

Class XII

BIOLOGY (Theory)

(CBSE 2019)

SOLUTION

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 labelled.

Section-A

1. At what stage does the meiosis occur in an organism exhibiting haploidic life cycle and mention the fate of the products thus produced? [1]

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. [$\frac{1}{2}$ + $\frac{1}{2}$]

2. Write the number of chromosomes body cells of honey bee workers and drone have. [1]

Sol. Number of chromosomes in body cells of worker honey bees is 32 (2n) while drones have 16 (n). [$\frac{1}{2}$ + $\frac{1}{2}$]

3. What are 'flocs', formed during secondary treatment of sewage? [1]

OR

Write any two places where methanogens can be found.

Sol. Flocs are masses of bacteria associated with fungal filaments to form mesh like structures. [1]

OR

Methanogens are found in

1. Marshes [½]
2. Rumen of cattle [½]

4. Name the layer of the atmosphere that is associated with 'good ozone'. [1]

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. [1]

OR

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

5. 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. [1]

Sol. In monohybrid cross for heights in pea plant, Punnett square shows that parental tall (Tt) plant when self pollinated, the $\frac{1}{4}$ th fertilization results TT (tall), $\frac{1}{2}$ lead to Tt (tall) and $\frac{1}{4}$ th lead to tt (dwarf) plants [½]

Tt × Tt (Self Pollination)

	♂	
		↓
♀	T	t
T	TT Tall	Tt Tall
t	Tt Tall	tt Dwarf

Phenotypic ratio – Tall : Dwarf
3 : 1

Genotypic ratio – TT : Tt : tt
1 : 2 : 1

[½]

Section-B

6. It is said apomixes is a type of asexual reproduction. Justify. [2]

Sol. Apomixis is a form of asexual reproduction that mimics sexual reproduction, because

- (1) In apomixis, reductional division and fusion of gametes does not occur which is a feature of asexual reproduction.
- (2) Embryos produced by apomixis are genetically identical to each other. Production of genetically identical structures is a feature of asexual reproduction. [1+1]

7. Mention four significant services that a healthy forest ecosystem provide. [2]

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.

[Write any four] $[\frac{1}{2} \times 4 = 2]$

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 even slightly the success of pollination will be reduced unless orchid flower co-evolves to maintain resemblance with female bee. [1]
- (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. [1]

8. Write the steps in sequence as carried in multiple ovulation embryo transfer technology. [2]

Sol. The steps involved in Multiple Ovulation Embryo Transfer technology (MOET) are :

- (a) The cattle/mares are administered hormones, with FSH-like activity. $[\frac{1}{4}]$
Administered hormone induces follicular maturation and superovulation and they produce 6-8 eggs per cycle instead of one egg. $[\frac{1}{4}]$
- (b) The animal is either mated with an elite bull or artificially inseminated. $[\frac{1}{4}]$
- (c) The fertilised eggs at 8-32 cells stages, are recovered non-surgically and transferred to surrogate mothers. $[\frac{1}{4}]$
- (d) The genetic mother is available for another round of superovulation. $[\frac{1}{4}]$

9. What is an origin of replication in a chromosome? State its function. [2]

Sol. There is a definite region in DNA of an organism where the replication originates. Such regions are termed as 'origin of replication'. [1]

Origin of replication in DNA is required to initiate the process of replication. [1]

10. List any four ways by which GMO's have been useful for enhanced crop output. [2]

Sol. GMO's have been useful for enhanced crop output in following ways :

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

(Any four) $[\frac{1}{2} \times 4 = 2]$

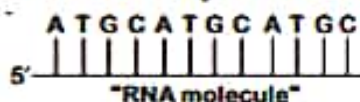
11. How is a continuous culture system maintained in bioreactors and why? [2]
- Sol. • In continuous culture system, the used medium is drained out from one side while fresh medium is added from the other to maintain the cells in their physiologically most active log/exponential phase. [1]
- Continuous culture method produces a larger biomass leading to higher yield of desired protein. [1]
12. How would the gene flow or genetic drift affect the population in which either of them happen to take place? [2]
- Sol. (i) Gene flow (gene migration multiple times) or genetic drift (sudden, chance event) affect the population by changing allele frequency in both old and new populations thereby altering the Hardy-Weinberg equilibrium. [1]
- (ii) (a) Disturbance in genetic equilibrium would be interpreted as resulting in evolution in a population. [½]
- (b) If the original drifted population become founders of a new population, the effect is called founder effect. [½]

