

SAMPLE PAPER-2(WITH SOLUTIONS)

General Instructions :

- (i) There are a total of **26** questions and **five** sections in the question paper, All questions are compulsory.
- (ii) Section **A** contains question number **1** to **5**, Very Short Answer type questions of **one** mark each.
- (iii) Section **B** contains question number **6** to **10**, Short Answer type I questions of **two** marks each.
- (iv) Section **C** contains question number **11** to **22**, Short Answer type II questions of three marks each.
- (v) Section **D** contains question number **23**, Value Based Question of **four** marks.
- (vi) Section **E** contains question number **24** to **26**, Long Answer type questions of **five** marks each.
- (vii) There is no overall choice in the question paper, however, an internal choice is provided in **one** question of **two** marks, **one** question of **three** marks and all **three** questions of **five** marks. An examinee is to attempt any **one** of the questions out of the **two** given in the question paper with the same question number.

Section A

Q1 : List two advantages of the use of unleaded petrol in automobiles as fuel.

Answer : Following are the two advantages of using unleaded petrol as fuel in automobiles:

- Unleaded petrol does not release lead compounds from exhaust fumes into the atmosphere and causes less pollution.
- As unleaded petrol does not emit harmful compounds, it helps in preventing health diseases like bronchitis, asthma and lung diseases.

Q2 : Retroviruses have no DNA. However, the DNA of the infected host cell does possess viral DNA. How is it possible?

Answer : After attacking the host cell, retrovirus enters into macrophages (as in case of HIV) where RNA genome of the virus replicates to form viral DNA using reverse transcriptase enzyme. This viral DNA gets incorporated into the host's cell DNA and directs the infected cells to produce more viruses. Hence, the infected host cell possesses viral DNA.

Q3 : State the cause of adenosine deaminase enzyme deficiency.

Answer : Adenosine deaminase (ADA) enzyme deficiency is caused due to the mutation in the gene encoding it and this gene is present on chromosome number 20.
ADA deficiency is inherited as an autosomal recessive trait.

Q4 : What is a cistron?

Answer : Cistron is a section of gene that codes for a certain polypeptide or protein.

Q5 : How many chromosomes do drones of honeybee possess? Name the type of cell division involved in the production of sperms by them.

Answer : Drones of honey bees are haploid and possess 16 chromosomes.

Drones of honey bees donate 16 chromosomes (one pair) to the progeny; thus, mitosis is the cell division that is involved in the production of sperms by drones.

Section B

Q6 : Expand the following and mention one application of each:

(i) PCR

(ii) ELISA

OR

(a) Mention the difference in the mode of action of exonuclease and endonuclease.

(b) How does restriction endonuclease function? (2)

Answer :

(i) PCR- Polymerase chain reaction is a technique in molecular biology to amplify a gene or a piece of DNA to obtain its several copies. Each cycle of PCR has three steps:

- a. Denaturation
- b. Primer annealing
- c. Extension of primers

Use - It is extensively used in the process of gene manipulation.

(ii) ELISA(Enzyme linked Immunosorbent Assay) is a technique in molecular biology which uses antigens and antibodies to identify infectious diseases. An infection is identified by the presence of antigens like proteins or by the synthesis of antibodies against the infection

Use - This technique is widely used for detecting AIDS.

OR

(a) Exonuclease removes the nucleotides from the ends of the DNA chain while endonuclease cuts the DNA at the specific positions within the DNA strand.

(b) Each restriction endonuclease finds its specific palindromic nucleotide sequences in the DNA and cut the DNA at these specific sites. It does so by binding to the DNA at these sites and cutting both the strands at specific points in their sugar-phosphate backbones.

Q7 : A student on a school picnic to park on a windy day started sneezing and having difficulty in breathing in reaching the park. The teacher enquired whether the student was allergic to something.

(a) What is an allergy?

(b) Write the two unique characteristics of the system involved in the response observed in the student.

Answer :

(a) An allergy is described as the exaggerated response of the immune system to an antigen that is present in the environment. Such an antigen which can elicit such a response is called an allergen.

(b) Two unique characteristics of this system are:

- It shows specificity, i.e. the response is mounted individually to a specific antigen.
- It exhibits memory. There is a low intensity primary response to an antigen the first time the immune system encounters it. Antigen specific antibodies are produced following this response.

Q8 : Explain the process of secondary treatment given to the primary effluent up to the point it shows significant change in the level of biological oxygen demand (BOD) in it.

Answer : Supernatant from the primary treatment is passed into large aeration tanks during secondary treatment. In these tanks, the effluent is agitated mechanically and air is pumped into it. This causes vigorous growth of the bacteria that lead to the formation of floc, which consists of bacteria and fungal filaments in a mesh-like structure. While growing, these microbes consume the major part of organic matter in the effluent; it decreases the biological oxygen demand (BOD).

After a significant drop in BOD is observed, effluent is passed on to the settling tank.

Q9 : (a) Select the analogous structures from the combinations given below :

(i) Forelimbs of whales and bats

(ii) Eyes of octopus and mammals

(iii) Tuber of sweet potato and potato

(iv) Thorns of *Bougainvillea* and tendrils of *Cucurbita*

(b) State the kind of evolution they represent.

Answer : (a) Analogous organs or structures are those that are similar in function but different in origin. From the given options, following are the analogous structures:

- Eyes of octopus and mammals perform the same basic visual function but they differ in the origin of their retina.
- Tubers of sweet potato and potato perform the same function of food storage but they are modifications of root and stem, respectively.

(b) The kind of evolution represented by analogous organs or structures is convergent evolution as they have different origins but evolve similar traits with evolution to perform the same function.

Q10 : A moss plant is unable to complete its life-cycle in a dry environment. State two reasons.

Answer : Mosses cannot complete their life cycle in a dry environment because of the following reasons:

1. They need water for sexual reproduction as water acts as a medium for flagellated sperm to reach the egg and undergo fertilisation.

2. Since their roots are rudimentary, they cannot absorb water. Therefore, they need to grow in moist environment for their survival.

Section C

Q11 : A heavily bleeding and bruised road accident victim was brought to a nursing home. The doctor immediately gave him an injection to protect him against a deadly disease.

(a) Write what did the doctor inject into the patient's body.

(b) How do you think this injection would protect the patient against the disease?

(c) Name the disease against which this injection was given and the kind of immunity it provides.

Answer : (a) In the patient's body, the doctor has injected antiserum containing preformed antibodies against the causative organism or toxin produced by it.

(b) The solution injected by the doctor had antibodies; hence, the injection would protect the patient against the disease and provide him humoral immunity.

(c) The disease against which this injection was given is tetanus caused by *Clostridium tetani*, which usually exists in environment as spores and may gain access to the body through wound.

The kind of immunity that the injection containing antiserum provides is passive immunity as preformed antibodies are used because fast action is required in this emergency case.

Q12 : (a) Why is human ABO blood group gene considered a good example of multiple alleles?

(b) Work out a cross up to F₁ generation only, between a mother with blood group A (Homozygous) and the father with blood group B (Homozygous). Explain the pattern of inheritance exhibited. (3)

Answer :

(a) A gene is represented by two alleles. But, for the blood group in humans there are three alleles namely I^A , I^B and i governing a same character. Thus, it is an example of multiple allele.

Allele from Parent 1	Allele from Parent 2	Genotype of offspring	Blood type of offspring
I^A	I^A	$I^A I^A$	A
I^A	I^B	$I^A I^B$	AB
I^A	i	$I^A i$	A
I^B	I^A	$I^A I^B$	AB
I^B	I^B	$I^B I^B$	B
I^B	i	$I^B i$	B
i	i	$i i$	O

(b)

Mother x Father

(I^A I^A) (I^B I^B)

↑

Child (I^A I^B)

Thus, the child will have blood group AB.

The pattern of inheritance is called co-dominance.

Q13 : Describe the structure of RNA polynucleotide chain having four different types of nucleotides.

