

# BIOLOGY

Maximum Marks : 70

Time : 3 Hours

**General Instructions :**

- (i) All questions are compulsory.
- (ii) The question paper has five sections and 33 questions.
- (iii) Section-A has 16 questions of 1 mark each; Section-B has 5 questions of 2 marks each; Section- C has 7 questions of 3 marks each; Section- D has 2 case-based questions of 4 marks each; and Section-E has 3 questions of 5 marks each.
- (iv) There is no overall choice. However, internal choices have been provided in some questions. A student has to attempt only one of the alternatives in such questions.
- (v) Wherever necessary, neat and properly labeled diagrams should be drawn.

**SECTION - A**

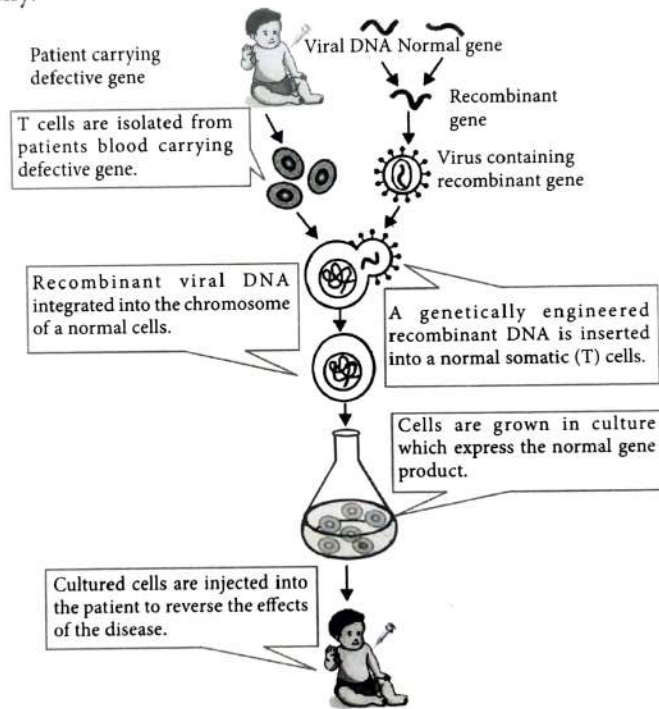
**Q. No. 1 to 12 are multiple choice questions. Only one of the choices is correct. Select and write the correct choice as well as the answer to these questions.**

1. Which of the following is the most widely accepted method of contraception in India at present?  
(a) Cervical caps      (b) Tubectomy      (c) Diaphragms      (d) Intra uterine devices
2. Match column I (terms) with column II (definitions) and select the correct option from the codes given below.

	Column I		Column II
A.	Parturition	(i)	Attachment of an embryo to endometrium
B.	Gestation	(ii)	Transfer of sperms into the female genital tract
C.	Insemination	(iii)	Delivery of baby from uterus
D.	Implantation	(iv)	Duration of pregnancy
E.	Fertilisation	(v)	Fusion of the egg and sperm
		(vi)	Stoppage of ovulation and menstruation

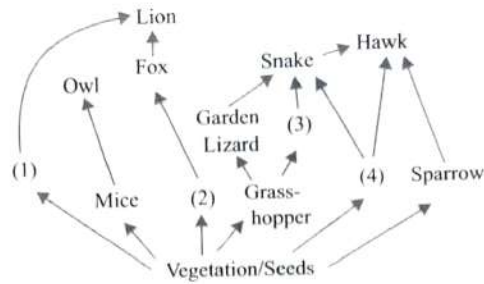
- (a) A-(ii), B-(iv), C-(i), D-(v), E-(vi)
- (b) A-(iv), B-(iii), C-(i), D-(v), E-(ii)
- (c) A-(v), B-(vi), C-(ii), D-(iii), E-(iv)
- (d) A-(iii), B-(iv), C-(ii), D-(i), E-(v)
3. Which one of the following codons codes for the same information as UGC?  
(a) UGU      (b) UGA      (c) UAG      (d) UGG
4. The Hardy-Weinberg principle cannot operate if  
(a) the population is very large  
(b) frequent mutations occur in the population  
(c) the population has no chance of interaction with other populations  
(d) free interbreeding occurs among all members of the population.

