Previous Year Question Paper 2019

GENERAL INSTRUCTIONS :

(i) There are total 27 questions and four 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 12, short answer type-I questions of two marks each.
(iv) Section C contains question number 13 to 24, short answer type-II questions of three marks each.
(v) Section D contains question number 25 to 27, long answer type questions of five marks each.
(vi) There is no overall choice in the question paper, however, an internal choice is provided in two questions of one mark, two questions of two marks, four questions of three marks and all the three questions of five marks. In these questions, an examinee is to attempt any one of the two given alternatives.
(vii) Wherever necessary, the diagram drawn should be neat and properly labeled.

Section A

1: British geneticist R.C. Punnett developed a graphical representation of a genetic cross called "Punnett Square". Mention the possible result this representation predicts of the genetic cross carried.

Sol:-

Punnett Square for Mendelian monohybrid cross between pure line tall and dwarf plant will appear as following :

Parent Generation

TT × tt

↓

F_1 Generation Tt

↓

Tt × Tt

(Selfing)

F_2 Generation

	T	t
T	TT	Tt
t	Tt	tt

Result of F_2 generation phenotypic ratio of monohybrid cross is $3:1$.

2: State the two principal outcomes of the experiments conducted by Louis Pasteur on origin of life.

Sol:-

Louis Pasteur by careful experimentation demonstrated that:
(i) Life comes only from pre-existing life.
(ii) In pre-sterilized flasks, life did not come from killed yeast while in another flask open to the air; new organisms arose from killed yeast.

3: Name the layer of the atmosphere that is associated with 'good ozone'.

OR

Mention the term used to describe a population interaction between an orchid growing on a forest tree.

Sol:-

Good ozone is found in upper part of the atmosphere called the stratosphere.

OR

Between an orchid growing on a forest tree, the population interaction is commensalism in which orchid is benefitted and forest tree remains unaffected.

4: What are 'flocs', formed during secondary treatment of sewage?

OR

Write any two places where methanogens can be found.

Sol:-

Flocs are masses of bacteria associated with fungal filaments and they are helpful in increasing the decomposition rate and they are put in the aeration tank while secondary sewage treatment is in process.

5: At what stage does the meiosis occur in an organism exhibiting haploidic life cycle and mention the fate of the products thus produced?

Sol:-

Organisms exhibiting haploidic life cycle show meiosis at zygote stage of their life cycle. Products of meiosis, in their life cycle are haploid cells, which germinate/develop to produce new organisms.

Section B

6: You are conducting artificial hybridization on papaya and potato. Which one of them would require the step of emasculation and why ? However for both you will use the process of bagging. Justify giving one reason.

Sol:-

Potato plant bears bisexual flowers. This is the reason that the process of emasculation, that is, removal of stamen will be performed in potato and not in papaya that bears unisexual flowers. However, bagging is performed in both the flowers because the stigma needs to be protected from getting pollinated with undesired pollen.

7: How would the gene flow or genetic drift affect the population in which either of them happens to take place?

Sol:-

(i) Gene flow (gene migration multiple times) or genetic drift (sudden, chance event) affects the population by changing allele frequency in both old and new populations thereby altering the Hardy-Weinberg equilibrium.

(ii) (a) Disturbance in genetic equilibrium would be interpreted as resulting in evolution in a population.

(b) If the original drifted population becomes founders of a new population, the effect is called founder effect.

8: Differentiate between the roles of B-lymphocytes and T-lymphocytes in generating immune responses.

OR

Principle of vaccination is based on the property of "memory" of the immune system. Taking one suitable example, justify the statement.

Sol:-

T lymphocytes	**B lymphocytes**
Originate in the bone marrow and mature in the thymus.	They are born and also mature in bone marrow.
T cells multiply and differentiate into helper, regulatory, or cytotoxic T cells or become memory T cells.	B lymphocyte differentiates into a plasma cell, which secretes immunoglobulin.
T cells are involved in cell- mediated immunity	B cells are primarily responsible for humoral immunity (relating to antibodies).

OR

The principle of vaccination is based on the property of 'memory' of the immune system. In vaccination, a preparation of antigenic proteins of the pathogen or attenuated (inactivated/weakened) pathogen is introduced in the body. The antibodies produced in the body against these pathogens will neutralize the pathogenic agents during actual infection. The vaccine also generates memory B-cells and T-cells that recognize the pathogen quickly on subsequent exposure. For example, vaccination against polio prevents the actual pathogen from resulting in infection.

9: Explain the relevance of "Totipotency" and "Somaclones " in raising healthy banana plants from virus infected banana plants.

Sol:-

Totipotency can be defined as the ability of a cell/explant to give rise to the whole new plant. This property allows the meristem tissue of a Banana plant to be grown in a culture medium. As the meristematic cells are not infected (virus-free) and being totipotent, they can form the callus. The somaclones are produced via tissue culture and are called so because of their genetic and morphological similarity to the parent plant. These somaclones then give rise to the new plantlets that are infection free.