Answer :

A RNA nucleotide has three main components **^ a nitrogenous base, a ribose sugar and a phosphate group.**

- The ribose sugar and the phosphates form the backbone of a polynucleotide chain with nitrogenous bases linked to sugar moiety and projecting from the backbone.
- Two types of nitrogenous bases are present i.e. Purines (Adenine and Guanine) and Pyrimidines (Cytosine and Uracil).
- A nitrogenous base is linked to the ribose sugar through N-glycosidic linkages to form a nucleoside (like adenosine, guanosine or cytidine and uridine).
- A phosphate group is linked to 5'-OH of a nucleoside through phosphoester linkage to form a corresponding nucleotide.
- Every nucleotide residue has an additional ^OH group present at 2'-position in the ribose.
- Many nucleotides are linked through 3'-5' phosphodiester linkages to each other to form the polynucleotide chain.
- The end of the chain which has a free phosphate moiety at 5'-end of ribose sugar is referred to as 5-end and the other end of the chain having a free 3'-OH group at the ribose sugar is referred to as 3'-end of the polynucleotide chain.

Q14 : (a) Differentiate between inbreeding and outbreeding.

(b) Explain inbreeding depression and how it can be overcome.

(c) Mention two advantages of inbreeding programme in cattle. (3)

Answer :(a)

Inbreeding	Outbreeding
Mating of closely related individuals within the same breed for 4 ^ 6	Breeding the unrelated animals of the same or different breed not having

generations.	common ancestor.
It cannot be divided into further types.	It includes out-crossing, cross-breeding, and interspecific hybridisation.
The number of organisms with the desired traits can be increased in the population due to continuous inbreeding.	The organism produced has desired character of both parents and is mostly infertile.

(b) Inbreeding depression can be overcome by out-breeding i.e. mating some selected animals of the breeding population with unrelated superior animals of the same breed that have different ancestors.

(c) Advantages of inbreeding in cattle:

- i. Increases the productivity of inbred population.
- ii. Elimination or reduction of less desirable genes.
- iii. Pure breed of progeny is obtained.

Q15 : State what is apomixis. Comment on its significance. How can it be commercially used?

Answer : Apomixis is a form of asexual reproduction in which embryo is formed without meiosis and fusion of haploid gametes. It can take place through diploid sporophytic cells of ovule or from an unfertilised egg (parthenogenesis) itself.

Significance:

Certain species of plants belong to *Asteraceae*, and grasses exclusively use the phenomenon of apomixis for producing seeds.

Commercial applications of apomixis:

1. By apomixis, hybrid varieties of seeds can be produced, which will provide higher and better yield.
2. Apomixis prevents the loss of specific characteristics in the hybrid plants.
3. Apomixis is a cost-effective method of producing seeds.

Q16 : How have human activities caused desertification? Explain.

OR

How does algal bloom destroy the quality of a fresh water body? Explain.(3)

Answer : Following human activities contribute to desertification:

- i. Deforestation: Humans cut down trees to serve their own purposes like construction of roads and houses, etc which is the main cause of desertification.
- ii. Improper farming practices: If same crop is grown continuously makes the soil deficient of nutrients resulting in the loss of fertility of soil.
- iii. Excessive ploughing of field.
- iv. Soil erosion: Soil erosion by different human activities like deforestation due to construction of houses and industrialization.

v. Mining activities and leaching of minerals further destroys soil quality and renders it totally infertile.

OR

An algal bloom is the phenomenon of excessive growth of planktonic forms in a nutrient rich water body. As the planktonic species multiply on the surface they form a layer that eventually covers the entire surface of the water body. They block sunlight, which does not reach submerged aquatic plants that may have a role in supplying necessary nutrients to other aquatic life forms and keeping the water clean.

Excretory substances released by planktons build up in concentration and pollute the water. Some algal species even release substances that are toxic for other life forms in the water body. Also, due to the high respiratory needs of such a huge concentration of biomass on the surface, the biological oxygen demand (BOD) of the water body increases, causing many of the life forms to die. Their carcasses further contribute to the deterioration of the quality of the water content.

Q17 : Explain mutualism with the help of any two examples. How is it different from commensalism?

Answer : Mutualism is a kind of population interaction in which both the participating species derive a benefit from each others presence. Examples of mutualism are given below:

i. Associations between fungi and plants, called mycorrhizae: The plant is benefitted by essential soil nutrients that the fungus absorbs and transfers to the plant through its roots. The fungus in turn derives the benefit of receiving energy yielding carbohydrates from the plant.

ii. Pollination: The flowers of a plant provide sweet, mucilaginous nectar to birds or insects in return for getting help from the bird or insect in spreading their pollen grains onto other flowers. The plant-pollinator pair often undergoes co-evolution to safeguard against the use of the nectar by other non- useful organisms.

Mutualism differs from commensalism in that the latter provides a benefit to just one of the participating species, the benefitted species being called a commensal.

Q18 : (a) Why are transgenic animals so called?

(b) Explain the role of transgenic animals in (i) Vaccine safety and (ii) Biological products with the help of an example each.

Answer : Transgenic animals are called so as these animals possess the deliberate modification in their genome. The changes in the genome of the organisms are brought about by recombinant DNA technology.

Role of transgenic animal in vaccine safety-Transgenic mice are being developed for use in testing the safety of vaccines before they are used on humans.

Example: Transgenic mice are being used to test the safety of the polio vaccine. If successful and found to be reliable, they could replace the use of monkeys to test the safety of batches of the vaccine.

Role of transgenic animal in production of biological products-Transgenic cow, Rosie is used for the production of human protein-enriched milk, which contained β -actalbumin and was nutritionally more suitable for human babies.

Q19 : Explain co-evolution with reference to parasites and their hosts. Mention any four special adaptive features evolved in parasites for their parasitic mode of life.

Answer : Co-evolution can be defined as reciprocal adaptations in the two interacting organisms that brings about the evolutionary change in both of them. In terms of the relation of host and parasite, it can be explained as follows:

A parasite is an organism that is totally dependent on the host organism for its survival, but in doing so, it also harms the host. The host evolves over a long period of time to protect itself from parasite, while parasite evolves so that it can find another way to derive nutrition from the host and hence, the cycle continues.

Four special adaptive features evolved in parasites for their parasitic mode of life are as follows:

1. Parasites have organs for attachment such as suckers that help them to firmly attach to the host body and derive nutrition from them. For example, hooks and suckers in *Taenia solium*.
2. Parasites are covered by protective body covering, that is, cuticle (in case of *Ascaris lumbricoides*) and tegumen (in case of *Taenia solium*) to protect them from harmful effects of digestive enzymes of the host.
3. All parasitic organisms are usually devoid of locomotory structures; they do not require to move in search of food.
4. Parasitic organisms have high reproductive capacity to ensure the continuation of parasitic race.

Q20 : Rearrange the following in the current sequences to accomplish an important biotechnological reaction :

- (a) *In vitro* synthesis of region of DNA of interest
- (b) Chemically synthesised oligonucleotides
- (c) Enzyme DNA-polymerase
- (d) Complementary region of DNA
- (e) Genomic DNA template
- (f) Nucleotides provided
- (g) Primers
- (h) Thermostable DNA-polymerase (from *Thermus aquaticus*)
- (i) Denaturation of ds-DNA

Answer : The given step refer to the steps involved in the polymerase chain reaction:

- (b) Chemically synthesised oligonucleotides
- (f) Nucleotides provided
- (h) Thermostable DNA-polymerase (from *Thermus aquaticus*)
- (i) Denaturation of ds-DNA
- (g) Primers
- (e) Genomic DNA template
- (c) Enzyme DNA-polymerase