5. Identify the type of immunity obtained when an injection of antitoxin in tetanus is given?  
 (a) Active immunity (b) Humoral immunity  
 (c) Passive immunity (d) All of these
6. Select the correct option regarding a disease with its causal organism where haemozoin is released by the rupture of RBCs.  
 (a) Amoebiasis, *Plasmodium vivax* (b) Malaria, Rhinovirus  
 (c) Malaria, *Plasmodium falciparum* (d) Pneumonia, *Haemophilus influenzae*
7. BOD is (i) in polluted water and (ii) in potable water.  
 (i) (ii)  
 (a) more less  
 (b) less more  
 (c) less less  
 (d) medium less
8. Figure given below depicts the procedure for gene therapy. Pick up the disorder(s) for which this technique has been applied successfully.



- (a) Adenosine Deaminase (ADA) Deficiency  
 (b) AIDS  
 (c) Myasthenia gravis  
 (d) Both (a) and (c)
9. When an exotic species was introduced in an area, what may be the most probable effect?  
 A. The population of native species may decrease to very low level due to invasive alien species.  
 B. Introduced species may achieve highest population density due to lack of predation.  
 C. Species develop favourable mutations.  
 D. New species evolved due to different environment.  
 (a) A and B are correct. (b) A, C and D are correct.  
 (c) C and D are correct. (d) B, C and D are correct.
10. Tight one-to-one relationship between plant and pollinator is found in  
 (a) fig and wasp (b) fungus and roots of *Pinus*  
 (c) *Anabaena* and *Azolla* (d) all of these.

11. Given food web contains some missing organisms, (1), (2), (3) and (4). Identify these organisms and select the correct answer.



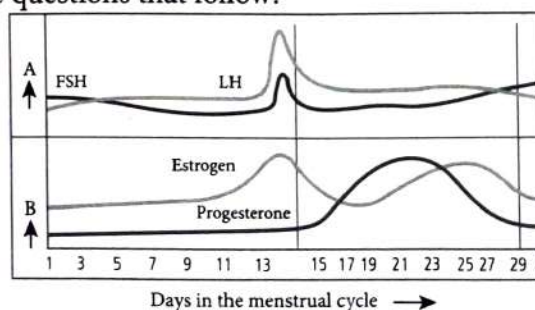
- |     | (1)      | (2)      | (3)      | (4)    |
|-----|----------|----------|----------|--------|
| (a) | Deer     | Rabbit   | Frog     | Rat    |
| (b) | Dog      | Squirrel | Bat      | Frog   |
| (c) | Rat      | Eagle    | Tortoise | Crow   |
| (d) | Squirrel | Cat      | Peacock  | Pigeon |
12. Which one of the following fish is being illegally introduced for aquaculture purposes and is posing a threat to the indigenous catfishes of Indian rivers?
- |                               |                        |
|-------------------------------|------------------------|
| (a) <i>Clarias gariepinus</i> | (b) Nile perch         |
| (c) <i>Clarias batrachus</i>  | (d) <i>Protopterus</i> |

Question No. 13 to 16 consist 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 and 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)** : After implantation, finger-like projections appear on the trophoblast called chorionic villi.  
**Reason (R)** : Chorionic villi are surrounded by the uterine tissue and maternal blood.
14. **Assertion (A)** : Mendel conducted artificial pollination experiments for his genetic studies using true-breeding pea lines.  
**Reason (R)** : A true-breeding line shows the stable trait inheritance and expression for several generations.
15. **Assertion (A)** : *Agrobacterium tumefaciens* is the causative agent of crown gall disease of dicots.  
**Reason (R)** : *Agrobacterium tumefaciens* transforms normal cell into tumour by inserting T-DNA.
16. **Assertion (A)** : Elimination of a competitively inferior species in a closely related or otherwise similar group is known as competitive exclusion principle.  
**Reason (R)** : If two species compete for the same resource, they could avoid competition by choosing different times for feeding or different foraging patterns.