10: **How is a continuous culture system maintained in bioreactors and why?**

Sol:-

In continuous culture system, the used medium is drained out from one side while fresh medium is added from the other to maintain the cells in their physiologically most active

log/exponential phase. Continuous culture method produces a larger biomass leading to higher yield of desired protein.

11: **List any four ways by which GMO's have been useful for enhanced crop output.**

Sol:-

GMO's have been useful for enhanced crop output in different ways:

(i) genetically modified crops are more tolerant to abiotic stresses (cold, drought, salt, heat) (ii) These genetic modifications have helped to reduce post harvest losses implying less damage to crop yield. (iii) Genetic modification has reduced reliance on chemical pesticides by creating pest resistant crops. eg. Tobacco, leading to greater crop yield. (iv) Creation of insect resistant crops such as Bt cotton and Bt corn has enhanced crop yield. (v) Increased efficiency of mineral usage by GM plants prevents early exhaustion of fertility of soil resulting in increased yield.

12: **Mention four significant services that a healthy forest ecosystem provides .**

OR

Substantiate with the help of one example that in an ecosystem mutualists

(i) tend to co-evolve and

(ii) are also one of the major causes of biodiversity loss.

Sol:-

Ecosystem services provided by healthy forest ecosystems are

(i) Purification of air.

(ii) Maintenance of biodiversity.

(iii) Provide wild life habitat.

(iv) Storage site for carbon.

(v) Cycling of nutrients.

(vi) Mitigate droughts and floods.

OR

(i) In nature, mutualists often co-evolve such as in Mediterranean orchid Ophrys. Ophrys employs sexual deceit to get pollinated by a species of bee. One petal of flower resemble to female bee. If female bee changes its colour pattern ever slightly the success of pollination will be reduced unless orchid flower co-evolves to maintain resemblance with female bee.

(ii) Co-extinction is one of the 'Evil Quartet' in which organisms with obligatory relationship like plant pollinator mutualism will result in extinction of one partner if other is eliminated in nature.

Section C

13: **Pollen banks are playing a very important role in promoting plant breeding programme the world over. How are pollens preserved in the pollen banks? Explain. How are such banks benefitting our farmer? Write any two ways.**

Sol:-

Pollen banks are used to store pollens for a very long period of time in viable conditions. Pollens are preserved in a bank using cryopreservation i.e., they are stored in a viable condition in low-temperature conditions (-196 degree Celsius) using liquid nitrogen.

The important applications of pollen banks for our farmers are the following:

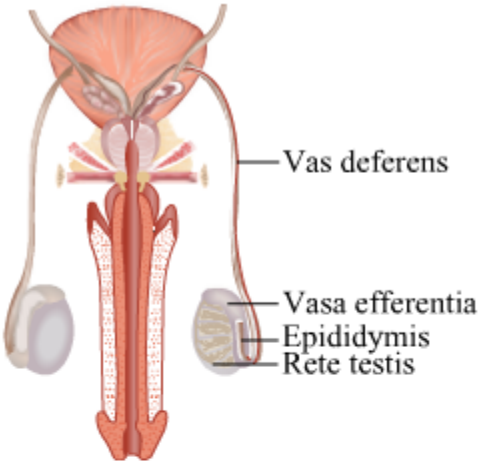
1. To preserve the agricultural biodiversity in the form of preservation of valuable genetic resources.

2. These pollens can be used in various crop hybridization breeding programmes, biochemical and physiochemical studies such as the study of allergens etc.

14: **Draw a labelled diagram to show interrelationship of four accessory ducts in a human male reproductive system.**

OR

Draw a sectional view of the human ovary showing the different stages of developing follicles, corpus luteum and ovulation.



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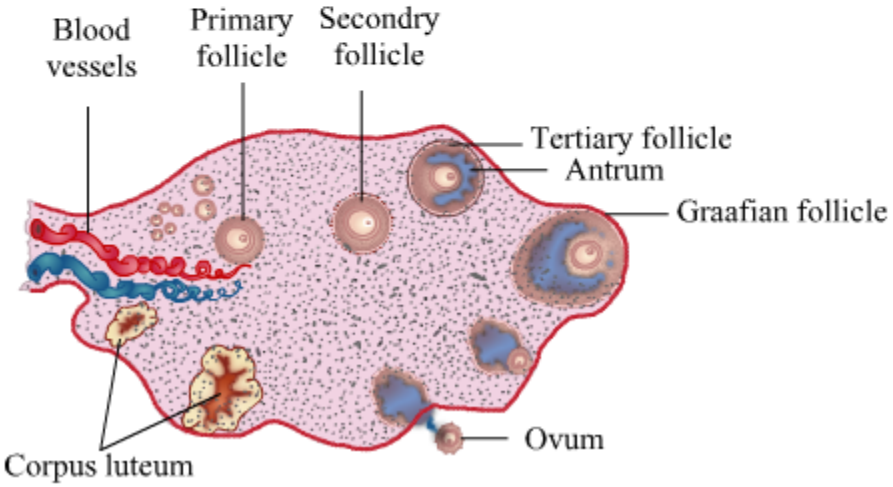


15: **Compare in any three ways the chromosomal theory of inheritance as proposed by Sutton and Bovery with that of experimental results on pea plant presented by Mendel.**

OR

(a) Explain linkage and recombination as put forth by T.H. Morgan based on his observations with Drosophila melanogaster crossing experiment.