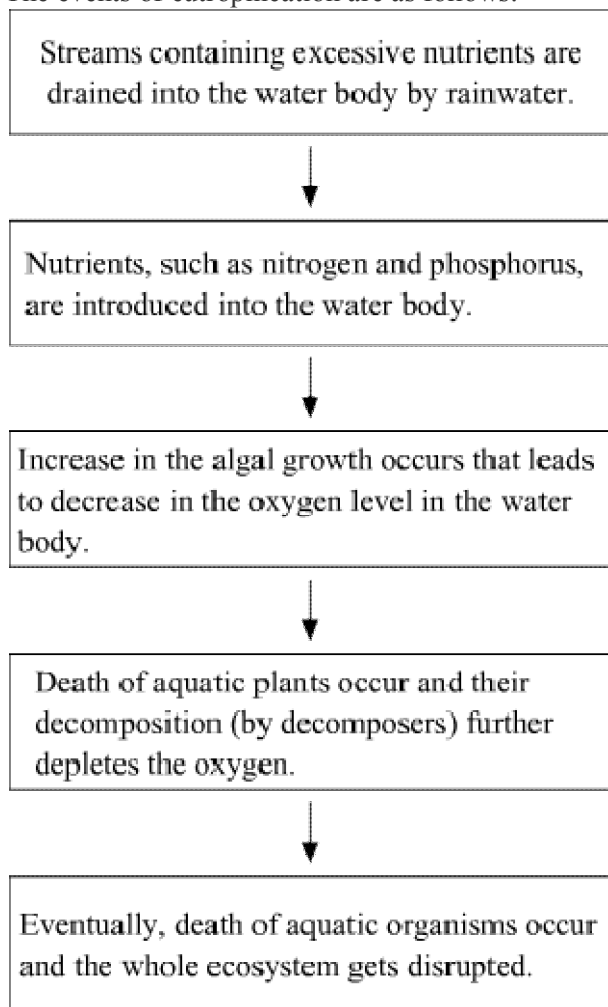
(d) Complementary region of DNA

(a) *In vitro* synthesis of region of DNA of interest

Q21 : With the help of a flow-chart exhibit the events of eutrophication.

Answer : Enrichment of water body by excessive nutrients is known as eutrophication.

The events of eutrophication are as follows:



Q22 : Enumerate any six essentials of good, effective Dairy Farm Management Practices.

Answer : Six important ways of good and effective dairy farm management practices are as follows:

1. Choosing the breeds that have high yielding potential is essential.
2. Proper accommodation (including the aspects of hygiene) and adequate water are essential for the care of cattle.
3. Periodic visit by a veterinary doctor should be compulsory for the good health of cattles.
4. The fodder given to the cattles should be of adequate quantity and good quality (including grains and protein concentrates).
5. The procedure of milking should be hygienic; emphasis should be given to storage and transportation of milk, so that the quality of milk is not affected.

6. Regular inspection of dairy farms should be done by appointed officials to ensure that all the instructions are being strictly followed.

Section D

Q23 : You have attended a birthday party hosted by one of your classmates. You found some guests at the party sitting in a corner making a lot of noise and consuming 'something'. After a while one of the boys from the group started screaming, behaving abnormally and sweating profusely. On enquiry you found that the group members were taking drugs.

- (a) Would you inform your parents/school authorities ? Yes/No. Give reasons in support of your answer.**
- (b) Prepare a note to be circulated amongst the schoolmates about the sources and dangers of any two drugs.**
- (c) Write any two ways that you will suggest to your school principal so as to promote awareness amongst the youth against the use of these drugs.**

Answer : a) Yes, I will inform the school authorities because such kind of behaviour may lead to many terrible consequences in future. It may lead to addiction to drugs which is bad for one's health and will also leave a negative impact on society.

b) Following are two drugs that are most commonly available:

Drugs	Sources	Dangers
Cocaine	Cocoa plant	Damage to blood vessels, increased heart rate, damage to lungs and kidneys, stroke and even death (if taken in large amount)
Marijuana	<i>Cannabis sativa</i>	Mental retardation, lung infection, increased risk of lung cancer

(c) Ways to promote awareness amongst the youth against the use of these drugs are as follows:

1. All students must be inspired to adopt a healthy lifestyle. They should be encouraged to participate in sports and other activities that make the mind and body healthy.
2. There should be a counsellor who must talk to students about their problems and situations that force them to adopt wrong habits (drug consumption). The counsellor should always be there to guide the students on how to deal with their problems.

Section E

Q24 : A child suffering from Thalassemia is born to a normal couple. But the mother is being blamed by the family for delivering a sick baby. (5)

- (a) What is Thalassemia?**
- (b) How would you counsel the family not to blame the mother for delivering a child suffering from this disease? Explain.**
- (c) List the values your counselling can propagate in the families.**

Answer :

(a) Thalassemia is a group of autosomal recessive blood disorders characterized by severe anemia as a result of production of faulty haemoglobin chains. Mutations in the genes coding for the alpha, beta or delta chains constituting haemoglobin lead to the synthesis of improperly folded haemoglobin that is incapable of transporting oxygen efficiently.

(b) Thalassemia is an autosomal recessive disease, which means the mutation is carried on one of the autosomes, so the carrier can be any one of the two parents. It has an equal probability of coming from the mother or the father, so to just blame the mother for the child's abnormality is unjustified.

(c) The values counseling can propagate in the families are:

- i. Give a healthy diet plan to the child
- ii. Accepting their child with all his/her positives and negatives
- iii. Neither of the parents is responsible for giving birth to a sick baby.
- iv. The defect is caused by a random change in the genes of the child.
- v. Encouraging the child to follow his/her treatment regularly and lead a happy and normal life.
- vi. Support the child emotionally by talking about fear, anxiety, and depression or stress the child feels.

Q25 : Draw a diagram of a mature embryo sac of an angiosperm and label the following parts in it.

(i) Filiform apparatus

(ii) Synergids

(iii) Central cell

(iv) Egg cell

(v) Polar nuclei

(vi) Antopodals

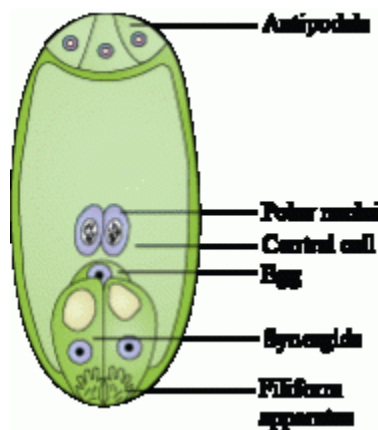
(b) Write the fate of egg cell and polar nuclei after fertilization.

OR

(a) Describe the events of Oogenesis with the help of schematic representation.

(b) Write two differences between Oogenesis and spermatogenesis.

Answer : (a)



(b) When the pollen grains fall on the stigma, the pollen tube enters one of the synergids and releases two male gametes.

- One of the male gametes moves towards the **egg cell** and fuses with it to complete the syngamy to form the zygote.
- The other male gamete fuses with the **two polar nuclei** and forms triploid primary endosperm nucleus (PEN). This is termed as triple fusion.
- Since two kinds of fusion—syngamy and triple fusion—take place, the process is known as double fertilisation, and is characteristic of flowering plants

OR

(a) Oogenesis

- The ovum is formed by the process of oogenesis.
- It starts during embryonic growth and millions of gamete mother cells (**oogonia**) are formed in the foetal ovary. These cells undergo meiosis, but get temporarily arrested at the prophase and are called **primary oocytes**.
- Before reaching puberty, a large number of primary oocytes degenerate and the remaining ones get surrounded by layers of granulosa cells and new theca and are called **secondary follicles**.
- The secondary follicles are then converted into **tertiary follicles** that have characteristic fluid-filled cavity called antrum. At this stage, the primary oocyte present within the tertiary follicle completes meiosis, which results in the formation of haploid secondary oocyte and a tiny polar body.
- This tertiary follicle further changes into the **Graafian follicle**. The secondary oocyte is surrounded by the zone pellucida. Then the Graafian follicle ruptures to release the ovum by **ovulation**.

(b)

Spermatogenesis	Oogenesis
It is the process by which sperms are	It is the process by which ovum is formed

formed from the sperm mother cell in males	from the oogonia in females
After the second meiotic divisions in a single spermatogonium, 4 spermatids are obtained, which undergo maturation to form 4 sperm cells, or spermatozoa	After the second meiotic divisions in the single oogonium, only one ovum and three polar bodies are obtained.
Spermatogenesis occurs in males from puberty almost until death.	In females, oogenesis starts before birth and occurs until menopause.

Q26 : Describe the asexual and sexual phases of life cycle of Plasmodium that causes malaria in humans.

OR

(a) What is plant breeding? List the two steps the classical plant breeding involves.