## SECTION - B

17. In the figure given below, parts A and B show the level of hormones which influence the menstrual cycle. Study the figure and answer the questions that follow:



- (a) Name the organs which secrete the hormones represented in parts A and B.  
 (b) State the impact of the hormones in part B on the uterus of the human female during 6 to 15 days of menstrual cycle.

18. In *Pisum sativum*, the pod colour may be green (G) or yellow (g). What percentage of offsprings with green pod colour trait would be obtained in a cross of Gg × Gg?

OR

A true breeding pea plant, homozygous dominant for inflated green pods is crossed with another pea plant with constricted yellow pods (ffgg). With the help of Punnett square show the above cross and mention the results obtained phenotypically and genotypically in F<sub>1</sub> generation.

19. (a) What precaution(s) would you recommend to a patient requiring repeated blood transfusion?  
 (b) If the advise is not followed by the patient, there is an apprehension that the patient might contract a disease that would destroy the immune system of his/her body. Explain with the help of schematic diagram only how the immune system would get affected and destroyed.
20. What are recombinant proteins? How do bioreactors help in their production?

OR

Write the basis of naming the restriction endonuclease *EcoRI*.

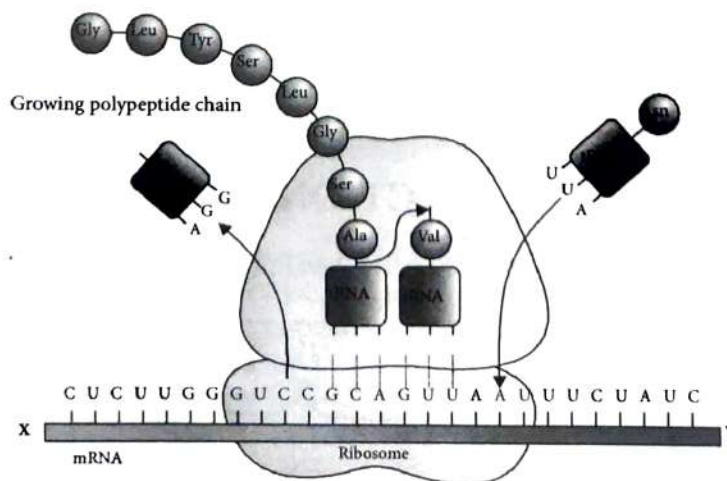
21. Construct a pyramid of biomass starting with phytoplanktons. Label 3 trophic levels. Is the pyramid upright or inverted. Give reason.

OR

Construct an ideal pyramid of energy when 1,00,000 joules of sunlight is available. Label all its trophic levels.

## SECTION - C

22. When does the corpus luteum degenerate? Explain the immediate consequences of its degeneration in human female.
23. Describe the development of endosperm in coconut.
24. (a) Identify the polarity of X to Y in the diagram below and mention how many more amino acids are expected to be added to this polypeptide chain.



- (b) Mention the codon and anticodon for alanine.  
 (c) Why are some untranslated sequences of bases seen in mRNA coding for a polypeptide? Where exactly are they present on mRNA?

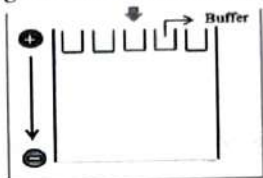
25. Explain convergent evolution taking one example for plants.

26. (a) The barriers in the innate immunity are given in the following table. Identify A, B, C, and D.

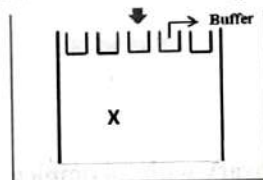
Type of barrier	Barrier
(i) A	Skin, Mucous membrane
(ii) Physiological	B, in the eye
(iii) Cytokine	C
(iv) Cellular	WBC, D

(b) Why sharing of injection needles between two individuals is not recommended?

27. Carefully observe the given picture. A mixture of DNA with fragments ranging from 200 base pairs to 2500 base pairs was electrophoresed on agarose gel with the following arrangement.