(b) Write the basis on which Alfred Sturtevant explained gene mapping.

Sol:-

Through any of the given ways chromosomal theory of inheritance and experimental results presented by Mendel can be compared:
(i) In a diploid organism, the factors (genes) and chromosomes occur in pairs.
(ii) Both chromosomes as well as genes segregate at the time of gamete formation such that only one of each pair is transmitted to a gamete.
(iii) A gamete contains only one chromosome of a type and only one of the two alleles of a trait.
(iv) The paired condition of both chromosomes as well as Mendelian factors is restored during fertilisation.

OR

(a) T.H. Morgan studied X-linked genes in Drosophila and saw that when the two genes in a dihybrid cross were situated on the same chromosome, the proportion of parental gene combinations was much higher than the non-parental type. He attributed this due to the physical association or linkage of the two genes on a chromosome and coined the term linkage and the term recombination describes the generation of non-parental gene combination.
(b) Alfred Sturtevant explained gene mapping by using the frequency of recombination between gene pairs on the same chromosome as a measure of the distance between genes and he mapped their position on the chromosome.

16: **Explain the mechanism of DNA replication with the help of a replication fork.**
What role does the enzyme ONA-ligase play in a DNA replication fork?

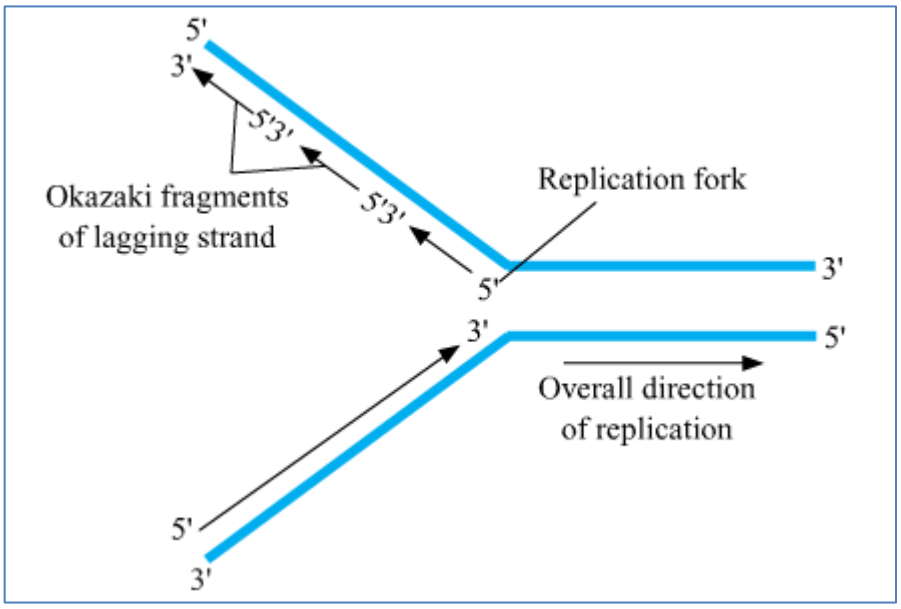
OR

Construct and label a transcription unit from which the RNA segment given below has been transcribed. Write the complete name of the enzyme that transcribed this RNA.

Sol:-

DNA replication occurs in small replication forks. It does not occur in its entire length in one time as DNA is a very large molecule and only that part of DNA opens up which is being replicated. The opening of the whole DNA molecule would be an energetically more expensive process.
The main enzyme involved in DNA replication is the DNA-dependent DNA polymerase. This enzyme catalyzes the polymerization of deoxynucleotides along the $5' \rightarrow 3'$ direction, and hence, replication is continuous along the $3' \rightarrow 5'$ strand (leading strand) and discontinuous along the template, i.e., the $5' \rightarrow 3'$ direction (lagging strand).
Okazaki fragments are short DNA segments on the lagging strand, formed in the $5'-3'$ direction, starting from RNA primers. A separate RNA primer is needed for the synthesis of each Okazaki fragment. These discontinuously synthesized fragments are later joined by the enzyme DNA ligase.