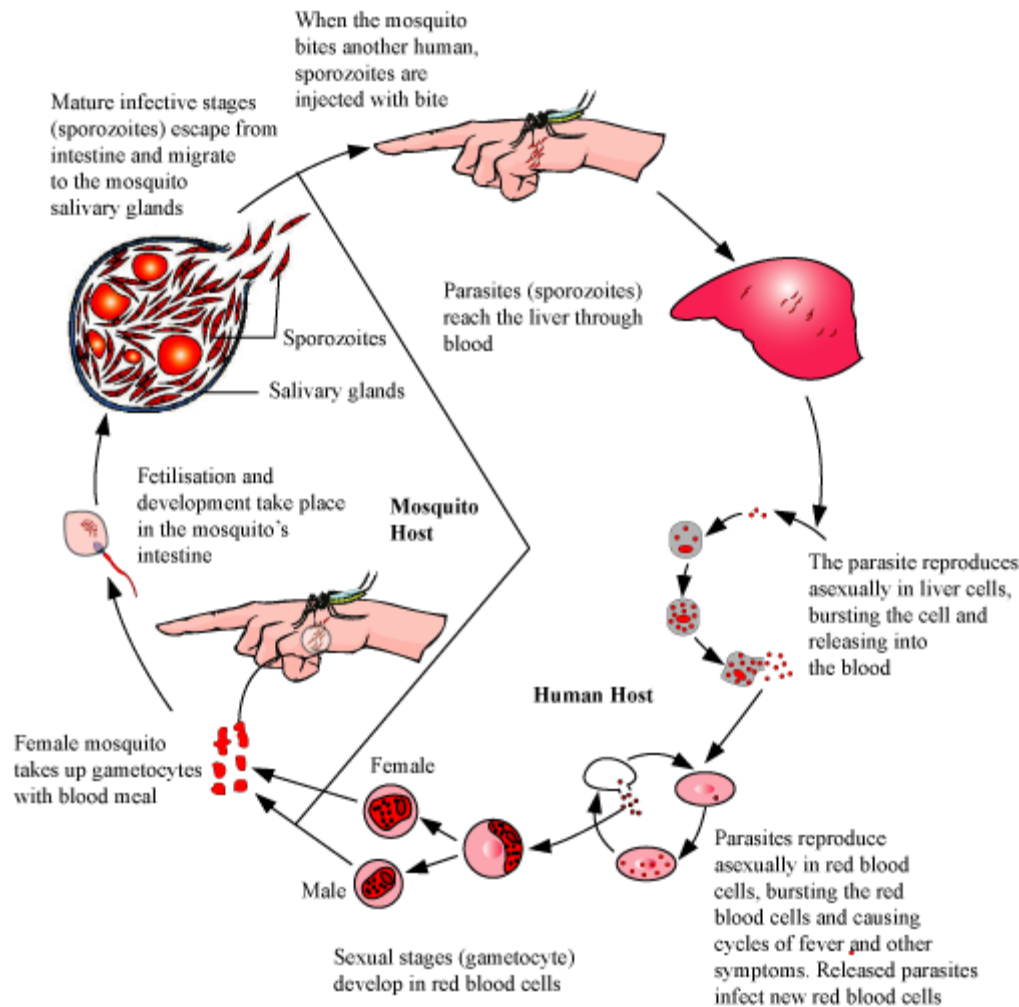
(b) How has the mutation breeding helped in improving crop varieties? Give one example where this technique has helped.

(c) How has the breeding programme helped in improving the public nutritional health? State two examples in support of your answer.

Answer : Life Cycle of *Plasmodium*

- *Plasmodium* requires two hosts to complete its life cycle.
- When female *Anopheles* mosquito bites a healthy human being, it releases *Plasmodium*, which lives in its body as sporozoite (infectious form).
- The parasites multiply (asexual reproduction) in the liver cells and finally burst the liver cells. Sporozoites are released in blood.
- Parasites enter RBCs and further multiply (asexual reproduction) here and finally burst RBCs also.
- Bursting of RBCs is accompanied by release of a toxic substance called haemozoin (associated with fever and chills).
- In the RBCs, only sporozoites change into gametocytes (sexual stage). Gametocytes multiply.
- When the diseased person is bitten by a female *Anopheles* mosquito, gametocytes are introduced into the mosquito.
- Gametocytes fertilise and develop inside the intestine of mosquito to form sporozoites.

- Sporozoites are stored in the salivary glands of mosquito and are released into the healthy person who is bitten by this mosquito.



OR

(a) Plant breeding is a technique that involves the crossing of two plants to produce the progeny with particular traits in their genes and passed on to the future generation in order to create desired plant types which are better suited for cultivation, give better yields, and are disease resistant.

Two steps involved in Classical plant breeding are:

- crossing of superior pure lines and
- selection of plants with desired characteristics.

(b) **Mutational breeding:** In this method, genetic variations are created, which then result in the creation of traits not found in the parental type. It has helped in creating disease resistant plants by providing resistance against bacterial, fungal and viral diseases.

(c) Breeding programme helped in improving the public nutritional health by breeding crops that are rich in nutrients.

This approach is called bio-fortification of crops. Objectives of bio-fortification are to improve â

- i. Protein content and quality
- ii. Oil content and quality
- iii. Vitamin content
- iv. Micronutrient and mineral content

Examples â

- i. Maize hybrids developed in the year 2000 have twice the amount of lysine and tryptophan compared to other maize hybrids.
- ii. Atlas 66 (a wheat variety having higher protein content)

SAMPLE PAPER-3(WITH SOLUTIONS)

General Instructions :

- (i) There are a total of **26** questions and **five** sections in the question paper, All questions are compulsory.
- (ii) Section **A** contains question number **1** to **5**, Very Short Answer type questions of **one** mark each.
- (iii) Section **B** contains question number **6** to **10**, Short Answer type I questions of **two** marks each.
- (iv) Section **C** contains question number **11** to **22**, Short Answer type II questions of three marks each.
- (v) Section **D** contains question number **23**, Value Based Question of **four** marks.
- (vi) Section **E** contains question number **24** to **26**, Long Answer type questions of **five** marks each.
- (vii) There is no overall choice in the question paper, however, an internal choice is provided in **one** question of **two** marks, **one** question of **three** marks and all **three** questions of **five** marks. An examinee is to attempt any **one** of the questions out of the **two** given in the question paper with the same question number.

Section A

Q1 : How many chromosomes do drones of honeybee possess? Name the type of cell division involved in the production of sperms by them.

Answer : Drones of honey bees are haploid and possess 16 chromosomes.

Drones of honey bees donate 16 chromosomes (one pair) to the progeny; thus, mitosis is the cell division that is involved in the production of sperms by drones.

Q2 : What is a cistron?

Answer : Cistron is a section of gene that codes for a certain polypeptide or protein.

Q3 : Retroviruses have no DNA. However, the DNA of the infected host cell does possess viral DNA. How is it possible?

Answer : After attacking the host cell, retrovirus enters into macrophages (as in case of HIV) where RNA genome of the virus replicates to form viral DNA using reverse transcriptase enzyme. This viral DNA gets incorporated into the host's cell DNA and directs the infected cells to produce more viruses. Hence, the infected host cell possesses viral DNA.

Q4 : Why do children cured by enzyme-replacement therapy for adenosine deaminase deficiency need periodic treatment?

Answer : Children cured by enzyme-replacement therapy for adenosine deaminase (ADA) deficiency need periodic treatment because it is not a completely curative method. In this method, a functional ADA cDNA is injected into a patient, by introducing it into the patient's lymphocytes using a retroviral vector. Since the lymphocytes have a definite life cycle, there is a need for periodic transfusion of the genetically engineered lymphocytes (having ADA) into the patient.

Q5 : List two advantages of the use of unleaded petrol in automobiles as fuel.

Answer : Following are the two advantages of using unleaded petrol as fuel in automobiles:

- Unleaded petrol does not release lead compounds from exhaust fumes into the atmosphere and causes less pollution.
- As unleaded petrol does not emit harmful compounds, it helps in preventing health diseases like bronchitis, asthma and lung diseases.

Section B

Q6 : Why do moss plants produce very large number of male gametes? Provide one reason. What are these gametes called?