Section-C

13. How does a bisexual flowering plant ensures cross pollination? Explain. [3]
- Sol. Bisexual flowering plants use different devices to encourage cross-pollination, such as
- (i) Different maturation time of androecium and gynoecium in the same flower. Such phenomenon is called Dichogamy.
e.g., In *Ficus* plant, stigma becomes receptive much before the release of pollen.
- (ii) Failure of the pollen grains from the same plant (same flower or different flower of same plant) from fertilising the ovule by inhibiting pollen germination or pollen tube formation. This phenomenon is called Self-incompatibility which is a genetically controlled mechanism.
- (iii) In some plants, the anther and stigma are placed at different position, so that pollen grains do not come in contact with stigma of the same flower. [1+1+1=3]
14. 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. [3]
- Sol. The following points are important for successful beekeeping :
- (i) Knowledge of the nature and habits of bees
- (ii) Selection of suitable location for keeping the beehives
- (iii) Catching and hiving of swarms (group of bees)
- (iv) Management of beehives during different seasons
- (v) Handling and collection of honey and of beeswax [½ × 5 = 2½]
- The most common Indian species used for beekeeping is *Apis indica*. [½]
15. Explain the mechanism of DNA replication with the help of a replication fork. What role does the enzyme DNA-ligase play in a DNA replication fork? [3]

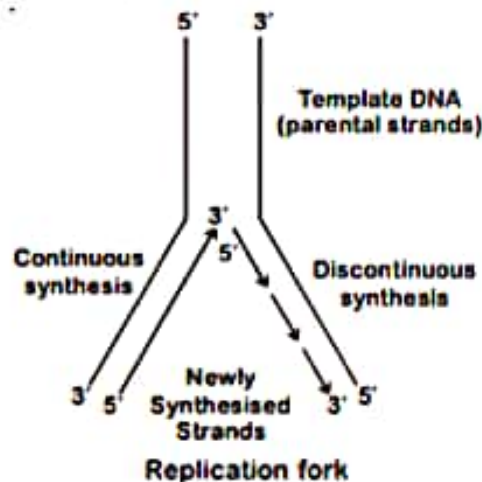
OR

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 is semiconservative. The process requires a set of enzymes. The main enzyme is referred as DNA-dependent DNA polymerase, since it uses DNA template to catalyse the polymerisation of deoxyribonucleotides. Deoxyribonucleotides serve dual purpose. In addition to acting as substrate, they provide energy for polymerisation reaction.

The replication occur within a small opening of DNA helix called as 'replication fork'.



The DNA-dependent DNA polymerase catalyse polymerisation only in one direction i.e. $5' \rightarrow 3'$. This creates some additional complications at the replication fork.

Consequently on one strand (the template with polarity $3' \rightarrow 5'$) the replication is continuous while on other (the template with polarity $5' \rightarrow 3'$), it is discontinuous. [2]

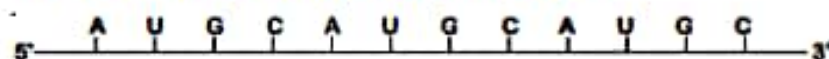
These discontinuously synthesised fragments are called 'Okazaki fragments' which are later joined by enzyme DNA ligase. [1]

OR

The process of copying genetic information from one strand of DNA into RNA is called 'transcription'.

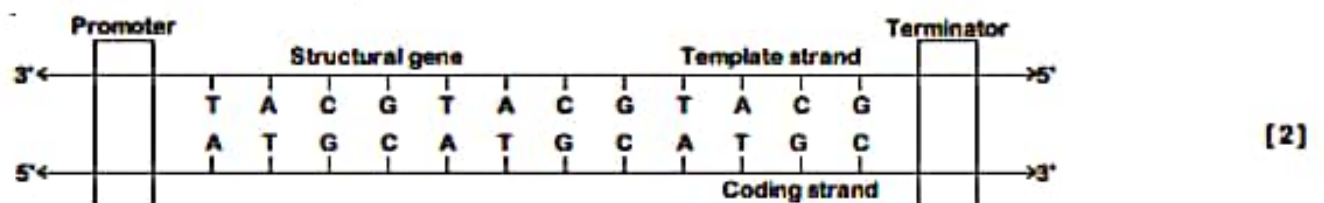
Transcription is catalysed by 'DNA dependent RNA polymerase'. [1]

The RNA molecule given in question should be



As RNA have uracil at the place of thymine.

For given RNA the transcription unit will be -



16. (a) Write two differences between *Homo erectus* and *Homo habilis*. [3]

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

Carboniferous, Silurian, Jurassic.