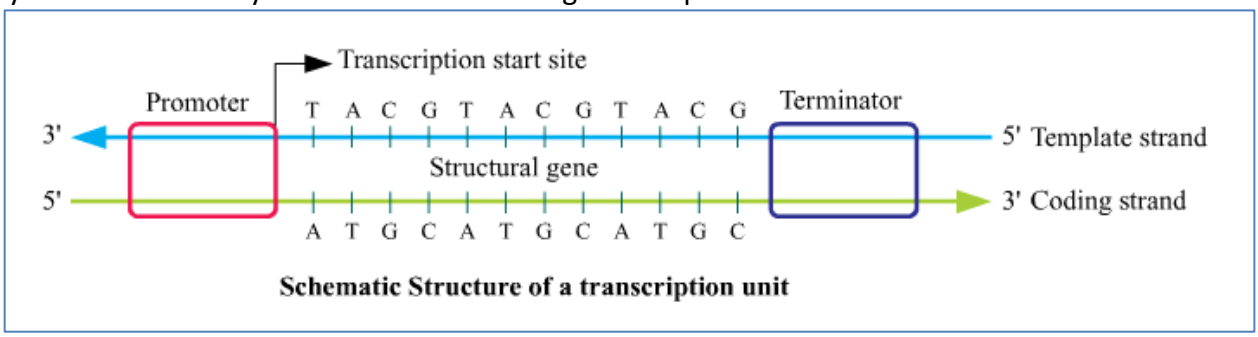
Ori stands for Origin of replication. This site has the highly conserved sequence of DNA among various species. The replication of DNA starts here because this site attracts some proteins which help in the opening and unwinding of DNA and this leads to the initiation of replication. The function of DNA Ligase is to join the two nucleotides. During the DNA replication process, it joins the Okazaki fragments of the daughter DNA to form the complete DNA molecule on the lagging strand.



OR

As per the question, the RNA strand given is having Thymine which is not possible. Hence, the question is wrong.

Taking U (Uracil) instead of T (Thymine) in the given strand the possible solution shall be RNA Polymerase is the enzyme which is used during transcription.



Schematic Structure of a transcription unit

17:

(a) Write two differences between Homo erectus and Homo habilis.

(b) Rearrange the following from early to late geologic periods :

Carboniferous, Silurian, Jurassic.

Sol:-

(a)

Character	Homo erectus	Homo habilis
(i) Brain capacity	900 cc	650-800 cc
(ii) Eating habit	They probably ate meat	They probably did not eat

		meat

(b) The correct sequence from early to late geological period is :
Silurian period $\rightarrow$ Carboniferous period $\rightarrow$ Jurassic period

18: **Name the group of bacteria involved in setting milk into curd. Explain the process they carry in doing so. Write another beneficial role of such bacteria.**

Sol:-

Lactobacillus and other Lactic Acid Bacteria (LAB) are responsible for the curdling of milk. These bacteria utilise and act upon the milk sugar lactose leading to its oxidation to lactic acid. This lactic acid produced in turn leads to partial digestion and coagulation of milk proteins to form curd. Action by LAB also leads to an increase in vitamin B_{12} content of the curd.

On consumption of curd, these bacteria add to the healthy and beneficial gut flora outcompeting the growth of harmful gut flora.

19: **Bee keeping practice is a good income generating industry. Write the different points to be kept in mind for successful bee keeping. Write the scientific name of the most common Indian species used for the purpose.**

Sol:-

The important points for successful bee keeping are as follows.
(i) Knowledge about habits and nature of bees
(ii) Selection of suitable location for placing beehives
(iii) Catching and hiving of group of bees
(iv) Management of beehives during various seasons The scientific name of the most common Indian species used for apiculture is Apis indica.

20:

(a) Match the microbes listed under Column -A with the products mentioned under Column -B.

Column-A	**Column-B**
(H) Peniciffium notatum	**(i)** Statin
(I) Trichoderma polysporum	**(ii)** ethanol
(J) Monascus purpures	**(iii)** antibiotic
(K) Saccharomyces cerevisia	**(iv)** Cyclosporin-A

(b) Why does 'Swiss Cheese' develop large holes?

Sol:-

(a)

(H) Peniciffium notatum	**(iii)** antibiotic
(I) Trichoderma polysporum	**(iv)** Cyclosporin -A
(J) Monascus pupurea	**(i)** Statin
(K) Saccharomyces cerevisiae-	**(ii)** ethanol

(b) Swiss cheese develops large holes because of the large amount of carbon dioxide produced by the bacterium Propionibacterium shermanii.