Answer :

Mosses are bryophytes and they need water for fertilisation. They lay their flagellated male gametes that swim across the water to reach the female gamete. During this process, many of the male gametes are destroyed or lost. Thus, moss plants produce very large number of male gametes so that even if some of the gametes get destroyed, the remaining can fertilise the female gamete.

These male gametes are called antherozoids.

Q7 : Select the homologous structures from the combinations given below :

(i) Forelimbs of whales and bats

(ii) Tuber of potato and sweet potato

(iii) Eyes of octopus and mammals

(iv) Thorns of *Bougainvillea* and tendrils of *Cucurbita*

(b) State the kind of evolution they represent.

Answer : (a) Homologous organs or structures are those that are similar in anatomy or structure but perform different functions.

From the given options, following are homologous structures:

- Forelimbs of whales and bats are similar in structure but perform different functions of swimming and flying, respectively.
- Thorns of *Bougainvillea* and tendrils of *Cucurbita* are both modifications of a stem arising from axillary bud but perform different functions of protection and climbing, respectively.

(b) The evolution represented by homologous organs or structures is divergent evolution as they have common origin but have diverged (became dissimilar) with evolution.

Q8 : (a) Why are the plants raised through micropropagation termed as somaclones ?

(b) Mention two advantages of this technique.

Answer : (a) The plants obtained by micropropagation are called somaclones because they are genetically identical to each other as well as to the parent plant.

(b) The advantages of micropropagation are as follows:

- It helps in the propagation of a large number of plants in a short span of time.
- It helps in the production of healthier plants that are disease and pest resistant.

Q9 : Explain the different steps involved during primary treatment phase of sewage.

Answer : The primary phase of sewage treatment involves physical removal of particles by filtration and sedimentation.

Different steps involved during the primary treatment are as follows:

- Initially, floating debris of sewage water is removed by **sequential filtration**.
- Then, grit (soil + small pebbles) is removed by **sedimentation**. The remaining solid particles, which have settled down, form the sludge while the supernatant forms the effluent.
- Effluent is then taken for secondary treatment.

Q10 : What is mutualism? Mention any two examples where the organisms involved are commercially exploited in agriculture.

OR

List any four techniques where the principle of *ex-situ* conservation of biodiversity has been employed.

Answer : Mutualism is a relationship between the organisms of two species in which both organisms are benefited.

Examples of the organisms involved that are commercially exploited in agriculture are as follows:

(i) Commercial exploitation of *Rhizobium* in agriculture

Continuous growth of crops leads to the nutrient deficiency in soil. Farmers, then, grow leguminous crops containing *Rhizobium* in its roots to replenish the lost nutrients (especially nitrogen) in the soil.

(ii) Commercial exploitation of Mycorrhiza in agriculture

Mycorrhiza is an association of the soil fungus with the roots of higher plants. Farmers use Mycorrhiza commercially in agriculture as it improves the soil quality and reduces soil erosion by improving plant rooting capacity. The fungal hyphae spread into the root tissues and help the plants to optimally use the soil's water and minerals.

Thus, to increase the yield of plants and to replenish the soil nutrients, Mycorrhiza is commercially exploited in agriculture.

OR

Four techniques where the principle of *ex-situ* conservation of biodiversity has been employed are as follows:

- Preservation of the gametes of threatened species (using cryopreservation techniques) in viable and fertile condition for long periods
- *In-vitro* fertilisation of eggs
- Propagation of plants using tissue culture technique
- Keeping the seeds of different genetic strains that are commercially important plants for long periods in seed banks

Section C

Q11 : State what is apomixis. Comment on its significance. How can it be commercially used?

Answer : Apomixis is a form of asexual reproduction in which embryo is formed without meiosis and fusion of haploid gametes. It can take place through diploid sporophytic cells of ovule or from an unfertilised egg (parthenogenesis) itself.

Significance:

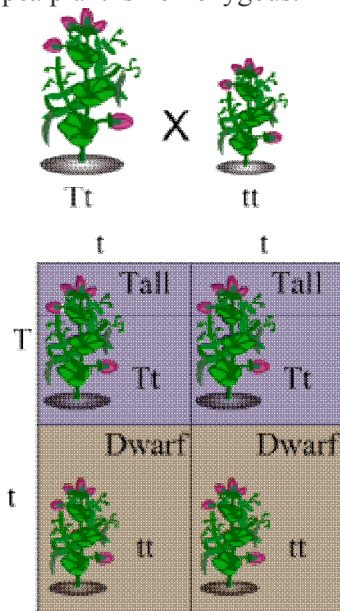
Certain species of plants belong to *Asteraceae*, and grasses exclusively use the phenomenon of apomixis for producing seeds.

Commercial applications of apomixis:

1. By apomixis, hybrid varieties of seeds can be produced, which will provide higher and better yield.
2. Apomixis prevents the loss of specific characteristics in the hybrid plants.
3. Apomixis is a cost-effective method of producing seeds.

Q12 : During a monohybrid cross involving a tall pea plant with a dwarf pea plant, the offspring populations were tall and dwarf in equal ratio. Work out a cross to show how it is possible.

Answer : The asked scenario is possible only when the tall pea plant is heterozygous and dwarf (small) pea plant is homozygous. This cross can be represented as follows:



In this case, the progeny would be 50% tall and 50% dwarf.

Q13 : Explain the significance of satellite DNA in DNA fingerprinting technique.

Answer : Satellite DNA consists of highly repetitive and generally non-coding DNA. It is very significant in DNA fingerprinting for the following reasons:

- It is specific for every species.
- It is a highly polymorphic DNA, an example of which is Variable Number of Tandem Repeats (VNTRs). This means that different individuals will vary in the number of repeats. These differences can be used for identification.
- VNTR sequences are inheritable and an individual inherits it from both parents. This can be used for paternity testing.
- Regions of crossing over can also be easily marked, making identification easier.

Q14 : What does the following equation represent? Explain

$$p^2 + 2pq + q^2 = 1$$

Answer : The equation of $p^2 + 2pq + q^2 = 1$ represents the genotypic frequencies of a population, when it is in Hardy-Weinberg equilibrium.

According to this law, the frequency of occurrence of alleles of a gene in a population remains constant through generations unless disturbances, such as mutations and non-random mating, are introduced.

Individual frequencies are represented as p and q such as in a diploid, where p and q represent the frequency of allele A and a respectively. The sum total of all allelic frequencies is 1.

The frequency of genotypes, AA is p^2 , that of aa is q^2 and that of Aa is $2pq$.

Hence, $p^2 + 2pq + q^2 = 1$, which is the expansion of $(p + q)^2$.

Q15 : A heavily bleeding and bruised road accident victim was brought to a nursing home. The doctor immediately gave him an injection to protect him against a deadly disease.

(a) Write what did the doctor inject into the patient's body.

(b) How do you think this injection would protect the patient against the disease?

(c) Name the disease against which this injection was given and the kind of immunity it provides.

Answer : (a) In the patient's body, the doctor has injected antiserum containing preformed antibodies against the causative organism or toxin produced by it.

(b) The solution injected by the doctor had antibodies; hence, the injection would protect the patient against the disease and provide him humoral immunity.

(c) The disease against which this injection was given is tetanus caused by *Clostridium tetani*, which usually exists in environment as spores and may gain access to the body through wound.

The kind of immunity that the injection containing antiserum provides is passive immunity as preformed antibodies are used because fast action is required in this emergency case.

Q16 : Enumerate any six essentials of good, effective Dairy Farm Management Practices.

Answer : Six important ways of good and effective dairy farm management practices are as follows:

1. Choosing the breeds that have high yielding potential is essential.
2. Proper accommodation (including the aspects of hygiene) and adequate water are essential for the care of cattle.
3. Periodic visit by a veterinary doctor should be compulsory for the good health of cattles.
4. The fodder given to the cattles should be of adequate quantity and good quality (including grains and protein concentrates).
5. The procedure of milking should be hygienic; emphasis should be given to storage and transportation of milk, so that the quality of milk is not affected.
6. Regular inspection of dairy farms should be done by appointed officials to ensure that all the instructions are being strictly followed.