Sol. (a)

Character	<i>Homo erectus</i>	<i>Homo habilis</i>
(i) Brain capacity	900 cc	650–800cc
(ii) Eating habit	They probably ate meat.	They probably did not eat meat.

[$\frac{1}{2} \times 4 = 2$]

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(b) The correct sequence from early to late geological period is :

Silurian period → Carboniferous period → Jurassic period [1]

17. List six advantages of “*ex-situ*” approach to conservation of biodiversity. [3]

Sol. *Ex-situ* conservation strategies help

- (i) To conserve those animals that have become extinct in wild but can be maintained in zoological parks. [$\frac{1}{2}$]
- (ii) To preserve gametes of threatened species in viable condition through cryopreservation. [$\frac{1}{2}$]
- (iii) To propagate threatened plants via tissue culture. [$\frac{1}{2}$]
- (iv) To grow plants with recalcitrant seeds in orchards where all possible varieties are maintained. [$\frac{1}{2}$]
- (v) To conserve seeds of commercially important plants in seed banks. [$\frac{1}{2}$]
- (vi) To save endangered or threatened plant that needs urgent measure to save it from extinction in botanical gardens. [$\frac{1}{2}$]

18. Effluent from the primary treatment of sewage is passed for secondary treatment. Explain the process till the water is ready to be released into natural water bodies. [3]

Sol. For secondary treatment of waste water the primary effluent is passed into large aeration tanks, where it is constantly agitated mechanically and air is pumped into it. This allows vigorous growth of useful aerobic microbes into flocs. While growing these microbes consume the major part of the organic matter in the effluent. This reduces the BOD of the effluent. The sewage is treated till the BOD is reduced.

Once the BOD of sewage is reduced significantly the effluent is then passed into a settling tank where the bacterial flocs are allowed to sediment, this sediment is called activated sludge. A small part of the activated sludge is pumped back into the aeration tank to serve as the inoculum. The remaining major part of the sludge is pumped into anaerobic sludge digesters. The effluent from the secondary treatment plant is generally released into natural water bodies like rivers and streams. [3]

19. 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. [3]

- (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) Both girls suffer from adenosine deaminase deficiency due to probable deletion of gene that codes for ADA production. [1]

(b) Girl A was treated with injections of functional ADA or bone marrow transplant. These techniques are not completely curative as these lymphocytes are not immortal and require repeated treatment. [1]

(c) Girl B was treated using gene-therapy where the gene isolate from marrow cells producing ADA was introduced into cells at an early embryonic stage for a possible permanent cure. [1]

20. Draw a labelled diagram to show interrelationship of four accessory ducts in a human male reproductive system. [3]

OR

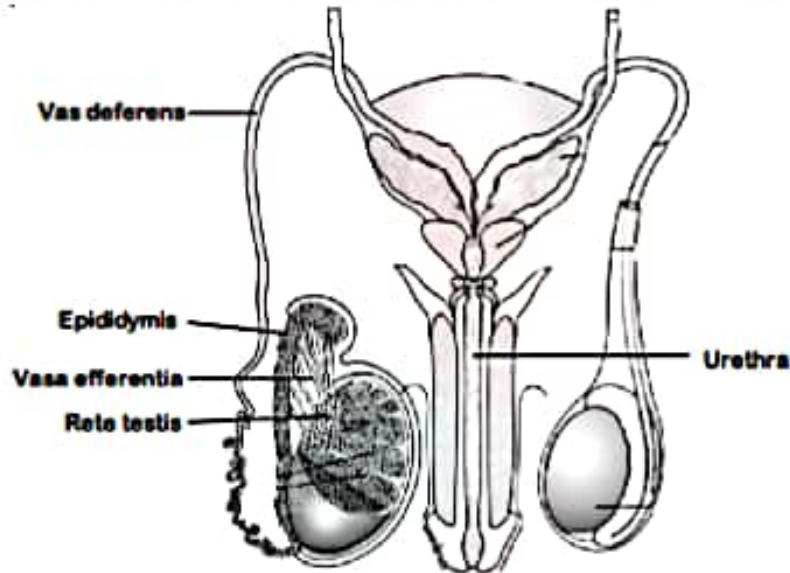
Draw a sectional view of the human ovary showing the different stages of developing follicles, corpus luteum and ovulation.