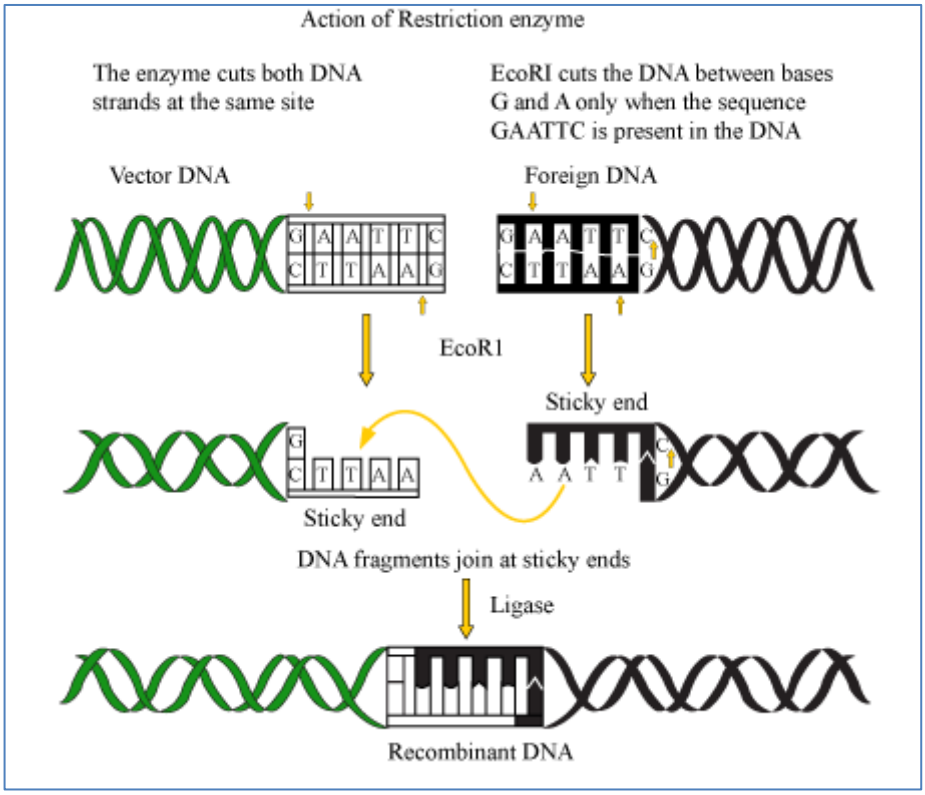
21: **Describe the formation of recombinant DNA by the action of EcoRI.**

OR

Describe the process of amplification of "gene of interest" using PCR technique.

Sol:-

Restriction endonuclease enzyme EcoRl is used in the molecular biology to cut the foreign DNA and vector DNA to form overhangs (called sticky ends). These sticky ends then form hydrogen bonds with their complementary counterparts. The segments with the help of DNA ligases are joined to produce recombinant DNA.