Q17 : State the medicinal value and the bioactive molecules produced by *Streptococcus*, *Monascus* and *Trichoderma*.

OR

What are methanogens ? How do they help to generate biogas ?

Answer : *Streptococcus*: It produces streptokinase enzyme that is used to dissolve clots formed in the blood vessels.

Monascus: It produces statins that help in lowering blood cholesterol levels.

Trichoderma: It produces cyclosporin A that is used as an immunosuppressive agent in organ transplantation.

OR

Microorganisms that produce methane along with CO₂ and H₂ under anaerobic conditions are called methanogens. For example: *Methanobacterium*

Methanogens are the bacteria found in cattle dung (gobar) and in anaerobic sludge during sewage treatment. They grow anaerobically on cellulosic material and produce a large amount of methane (main constituent of biogas) along with CO₂ and H₂. Thus, methanogens are used in biogas production.

Q18 : Rearrange the following in the current sequences to accomplish an important biotechnological reaction :

- (a) *In vitro* synthesis of region of DNA of interest
- (b) Chemically synthesised oligonucleotides
- (c) Enzyme DNA-polymerase
- (d) Complementary region of DNA
- (e) Genomic DNA template
- (f) Nucleotides provided
- (g) Primers
- (h) Thermostable DNA-polymerase (from *Thermus aquaticus*)
- (i) Denaturation of ds-DNA

Answer : The given steps refer to the steps involved in the polymerase chain reaction:

- (b) Chemically synthesised oligonucleotides
- (f) Nucleotides provided
- (h) Thermostable DNA-polymerase (from *Thermus aquaticus*)
- (i) Denaturation of ds-DNA
- (g) Primers
- (e) Genomic DNA template
- (c) Enzyme DNA-polymerase
- (d) Complementary region of DNA
- (a) *In vitro* synthesis of region of DNA of interest

Q19 : Describe any three potential applications of genetically modified plants.

Answer : Three potential applications of genetically modified (GM) plants are as follows:

(i) **Nutrient Enrichment**

GM plants provide essential nutrients to people through the consumption of main staple crop.

Example: Golden rice is a variety of rice that is genetically engineered by inserting genes to produce beta carotene, which is a precursor of vitamin A. Thus, consumption of this crop helps in the prevention of vitamin A deficiency diseases.

(ii) **Insect/Pest Resistance**

GM crops, such as Bt cotton, are insect/pest resistant crops. It is a genetically modified variety of cotton that produces certain protein which acts as insecticides and kills certain insects such as lepidopterans and dipterans.

(iii) Abiotic Stress Resistance

GM crops are tolerance to stress conditions such as high and low temperature, salinity and drought.

Q20 : How did an American Company. Eli Lilly use the knowledge of r-DNA technology to produce human insulin?

Answer : Insulin hormone is released as a pro-hormone, which consists of three peptide chains: A, B and C. This pro-hormone insulin is converted to mature insulin by removal of C peptide.

The American company, Eli Lilly, used the knowledge of r-DNA technology as follows:

1. Preparation of DNA corresponding to A and B chain separately
2. Extraction of plasmid from bacteria
3. Insertion of DNA corresponding to A and B chain separately in plasmid
4. Transforming the bacteria with this recombinant plasmid
5. Expression of the desired product from this DNA in a bioreactor
6. Purification of A and B chain
7. Linking them with disulfide bonds so that they act as human insulin

Q21 : How do snails, seeds, bears, zooplanktons, fungi and bacteria adapt to conditions unfavourable for their survival?

Answer : Snails adapt to unfavourable conditions by producing epiphragm during hibernation that covers the opening of its shell and thus prevent desiccation.

Seeds adapt to unfavourable conditions by getting into the state of dormancy.

Bears adapt to unfavourable conditions by hibernating and reducing their body metabolic activities by 75%.

Zooplanktons adapt to unfavourable conditions by entering into diapause (stage of suspended development).

Fungi adapt to unfavourable conditions by reducing their metabolic rate and by forming thick-walled spores.

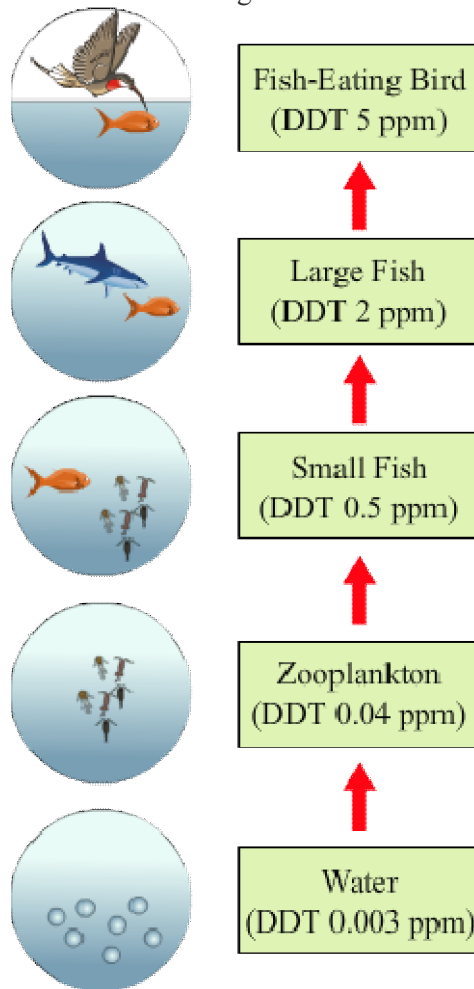
Bacteria adapt to unfavourable conditions by forming endospores.

Q22 : With the help of a flow chart, show the phenomenon of biomagnification of DDT in an aquatic food chain.

Answer : Biomagnification is the increase in the concentration of a toxin at successive trophic levels.

The toxin gets accumulated in the body of an organism and is passed on to the next trophic level. For example, DDT (dichlorodiphenyltrichloroethane) and other heavy metals such as mercury and cadmium are the toxins that cause biomagnification.

Flowchart of biomagnification of DDT



Section D

Q23 : Your school has been selected by the Department of Education to organize and host an interschool seminar on "Reproductive Health – Problems and Practices". However, many parents are reluctant to permit their wards to attend it. Their argument is that the topic is "too embarrassing."

Put forth four arguments with appropriate reasons and explanation to justify the topic to be very essential and timely.

Answer : Reproductive health is the total well-being in all aspects of reproduction. It includes the physical, emotional, behavioural and social well-being of an individual. Therefore, there is an urgent need to educate and discuss topics related to the reproductive health.

Following are the topics about reproductive health that should be discussed with the students:

- Sexually transmitted diseases, such as AIDS and Gonorrhoea, are transferred from one individual to another through sexual contact. Therefore, making the students aware about these diseases will help to prevent their spread.

- Lack of knowledge about the reproductive status may lead to unwanted pregnancies. Hence, it is necessary to create awareness among people, especially the youth.
- Learning about one's sexuality at a proper age may help the students to know about the different changes happening in their body; thereby, leading to a better mental and physical state of health.
- Counselling and creating awareness about reproductive health also help to curb the problems of infertility, birth control, mortality, etc.