- (a) What result will be obtained on staining with ethidium bromide? Explain with reason.  
 (b) The above set-up was modified and a band with 250 base pairs was obtained at X.

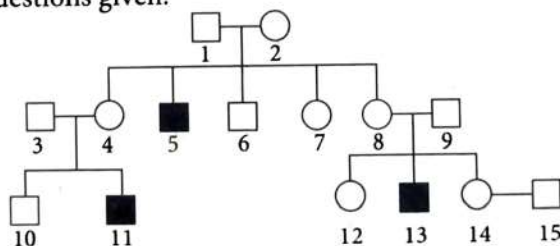


What change(s) were made to the previous design to obtain a band at X? Why did the band appear at the position X?

28. Explain, giving one example, how co-extinction is one of the causes of loss of biodiversity. List the three other causes also (without description).

### SECTION - D

29. The pedigree chart given below shows the inheritance of haemophilia in one family. Study the pattern of inheritance and answer the questions given:



(a) Is the trait recessive or dominant?

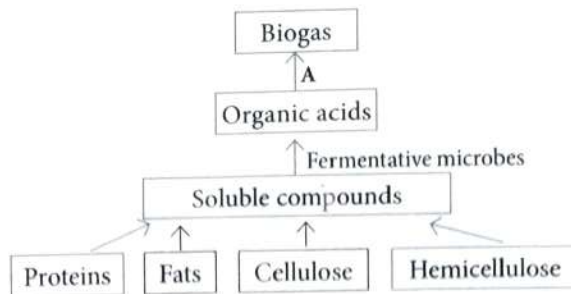
OR

(a) Is the trait sex-linked or autosomal?

(b) Give all the possible genotypes of the members 4, 5 and 6 in the pedigree chart.

(c) A blood test shows that the individual 14 is a carrier of haemophilia. The member numbered 15 has recently married the member numbered 14. What is the probability that their first child will be a haemophilic male?

30. Villagers in a place near Chambur started planning to make power supply for agricultural purposes from cow dung. They have started a biogas plant for the purpose. Study the given flow chart for biogas production and answer the following questions.



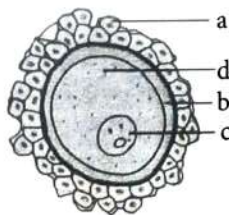
- Name the group of bacteria (A) responsible for biogas production.
- What is the composition of biogas?
- How is the bacteria responsible for biogas production useful to cattle?

**OR**

Why is biogas production more common in rural areas?

## SECTION - E

31. Given below is a diagrammatic representation of a human ovum.



- Identify the parts 'a', 'b' and 'c'.
- This ovum is released from the ovary with incomplete meiotic division. When, where and how is the meiotic division completed?
- How does an ovum ensure the entry of a single sperm during fertilisation?

**OR**

Angiosperm flowers may be monoecious, cleistogamous or show self-incompatibility. Describe the characteristic features of each one of them and state which one of these flowers promotes inbreeding and outbreeding.

32. (a) What is a genetic code?  
 (b) Explain the following :  
 (i) Degenerate codon; (ii) Unambiguous codon; (iii) Initiator codon.

**OR**

Name and describe the technique that will help in solving a case of paternity dispute over the custody of a child by two different families.

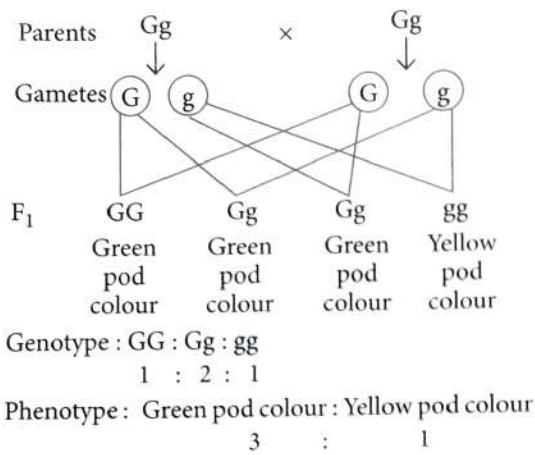
33. (a) A recombinant vector with a gene of interest inserted within the gene of  $\beta$ -galactosidase enzyme, is introduced into a bacterium. Explain the method that would help in selection of recombinant colonies from non-recombinant ones.  
 (b) Why is this method of selection referred to as "insertional inactivation"?