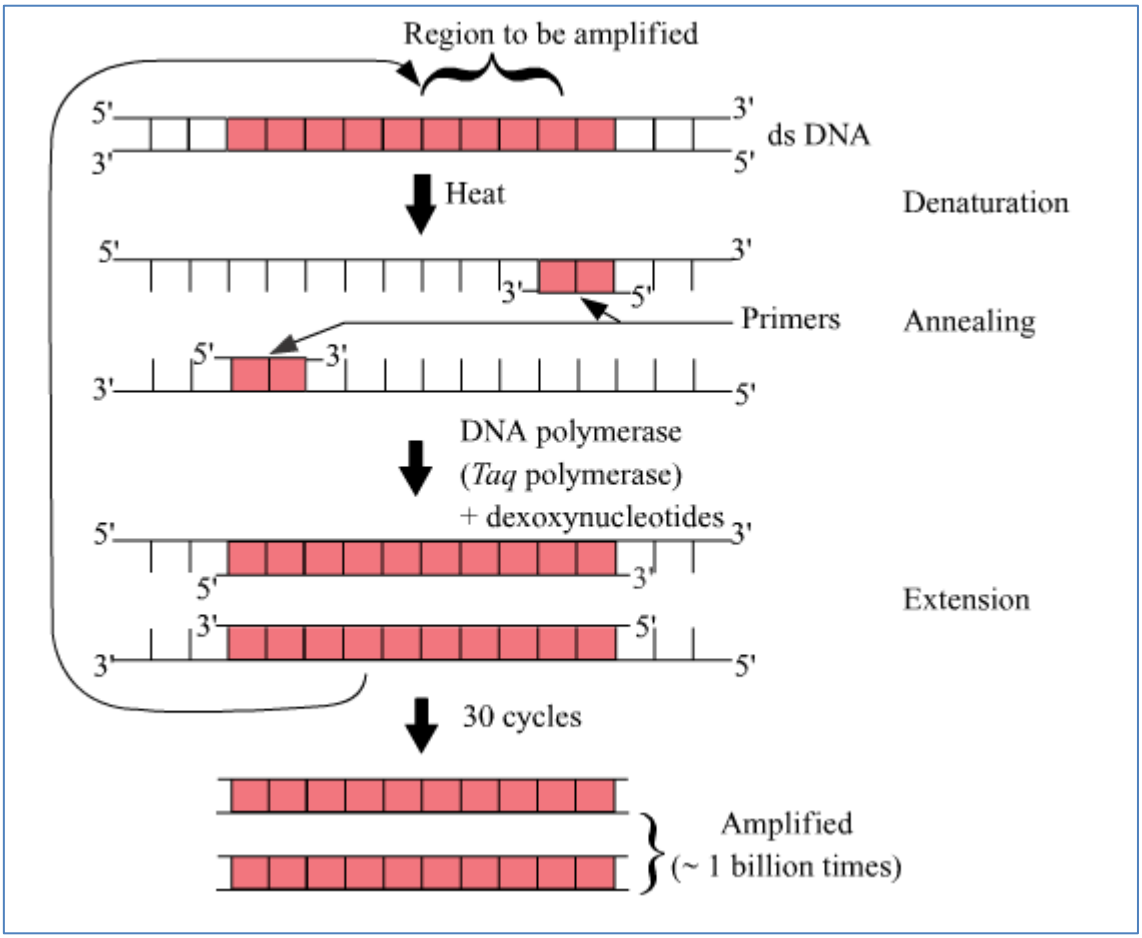
OR

To amplify the gene segment of the interest we should know the sequence of the gene of interest. Primers are designed for amplifying the gene of interest. Two sets of primers (chemically synthesized oligonucleotide stretches) that are complementary to the gene of interest, DNA polymerase enzyme, and deoxynucleotides are added. PCR can then be carried out for its amplification.

PCR consists of 3 steps: • Denaturation - Double-helical DNA is denatured by providing high temperature(95-degree Celsius). DNA polymerase does not get degraded in such high temperatures. The DNA polymerase used in this reaction is thermostable and is isolated from the thermophilic bacteria, Thermus aquaticus(Taq).

• Annealing- It is the step in which primers are annealed to single-stranded DNA templates. Two sets of primers are used. The temperature of the reaction mixture is lowered to 50- 65°C for some seconds to allow annealing of primers. DNA polymerase extends the primer in 5' to 3' direction.

• Extension - Replication of DNA occurs in vitro.



-This cycle is repeated several times to generate up to 1 billion identical copies of the DNA.

22: **Two children, A and B aged 4 and 5 years respectively visited a hospital with a similar genetic disorder. The girl A was provided enzyme-replacement therapy and was advised to revisit periodically for further treatment. The girl, B was, however, given a therapy that did not require revisit for further treatment.**

(a) Name the ailments the two girls were suffering from ?

(b) Why did the treatment provided to girl A required repeated visits ?

(c) How was the girl B cured permanently ?

Sol:-

(a)

ADA (adenosine deaminase) deficiency is a form of SCID (severe combined immunodeficiency)- a type of disorder that affects the immune system. The disease is caused by a mutation in a gene on chromosome 20. The gene codes for the enzyme adenosine deaminase (ADA). Without this enzyme, the body is unable to break down a toxic substance called deoxyadenosine. The toxin builds up and destroys infection-fighting immune cells called T and B lymphocytes.

(b)

Girl A was given Enzyme replacement therapy in which lymphocytes isolated from patient's blood are cultured in-vitro. Functional ADA cDNA are then introduced into the cultured lymphocytes. These lymphocytes are returned back to the patient's body. Lymphocytes are not

immortal. Therefore, repeated infusion of genetically engineered lymphocytes is required and hence it is not a permanent treatment and the patient have to revisit periodically in the future.

(c)

Girl B was treated with gene therapy through the gene isolated from bone marrow cells producing ADA is introduced into cells at early embryonic stages which are a permanent cure so the patient is cured permanently.

23: **List six advantages of "ex-situ' approach to conservation of biodiversity.**

Sol:-

The Ex-situ conservation involves protection of the plants and animals away from the natural habitat. Zoological parks, botanical gardens, and wildlife safari parks serve this purpose. It offers the following advantages:

(i) The endangered organisms are protected from their exploitation and can be maintained in artificial habitats.

(ii) Their breeding programs can be regulated and the gametes, as well as embryos, can be preserved in viable and fertile conditions.

(iii) Seeds from different genetic strains can be made to undergo hybridization and can be kept for future experiments.

(iv) The health of individuals can be monitored and medical assistance can be given as required.

(v) Modern reproductive technology can increase the chances of reproductive success.

(vi) Research into reproductive physiology, lifestyle, and ecology of an endangered species is made easier.

24: **While on a visit to a pond in the city-neighbourhood, the visitors were delighted to find large expanse of water covered with colourful algal mass.**

(a) As a student of biology, do you agree with their delight? Give reasons in support of your answer.

(b) Explain the cause of such algal growth.

Sol:-

(a) What the villagers saw and are delighted about is algal bloom over a stationary water body. This algal bloom will cut off the supply of light and oxygen to the submerged flora and fauna of the water body. It will outcompete the water bodies flora and fauna for nutrients and will rapidly grow and deplete other organisms in the given water body ecosystem of necessary nutrients. This will quickly lead to the death, decay and destruction of the already existing water body ecosystem.