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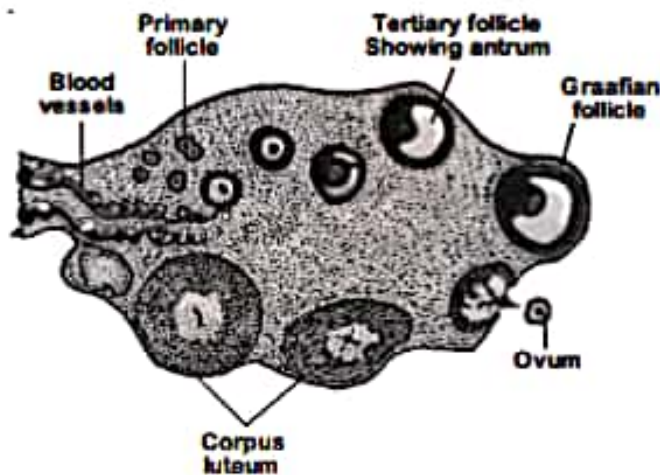
Draw a sectional view of the human ovary showing the different stages of developing follicles, corpus luteum and ovulation.

Sol. The male sex accessory ducts include rete testis, vasa efferentia, epididymis and vas deferens.



[1 Diagram + 2 labelling]

OR



[½ Diagram + 2½ Labelling]

21. Compare in any three ways the chromosomal theory of inheritance as proposed by Sutton and Boveri with that of experimental results on pea plant presented by Mendel. [3]

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.
- (Any three) [3]

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 were 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.

[2]

- (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.
- [1]

22. Describe the formation of recombinant DNA by the action of EcoRI. [3]

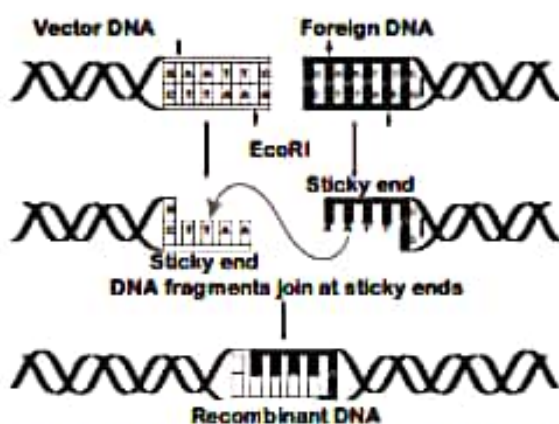
OR

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

Sol. Steps involved in the formation of recombinant DNA by action of restriction endonuclease enzyme - EcoRI:

The enzyme cuts both DNA strands at the same site

EcoRI cuts the DNA between bases G and A only when the sequence GAATTC is present in the DNA



[2]

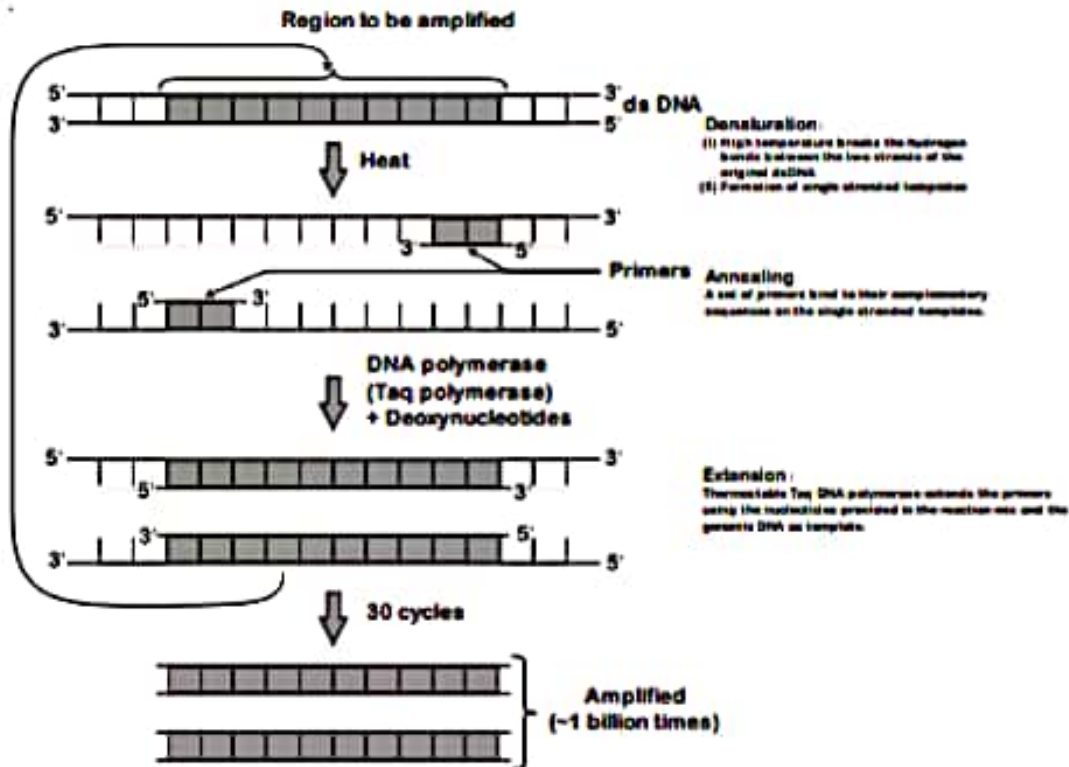
- (i) Restriction enzyme EcoRI cuts the strands of foreign and vector DNA at palindromic site 5'GAATTC3', between the same two bases on the opposite strands.
 - (ii) This leaves single stranded portions at the ends called sticky ends on each strand.
 - (iii) These sticky ends can be joined together (end to end) by the action of the enzyme DNA ligase to form recombinant DNA.
- [1]