Section E

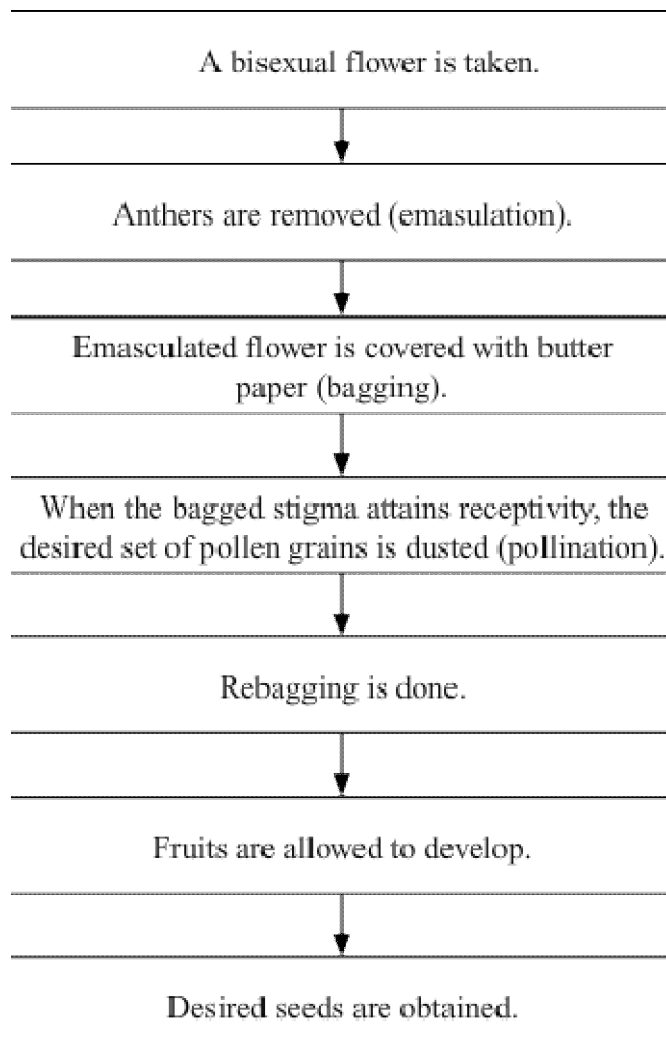
Q24 : (a) Plan an experiment and prepare a flow chart of the steps that you would follow to ensure that the seeds are formed only from the desired sets of pollen grains. Name the type of experiment that you carried out.

(b) Write the importance of such experiments.

OR

Describe the roles of pituitary and ovarian hormones during the menstrual cycle in a human female.

Answer : (a) To obtain seeds formed only from the desired sets of pollen grains one can opt for artificial hybridisation. Following are the steps involved:

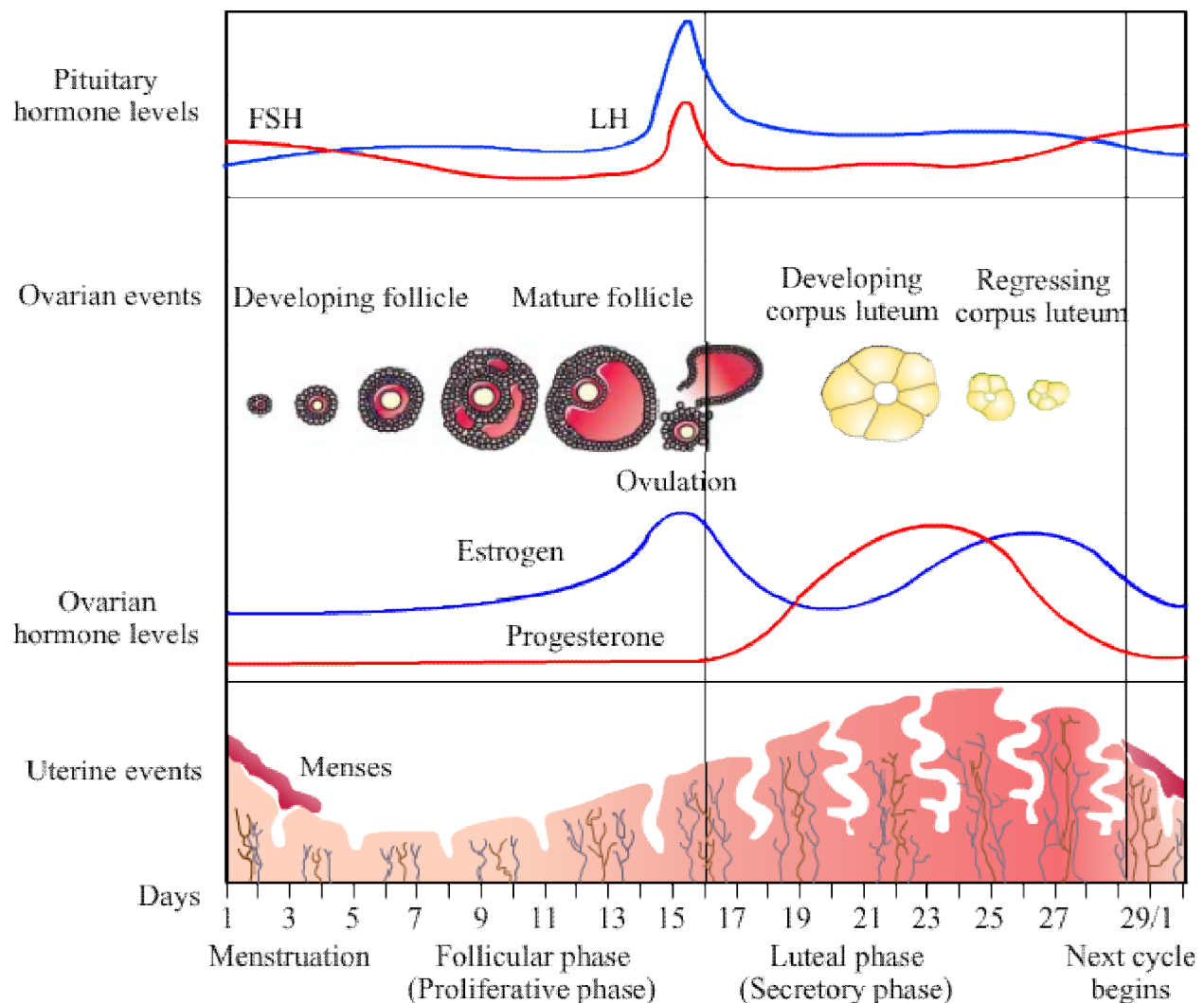


(b) Artificial hybridisation is important for the following reasons:

- It helps to improve the crop yield.
- It ensures that the crops produced have the desired characteristics.
- It helps to yield commercially superior varieties.

OR

Menstrual cycle is the reproductive cycle in all primates and begins at puberty (menarche). In human females, menstruation occurs once in a month (in about 28 to 29 days). The cycle of events, starting from one menstruation till the next is called the menstrual cycle. Following are the changes that are brought about by ovarian and pituitary hormones.



- The cycle starts with the menstrual phase, where the menstruation occurs. This is followed by the follicular phase. In this phase, the primary follicles mature into the Graafian follicles and the release of gonadotropins (LH and FSH) also increases. This causes follicular growth and the growing follicles produce oestrogen.
- The LH and FSH are at their peak in the middle of the cycle (14th day) and cause the rupture of the Graafian follicles to release ovum. This phase is called the ovulatory phase.
- The remains of the Graafian follicles get converted into the corpus luteum that secretes progesterone for the maintenance of the endometrium.
- In the absence of fertilisation, the corpus luteum degenerates; thereby, causing the disintegration of the endometrium and the start of a new cycle.

Q25 : (a) Why are thalassemia and haemophilia categorized as Mendelian disorders ? Write the symptoms of these diseases. Explain their pattern of inheritance in humans.

(b) Write the genotypes of the normal parents producing a haemophilic son.

OR

How do m-RNA, t-RNA and ribosomes help in the process of translation ?

Answer : (a) Thalassaemia and haemophilia are categorised as Mendelian disorders because they occur by mutation in a single gene. Their mode of inheritance follows the principles of Mendelian genetics. Mendelian disorders can be

- autosomal dominant (muscular dystrophy)
- autosomal recessive (thalassaemia)
- sex linked (haemophilia)

Symptoms of Thalassaemia

- Thalassaemia minor results only in mild anaemia, characterised by low haemoglobin level.
- Thalassaemia major is also known as Cooley's anaemia. In this disease, affected infants are normal but as they reach 6 to 9 months of age, they develop severe anaemia, skeletal deformities, jaundice, fatigue, etc.

Symptoms of Haemophilia

- Person suffering from this disease does not develop a proper blood clotting mechanism.
- A haemophilic patient suffers from non-stop bleeding even on a simple cut, which may lead to death.

Pattern of Inheritance of Thalassaemia

Pair of alleles Hb^A and Hb^T controls the expression of this disease.

Conditions for thalassemia:

- Hb^A and Hb^A : Normal
- Hb^A and Hb^T : Carrier
- Hb^T and Hb^T : Diseased

Let us assume that both father and mother are the carriers ($Hb^A Hb^T$) of beta thalassaemia.