(b) The flushed out and washed nutrients from the excess fertilisers of the nearby fields had accumulated and promoted the sudden burst in the growth of algal bloom on the water body. This phenomenon is often termed as Cultural or Accelerated Eutrophication.

Section D

25: **(a)** Explain one application of each one of the following:

(A) Amniocentesis

(B) Lactational amenorrhea

(C) ZIFT

(b) Prepare a poster for the school programme depicting the objectives of : "Reproductive and Child Health Care Programme".

OR

(a) Explain any two ways by which apomictic seed can develop.

(b) List one advantage and one disadvantage of a apomictic crop.

(c) Why do farmers find production of hybrid seeds costly?

Sol:-

(a)

(A) Amniocentesis is a process by which amniotic fluid (fluid present inside the uterus surrounding the unborn baby) from the uterus of a pregnant lady is taken out by a needle to test the developmental abnormalities of the baby inside the mother's womb. This test can detect genetic disorders like thalassemia, Down's syndrome, anaemia, and many other abnormalities before birth.

(B) Lactational amenorrhea: It is the absence of menstruation during lactation. So, in the lactation period, the chances of conception are almost zero.

(C) ZIFT: It stands for zygote intrafallopian transfer. In ZIFT, the sperm from a donor male and the ova from a donor female are fused in the laboratory. The zygote so formed is transferred into the fallopian tube at the 8 blastomeres stage. This process is used to treat the condition of infertility.

OR

(a) The two ways in which apomictic seeds can develop are:-

1. Recurrent Apomixis: An embryo sac develops from the megaspore mother cell with disturbed meiosis due to which the egg-cell is diploid. The embryo subsequently develops directly from the diploid egg-cell without fertilization.

2. Adventive Polyembryony: Embryos arise from a cell or a group of cells either in the nucellus or in the integuments, e.g. in oranges and roses. Since it takes place outside the embryo sac, it is not grouped with recurrent apomixis. Embryo within the embryo sac may also develop simultaneously, thus giving rise to polyembryony condition, as in Citrus, Opuntia.

(b) An advantage of apomictic crop is that the vigor is maintained and these seeds can be raised to grow new crop year after year resulting in tremendous crop production. A disadvantage of the apomictic crop is that it reduces genetic diversity.

(c) The production of hybrid seeds involves a process of artificial hybridization that comes along with steps such as emasculation, bagging, raising of seedlings in nursery beds etc. This process requires intensive labor and is also not feasible economically for all farmers. Also, the hybrid seeds cannot be used for the next season. This further adds to their cost.

26: **Differentiate between incomplete dominance and co -dominance. Substantiate your answer with one example of each.**

OR

(a) Write the contributions of the following scientists in deciphering the genetic code.
Georce Gamow ; Hargobind Khorana ; Marshall Nirenberg ; Severo Ochoa

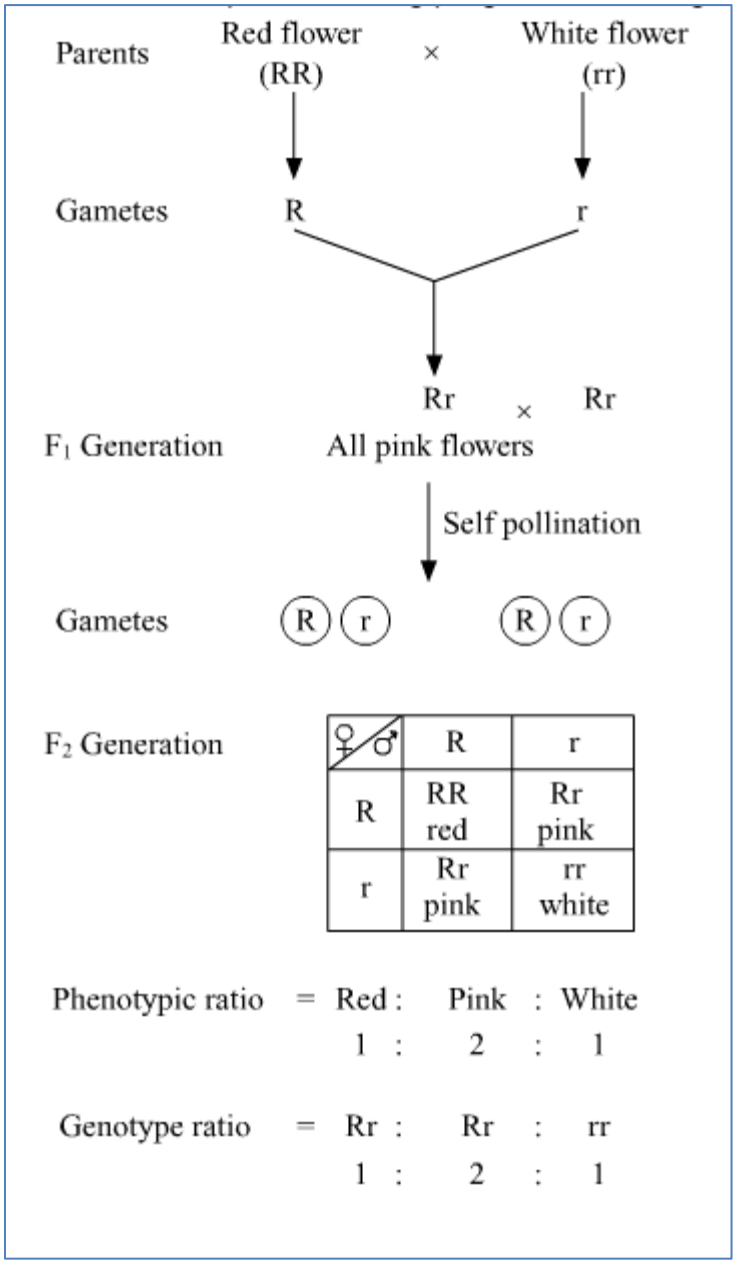
(b) State the importance of a Genetic code in protein biosynthesis.