**OR**

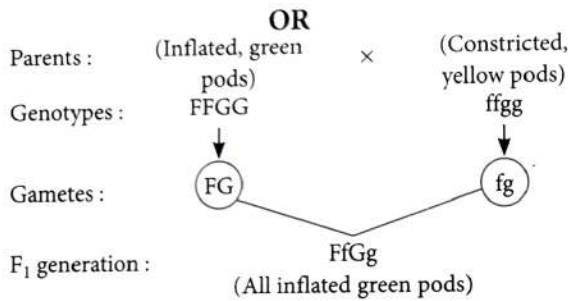
Rahul was having a debate with Rohan regarding the advantages and disadvantages of transgenic animals. Rahul viewed that the production of transgenic animals violates the integrity of species and animals suffer from cruelty so, it is unethical. On the other hand, Rohan emphasised the benefits that transgenic animals provide to the human race in various fields especially medicine.

- How do transgenic animals benefit humans?
- List the ethical issues related with the production of transgenic animals.

1. (d)
2. (d) : The reproductive events in humans include formation of gametes (gametogenesis), *i.e.*, sperms in males and ovum in females, transfer of sperms into the female genital tract (insemination) and fusion of male and female gametes (fertilisation) leading to formation of zygote. This is followed by formation and development of blastocyst and its attachment to the uterine wall (implantation), embryonic development (gestation) and delivery of the baby (parturition).
3. (a) : Both the codons UGC and UGU code for amino acid cystine. UAA, UGA and UAG are stop codons. UGG codes for amino acid tryptophan.
4. (b) : The Hardy-Weinberg principle says that allele frequencies in a population are stable and constant from generation to generation as long as:
  - the population is large enough and changes in allele frequencies due to chance or accident are insignificant.
  - mating occurs at random.
  - mutation does not occur or if it does occur it must reach a state of equilibrium.
  - all the members of the population survive and have equal reproductive rates.
5. (c) : If a person is infected with some deadly microbes, a quick immune response is required against microbes. This quick response can be initiated by directly injecting the preformed antibodies or antitoxin. This type of immunisation is called passive immunisation.
6. (c)                      7. (a)                      8. (a)
9. (a) : The population of native species may become very low due to introduction of invasive alien species. Increase in population of exotic species could be due to lack of predators.
10. (a) : In many species of fig trees, there is tight one-to-one relationship with pollinator species of wasp.
11. (a)
12. (a) : *Clarias gariepinus*, the African catfish has been illegally introduced for aquaculture in India. It is threatening native catfish (*Clarias batrachus*) of Indian rivers.
13. (b) : After implantation, finger-like projections appear on the trophoblast called chorionic villi which are surrounded by the uterine tissue and maternal blood. The chorionic villi and uterine tissue become interdigitated with each other and jointly form a structural and functional unit between developing embryo (fetus) and maternal body called placenta.
14. (a) : Mendel carried out hybridisation experiments on garden pea for many years. He performed various types of cross breeding and then allowed the offspring to self breed. All selected varieties used by him were pure lines of true breeding lines, *i.e.*, they produce offspring resembling the parents. These lines show the stable trait inheritance and expression for several generations making them suitable for genetic studies.
15. (a) : *Agrobacterium tumefaciens* is a rod shaped, Gram -ve soil bacterium which causes crown gall disease in over 140 species of dicots but it does not infect cereals. The bacterium contains tumour inducing plasmid (Ti plasmid) which integrates a segment of its DNA (T-DNA) into the DNA of its host plant thereby inducing formation of cancerous growth called crown gall tumour usually at graft or bud union, on roots and lower stem.
16. (b) : Gause's competitive exclusion principle states that two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior one is eliminated eventually. This may be true if resources are limiting, but not otherwise. Mechanism of Resource partitioning states that if two species compete for the same resource, they could avoid competition by choosing, for instance, different times for feeding or different foraging patterns.
17. (a) A - Pituitary gland; B - Ovary  
(b) During proliferative phase (days 6-15) of menstrual cycle, estrogen secretion increases and endometrium of the uterus regenerates.
18. In *Pisum sativum*, green pod colour is dominant over yellow. Thus, the cross between Gg × Gg will be:



Thus, 75% of offsprings produced are green pod colour.

