibodies or antitoxin when quick immune response is required.

**SECTION - B**

17. (a) Name (i) a GM cereal crop having enhanced nutritional value, (ii) the nutrient it is rich in. [2]

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

**Ans. (a) (i) Golden rice**

**(ii) Vitamin A**

- (b) Advantages of genetically modified crops are:

(i) It makes crops more tolerant to abiotic stresses like cold, drought, salt, heat, etc.

(ii) Most of the GM plants have been developed for pest-resistance, which increases the crop productivity and therefore, reduces the reliance on chemical pesticides.

(iii) It helps to reduce post harvesting loss of crops.

(iv) It increases efficiency of mineral usage by plants. This prevents early exhaustion of fertility of soil. **(Any two)**

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 way of treatment of cancer. The therapy involved activates the immune system and destroys the tumour.

(i) Write an example of one such biological response modifier used in immunotherapy.

(ii) Why do patients need such substances if immune system is already working in body?

(iii) State what is 'Contact inhibition'?

**Ans. (a) Bacterium : *Bacillus thuringiensis***

**Mode of action :** Bt spores, which contain cry protoxin are mixed with water and sprayed onto vulnerable plants such as *Brassica* and fruit trees, where these are eaten by the insect larvae. In the gut of the larvae, the toxin is released because the gut of larvae is alkaline that activates cry protoxin. This toxin lyses the lining of midgut and the larvae get killed. The bacterial disease will kill the caterpillars, but leave the other insects unharmed.

OR

- (b) (i) Biological response modifier  $\alpha$ -interferon activates the immune system and helps in destroying the tumor. It is used in immunotherapy.
- (ii) Tumor cells have been shown to avoid detection and destruction by the already working immune system of the body. Therefore, the patients are given substances called biological response modifiers.
- (iii) Normal cells show a property called contact inhibition by virtue of which contact with other cells inhibits their uncontrolled growth. Cancer cells appear to have lost this property. As a result, cancerous cells just continue to divide giving rise to masses of cells called tumors.

21. "Some species of insects and frogs have evolved with various specific features that help them from being detected." [2]

- (a) Justify the statement giving reasons.  
 (b) Mention any two such features.

- Ans. (a) Some species of insects and frogs avoid being detected easily by the predators by camouflage in which they get blended with their surroundings. 1
- (b) (i) Some species of insects and frogs are cryptically-coloured.  
 (ii) Some species are poisonous and therefore avoided by the predator.

## SECTION - C

27. Mention Darwin's observations made on finches during his visit to Galapagos Islands. Write the explanation given by Darwin on his observations. [2]

- Ans. A large variety of finches is present in Galapagos island that arose from a single species, which reached this island accidentally. As a result, many new species have evolved, diverged, and adapted to occupy new habitats. These finches have developed different eating habits and different types of beaks to suit their feeding habits. The insectivorous, blood sucking, and other species of finches with varied dietary habits have evolved from a single seed eating finch ancestor.

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.

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]

Ans. The process of RNA interference has been used to make tobacco plant resistant to *Meloidogyne incognita*, which infect the roots of tobacco plant and reduce the yield.

RNA interference (RNAi) Mechanism is as follows:

- (a) A small fragment of double stranded RNA is introduced in the cell of tobacco plant  
 (b) This double stranded RNA is converted into single stranded RNA after denaturation processing.  
 (c) This RNA then binds with the targeted m-RNA at the Complementary regions.  
 (d) The m-RNA degrades as it can not be processed by ribosomes. Therefore, translation of targeted m-RNA do not take place.

**RNAi Mechanism in tobacco Root:**

- (a) Parasite *Meloidogyne incognita*, attack the root cell of the plant which forms large knots/galls which damage the crop.  
 (b) Gem from *M. incognita* cloned by Ti plasmid and introduced in the tobacco plant by using *Agrobacterium* vector.  
 (c) It is done in such a way that both Antisense RNA and sense RNA get expressed because they are complimentary to each other.  
 (d) It then forms double stranded RNA. This RNA is used up by Nematode when it feeds upon the host plant.  
 (e) Then, RNAi gene gets activated, which is essential for development. They are silenced now and Nematodes would not be able to grow in host plant.

## SECTION - E

Ans. (a) (i) Charging of tRNA (Aminoacylation of tRNA): Here, amino acids are activated (amino acid + ATP) and linked to their cognate tRNA in the presence of aminoacyl tRNA synthetase. This process is commonly known as charging of tRNA or aminoacylation of tRNA. If two such charged tRNAs are brought close enough, the formation of peptide bonds between them would be favoured energetically. This is an essential step as only activated amino acids are carried to the site of protein synthesis by their respective tRNA.

(ii) In bacteria, the ribosome acts as a catalyst (23S rRNA) for the formation of peptide bonds.

(iii) Translation is initiated by formation of an initiation complex consisting of 30S ribosomal subunit, formyl-methionyl (fMet) tRNA, and mRNA. It begins at the 5'-end of mRNA in the presence of an *initiation factor*.

The mRNA binds to the small subunit of ribosome. AUG is recognized by the initiator tRNA.

Initiation codon for methionine is AUG. So methionyl tRNA complex would have UAC at the Anticodon site.

Now, the large subunit (50S) binds to the small subunit to complete the initiation complex.

Large subunit (70S) has two binding sites to which tRNA-carrying amino acids can bind. One is called aminoacyl tRNA binding site (A site) and the other is called peptidyl site (P-site).

**OR**

- (b) Dihybrid cross is a cross between two parents, which differs in two pairs of contrasting characters. In a Dihybrid cross between pea plants having round and yellow coloured seeds (RRYY) and wrinkled and green coloured seeds (rryy), Mendel obtained only round-yellow seeds in the F<sub>1</sub> generation. This indicated that round shape and yellow colour of seeds are dominant in nature while the wrinkled shape and green colour are recessive. Then F<sub>1</sub> progeny was self-pollinated. This resulted in four different combinations of seeds in F<sub>2</sub> generation. They were round-yellow, round-green, wrinkled-green and wrinkled-green seeds in the phenotypic ratio of 9:3:3:1.