Sol:-

Co-dominance is the phenomenon in which both the alleles of a contrasting character are expressed in the heterozygous condition. Both the alleles of a gene are equally dominant. ABO blood group in human beings is an example of co-dominance. The blood group character is controlled by three sets of alleles, namely 4^3. The alleles, I^A and I^B, are equally dominant and are said to be co-dominant as they are expressed in the AB blood group. Both these alleles do not interfere with the expression of each other and produce their respective antigens. Hence, the AB blood group is an example of co-dominance.

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

Incomplete dominance is a phenomenon in which one allele shows incomplete dominance over the other member of the allelic pair for a character. For example, a monohybrid cross between the plants having red flowers and white flowers in Antirrhinum species will result in all pink flower plants in the F_1 generation. The progeny obtained in F_1 generation does not resemble either of the parents and exhibits 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 genotype.



OR

(a) George Gamow proposed that if 20 amino acids are to be coded by 4 bases, then the code should be made up of three nucleotides.

$43 = 64 (42 = 16)$, which is less than 20; so, the codon was proposed to be a triplet. Har Gobind Khorana developed a chemical method to synthesise RNA molecules with defined combination of bases. Marshall Nirenberg developed cell-free systems for protein synthesis, which helped the code to be deciphered. Severo Ochoa discovered an enzyme (polynucleotide phosphorylase) which helped in the synthesis of RNA with defined sequences in a template-independent manner.

(b) The genetic code is a set of three different nucleotides taken at a time which code for a specific amino acid.

1. A codon is a triplet. 4^3 = 64 (61 codons code for amino acids while 3 are stop codons)

2. One codon codes for a single specific amino acid. Codons are unambiguous.

3. Codons are degenerate since some amino acids are coded by more than one codon.

4. The genetic code is universal. 1 codon codes for the same amino acid in all species.

5. Codons are read continuous. They lack punctuations.

6. AUG has dual functions - Codes for Methionine and acts as a start codon

27:

(a) What is "population" according to you as a biology student?

(b) "The size of a population for any species is nota static parameter." Justify the statement with specific reference to fluctuations in the population density of a region in a given period of time.

OR

(a) What is hydrarch succession?

(b) Compare the pioneer species and climax communities of hydrarch and xerarch succession respectively.

(c) List the factors upon which the type of invading pioneer species depend in secondary hydrarch succession. Why is the rate of this succ ession faster than that of primary succession?

Sol:-

(a) The term 'Population' refers to the group of individuals of a species living together in a group in a well-defined geographical area, sharing or competing for resources and potentially interbreeding. Although the term interbreeding implies sexual reproduction, a group of individuals resulting from even asexual reproduction is also considered a population.

(b) The size of a population of any species is not a static parameter. It keeps changing in time, depending on various factors including food availability, predation pressures, and weather. The population density in a given period can fluctuate due to the following four factors:

(i) Natality: It refers to the number of births during a given period in the population that are added to the initial density.

(ii) Mortality: It refers to the number of deaths during a given period that reduced the size.

(iii) Immigration: It is the number of individuals of the same species that have come into the habitat from elsewhere during the given period.

(iv) Emigration: It is the number of individuals who left the habitat and have gone elsewhere.

OR

(a) Succession that occurs in wetter areas and the successional series progress from hydric to the mesic condition is called the hydrarch succession.

(b) The species that invade a bare area are called the pioneer species while the climax community is established over the process of succession and it is in near equilibrium with the environment. The pioneer species of hydrarch succession are phytoplankton and the climax community is the xerophytic forest. The pioneer species of xerarch succession are lichens and the climax community is the mesophytic forest.
(c) In secondary succession the species that invade depend on the condition of the soil, availability of water, the environment and the seeds and propagules already present. Since the soil is in existence already, the rate of secondary succession is faster than the primary succession, in which the soil is gradually produced.