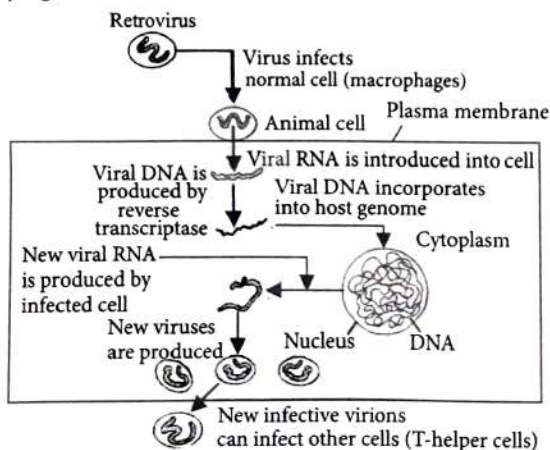


Phenotype in F<sub>1</sub> generation – All Inflated green pods  
Genotype in F<sub>1</sub> generation – FfGg

19. (a) If a patient requires repeated blood transfusion, it should be ensured that donor's blood has been screened for HIV and the syringes used should be new and disposable.

(b) If the patient does not follow these precautions, then he/she might get infected with HIV which causes AIDS (Acquired Immuno Deficiency Syndrome).

AIDS is a disorder of cell mediated immune system of the body. There is a reduction in the number of helper T-cells which stimulate antibody production by B-cells. This results in the loss of natural defence of the body against viral infection.



Thus, the immune system gets hampered due to the action of AIDS virus on T-lymphocytes and macrophages.

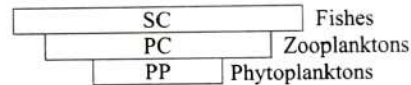
20. Recombinant protein is a protein obtained by introducing recombinant DNA into a heterologous host and causing it to produce the gene product. Bioreactors are vessels in which raw materials are biologically converted into specific products. A bioreactor provides the optimal conditions for achieving the desired product by providing optimum growth conditions (temperature, pH, substrate, salts, vitamins, oxygen). To maintain a higher yield, optimum temperature must be maintained and suitable pH must be provided.

OR

*EcoRI* is obtained from bacterium *Escherichia coli* RY13.

The capital letter *E* comes from genus *Escherichia*. The letters *co* from species *coli*. The letter *R* is from RY13 (strain). The roman number *I* indicates that it was the first enzyme isolated from bacterium *E. coli* RY13.

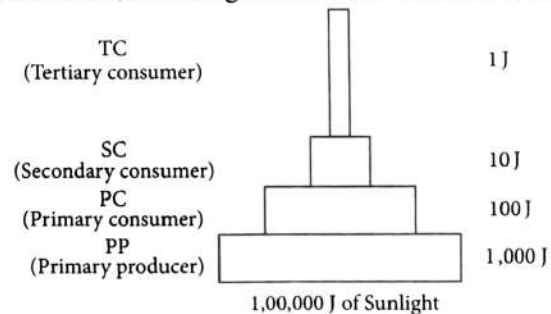
21. Pyramid of biomass starting with phytoplanktons will be for an aquatic ecosystem. It can be drawn as follows:



The pyramid of biomass in aquatic ecosystem is generally inverted because the biomass of fishes far exceeds that of phytoplanktons.

OR

An ideal pyramid of energy with primary producers when 100000 J of sunlight is available as shown below:



22. In the absence of fertilisation, the corpus luteum degenerates. Degeneration of the corpus luteum leads to decrease in the production of progesterone. As progesterone is needed for the maintenance of the endometrium, its reduction leads to disintegration of endometrium thus causing menstruation.