Parents	$Hb^A Hb^T$ (Father)		$Hb^A Hb^T$ (Mother)	
	x			
Offsprings	$Hb^A Hb^A$ Normal child	$Hb^A Hb^T$ Carrier child with thalassaemia trait	$Hb^A Hb^T$ Carrier child with thalassaemia trait	$Hb^T Hb^T$ Child with severe thalassaemia

Pattern of Inheritance of Haemophilia:

Haemophilia is an X-linked genetic disorder. Compared to females, males have higher chances of getting affected because females have XX chromosomes while males have only one X with Y chromosome.

Thus, for a female to get affected by haemophilia, she has to have the mutant gene on both the X

chromosomes while males can be affected if they carry it on the single X chromosome.

Conditions for haemophilia:

XY; XX: Normal

X^hY : Haemophilic

X^hX : Carrier

X^hX^h : Haemophilic

Let us assume that a carrier female (X^hX) is married to a normal male.

Parents		XY (Male)	x	X^hX (Female)
Offspring	X^hX Carrier female	XX Normal female	X^hY Haemophilic male	XY Normal male

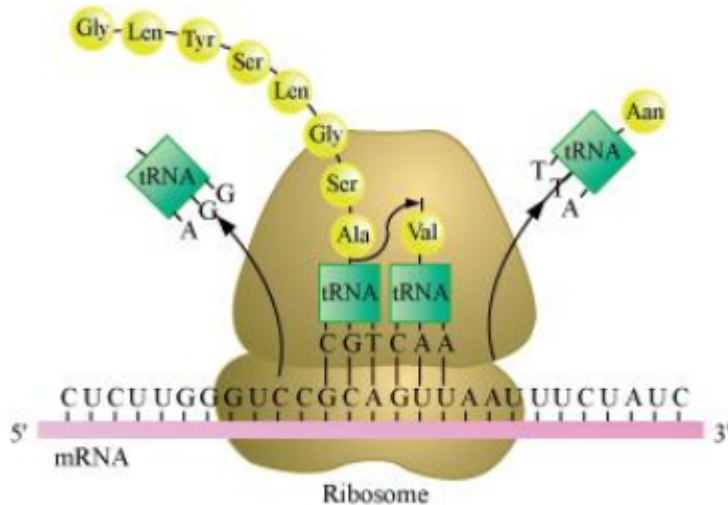
(b) When a normal male marries a carrier female (she is considered normal as she contains the mutant gene on one of her X chromosomes), they can produce a haemophilic son. So, the genotype of the parents would be XY and X^hX .

Parents		XY (Father)	x	X^hX (Mother)
Offspring	X^hX Carrier daughter	XX Normal daughter	X^hY Haemophilic son	XY Normal son

OR

- Translation is the process of polymerising amino acid to form a polypeptide chain.
- The triplet sequence of base pairs in mRNA defines the order and sequence of amino acids in a polypeptide chain.

The process of translation involves the following three steps:



(i) Initiation

(ii) Elongation

(iii) Termination

- During the initiation of the translation, tRNA gets charged when the amino acid binds to it using ATP.
- The start (initiation) codon (AUG) present on mRNA is recognised only by the charged tRNA.
- The ribosome acts as an actual site for the process of translation and contains two separate sites in a large subunit for the attachment of subsequent amino acids.
- The small subunit of ribosome binds to mRNA at the start codon (AUG) followed by the large subunit. Then, it initiates the process of translation.
- During the elongation process, the ribosome moves one codon downstream along with mRNA so as to leave the space for binding of another charged tRNA.
- The amino acid brought by tRNA gets linked with the previous amino acid through a peptide bond and this process continues to result in the formation of a polypeptide chain.
- When the ribosome reaches one or more stop codon (VAA, UAG and UGA), the process of translation gets terminated.
- The polypeptide chain is released and the ribosomes get detached from mRNA.

Q26 : (a) List the different attributes that a population has and not an individual organism.

(b) What is population density ? Explain any three different ways the population density can be measured, with the help of an example each.

OR

"It is often said that the pyramid of energy is always upright. On the other hand, the pyramid of biomass can be both upright and inverted." Explain with the help of examples and sketches.

Answer : (a) Following are the attributes that a population has but an individual organism does not have:

- Birth rate: per capita births

- Death rate: per capita deaths
- Sex ratio: Ratio of number of males to females in a population

(b) Population density means number of individuals present per unit area. Population density can be measured by determining the population size. The different methods to study population size are as follows:

(1) Quadrat method: It is a method that involves the use of square of particular dimensions to measure the number of organisms.

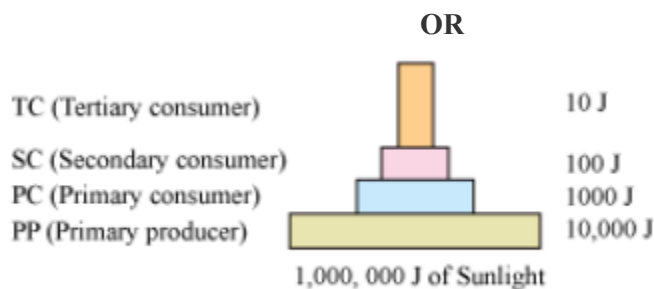
Example: The number of Parthenium plants in a given area can be measured using the quadrat method.

(2) Direct observation: It involves the counting of organisms in the given area.

Example: In order to determine the number of bacteria growing in a Petri dish, their colonies are counted.

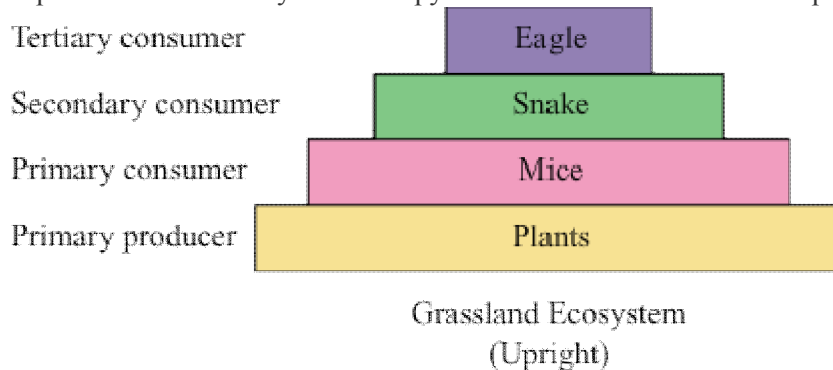
(3) Indirect method: In this method, there is no need to count the organisms individually.

Example: The number of fishes caught per trap gives the measure of their total density in a given water body.

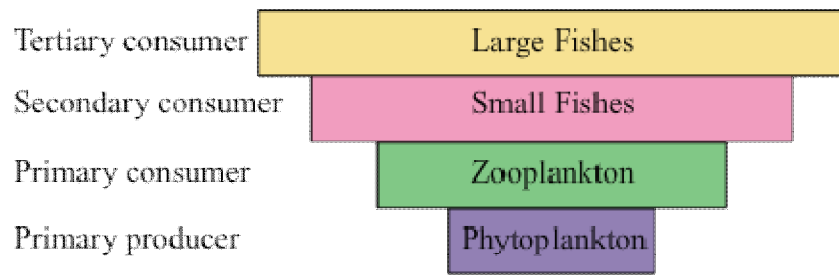


The pyramid of energy represents the total amount of energy consumed by each trophic level in a given food chain. An energy pyramid is always upright because the total amount of energy available for utilisation in the top levels is less than the energy available in the lower levels. This happens because according to the 10% law of energy transfer, only 10% of the total energy is transferred from one trophic level to another.

The pyramid of biomass is a graphical representation of the total amount of living matter present at each trophic level of an ecosystem. The pyramid of biomass can be both upright and inverted.



The pyramid of biomass is upright in grasslands and forest ecosystems because the amount of biomass present at the producer level is higher than at the top carnivore level.



Pond Ecosystem
(Inverted)

The pyramid of biomass is inverted in a pond ecosystem as the biomass of fishes exceeds the biomass of zooplankton (upon which they feed).