23. In *Cocos nucifera* (coconut), the coconut water represents free-nuclear endosperm and the surrounding kernel represents the cellular endosperm.



The primary endosperm nucleus (PEN) first undergoes a number of free nuclear divisions without wall formation to form a large number of free nuclei (free nuclear endosperm). When the fruit is about 50 mm long, the embryo sac gets filled with a clear fluid in which numerous nuclei of various sizes float. At a later stage (about 100 mm long fruit), the suspension shows, in addition to free nuclei, several cells each enclosing a variable number of nuclei. Gradually these cells and free nuclei start settling at the periphery of the cavity, and layers of cellular endosperm start appearing. This forms the coconut meat. The quantity of the cellular endosperm increases further by divisions of the cells.

24. (a) X to Y is  $5' \rightarrow 3'$

No more amino acids will be added after encountering any one of the stop codon i.e., UAA, UAG or UGA.

(b) Codon- GCA; Anticodon- CGU

(c) The untranslated regions are required for an efficient translation process. They are present before the initiation codon at the 5'-end and after the stop/termination codon, at the 3'-end.

25. Convergent evolution refers to the development of similar adaptive functional structures in unrelated group of organisms. It is also called adaptive convergence. *E.g.*, sweet potato (root modification) and potato (stem modification). Both look alike and perform the same function of food storage but are different in origin.

26. (a) A - Physical

B - Lysozyme

C - Interferon

D - Natural killer cells

(b) Sharing of injection needles between two individuals can transmit various diseases like AIDS and hepatitis B, as these diseases are transmitted *via* blood and semen.

27. (a) No bands will be obtained and all DNA will be seen in the well only, as DNA fragments being negatively charged will not move towards negative end/ cathode. DNA being negatively charged will remain stationed at the positive end/ anode end of the agar block.

(b) Position of the positive terminal/ anode end/ and the negative terminal/ cathode end was inter-changed. The fragment with least base pairs separated faster and moved faster towards the anode end.

28. Co-extinction means that when a species becomes extinct, the plant and animal species associated with it in an obligatory relation also become extinct. For

example, the case of a co-evolved plant-pollinator mutualism like in *Pronuba yuccasella* and *Yucca* where extinction of one invariably leads to the extinction of the other.

The three other causes of biodiversity loss are:

- (i) Habitat loss and fragmentation
- (ii) Over-exploitation
- (iii) Alien species invasion.

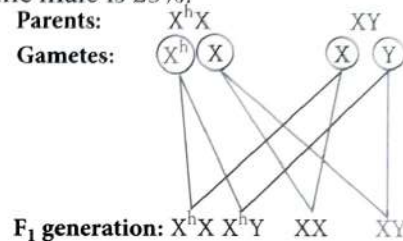
29. (a) It is a recessive trait.

OR

(a) It is a sex-linked trait.

(b) The possible genotypes of members 4, 5 and 6 are as follows:  $XX^h$ ;  $X^hY$  and  $XY$  respectively.

(c) The probability of their first child being a haemophilic male is 25%.



30. (a) Methanogens or A (*e.g.*, *Methanobacterium*) grow anaerobically on cellulosic material and produce large amount of methane along with  $CO_2$  and  $H_2$ .

(b) Biogas is a mixture of gases, composed mainly of methane alongwith carbon dioxide and hydrogen.

(c) Methanogens are also present in rumen of cattle. These bacteria help in the breakdown of cellulose present in food of cattle and thus, play important role in nutrition of cattle.

OR

The excreta of cattle (dung) is rich in methanogen bacteria which is required for biogas production. Cattle dung is available in large quantities in rural areas, so, biogas plants are more often built in rural areas.

31. (i) : a - Cells of corona radiata

b - Perivitelline space

c - Ovum nucleus

(ii) The meiotic division is completed before fertilisation in fallopian tube.

The entry of sperm stimulates the egg (secondary oocyte) to resume and complete the suspended meiosis - II. This produces a haploid mature ovum and a second polar body.

(iii) Binding of the sperm to the zona pellucida of secondary oocyte induces depolarisation of the oocyte plasma membrane and prevents polyspermy, *i.e.*, entry of more than one sperm into the oocyte.

**OR**

Monoecious flowers are bisexual, *i.e.*, they bear both male and female reproductive organs on the same plant, *e.g.*, maize.

Cleistogamous flowers are those flowers which do not open at all. These flowers are bisexual and remain closed causing self pollination. In cleistogamous flowers, the anthers dehisce inside closed flowers. Growth of style brings the pollen grains in contact with stigma. Pollination and seed setting are assured. Pollinators are not required, *e.g.*, *Commelina benghalensis*, balsam.

Self incompatibility is inability of pollen of a plant to fertilise the pistil of the same plant, *e.g.*, *Primula*.

Monoecious and cleistogamous flowers promote inbreeding whereas self incompatibility in plants promotes outbreeding.

32. (a) The relationship between the sequence of amino acids in a polypeptide and nucleotide sequence of DNA or mRNA is called genetic code.

(b) (i) Degenerate codon : More than one codons code for a single amino acid. In degenerate codons, generally the first two nitrogen bases are similar while the third one is different. *E.g.*, UUU and UUC code for phenylalanine.

(ii) Unambiguous codon : No codon code for more than one amino acid. *E.g.*, AUG codes for methionine.

(iii) Initiator codons : The start codon is the first codon of mRNA transcript. It initiates the process of translation. *E.g.*, AUG.

**OR**

DNA fingerprinting technology is a technique of determining nucleotide sequences of certain portion of DNA which are unique to each individual. DNA fingerprints can be prepared from extremely minute amounts of blood, semen, hair bulb or certain other cells of the body. The major steps are as follows :

(i) DNA is extracted from the cells. It is cut into fragments with the help of restriction enzymes. The fragments of DNA also contain VNTRs (Variable Number Tandem Repeats) which vary in number from person to person.

(ii) DNA fragments are separated by passing through gel electrophoresis.

(iii) Separated DNA sequences are transferred from gel onto a nitrocellulose or nylon membrane.

(iv) Radioactive DNA probes complementary to VNTRs are poured over the nylon membrane. Some of them bind with VNTRs (Southern Blotting).

(v) X-ray film is exposed to the nylon sheet which gives dark bands at the probe sites. Thus, hybridised fragments are detected by autoradiography. The dark bands on X-ray film represent the DNA fingerprints (DNA profiles).

33. (a) Insertional inactivation refers to the process where insertion of rDNA within the coding sequence of an enzyme causes its inactivation. The non-recombinants having intact functional gene, *e.g.*  $\beta$ -galactosidase produce blue colour with chromogenic substrate but when rDNA is inserted within the coding sequence of enzyme  $\beta$ -galactosidase, recombinants do not produce any colour. Hence, recombinants can be easily differentiated from non-recombinants due to insertional inactivation.

(b) In this method, insertion of recombinant DNA in the coding sequence of enzyme  $\beta$ -galactosidase causes its inactivation, hence named insertional inactivation.

**OR**

(a) Benefits derived from transgenic animals are as follows:

(i) They produce useful biological products, that can be created by introduction of portion of gene, which codes for a particular product such as human protein ( $\alpha$ -1-antitrypsin) from transgenic sheep is used to treat emphysema.

(ii) Transgenic mice are being developed for use in testing the safety of vaccines before they are used for humans.

(iii) They carry genes which make them more sensitive to toxic substances than non-transgenic animals. They are then exposed to toxic substances and the effects are studied.

(iv) Transgenic animals can be specifically designed to allow the study of how genes are regulated and how they affect the normal functions of the body and its development, *e.g.*, study of complex factors involved in growth such as insulin-like growth factor.

(v) Many transgenic animals are designed to increase our understanding of how genes contribute to the development of disease. Today transgenic models exist for many human diseases such as cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer's.

(b) The ethical issues concerned with the production of transgenic animals include:

(i) Use of animals in biotechnology causes great suffering to them.

(ii) It is disrespectful to living beings, and only exploits them for the benefit of human beings.