OR

The amplification of gene interest using PCR (Polymerase Chain Reaction) technique involves following steps:

- (i) Denaturation at 94°C
- (ii) Annealing at 50° – 60°C
- (iii) Extension at 72°C

[1]



[2]

23. (a) Match the microbes listed under Column-A with the products mentioned under Column-B. [3]

Column-A	Column-B
(H) <i>Penicillium notatum</i>	(i) Statin
(I) <i>Trichoderma polysporum</i>	(ii) ethanol
(J) <i>Monascus purpurea</i>	(iii) antibiotic
(K) <i>Saccharomyces cerevisiae</i>	(iv) Cyclosporin-A

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

Sol. (a) Column-A	Column-B
(H) <i>Penicillium notatum</i>	(iii) Antibiotic
(I) <i>Trichoderma polysporum</i>	(iv) Cyclosporin-A
(J) <i>Monascus purpureus</i>	(i) Statin
(K) <i>Saccharomyces cerevisiae</i>	(ii) Ethanol

[½ + ½ + ½ + ½]

- (b) Swiss cheese is ripened with the help of bacterium called *Propionibacterium shermanii*. The large holes in Swiss cheese are due to production of a large amount of CO₂ by this bacterium during fermentation.

[1]

24. Explain any two most important levels of biological organisation showing biodiversity with the help of an example each. [3]

Sol. Biodiversity at the levels of biological organisation:

(i) Genetic Diversity:

Genetic diversity is a measure of variety in genetic information contained in the organisms. Within a species, genetic diversity occurs in the differences of alleles, entire genes and chromosomal structures. [1]

Example: 1,000 varieties of mango are found in India due to genetic variation. [½]

(ii) Species Diversity:

Species diversity refers to the variety of species within a region. Maximum taxonomic diversity occur where species of taxonomically different groups occur in almost equal abundance. [1]

Example: Western Ghats have greater amphibian diversity as compared to Eastern Ghats. [½]

(iii) Ecological Diversity:

Ecological diversity is the variety of ecosystems which indicate diversity in the number of niches, trophic levels, food webs, nutrient cycles and ecological processes sustaining energy flow. [1]

Example: High ecosystem diversity in India is due to occurrence of large number of ecosystems like deserts, rain forests, mangroves, coral reefs, estuaries and alpine meadows. [½]

[Any two]

Section-D

25. (a) Differentiate between spermatogenesis and Oogenesis on the basis of [5]

(i) Time of initiation of the process

(ii) Site of completion of the process

(iii) Nature of meiotic division undergone by gamete mother cells

- (b) Name the hormones and state their role involved in controlling spermatogenesis in humans.

OR

(a) Explain the process of double fertilization in angiosperms.

(b) Why does the development of endosperm precedes that of embryo?

(c) List the parts of a typical dicot embryo.

- Sol. (a)** [1 + 1 + 1 = 3]

	Basis	SPERMATOGENESIS	OOGENESIS
(i)	Time of initiation of the process	At the age of puberty	During embryonic development stage (Before birth)
(ii)	Site of completion of the process	Seminiferous tubules	Fallopian tube
(iii)	Nature of meiotic division undergone by gamete mother cells	Equal cytoplasmic division, continuous	Unequal cytoplasmic division; discontinuous

(b) Hormones involved in controlling spermatogenesis are :

	Hormone	Role in spermatogenesis
(i)	Gonadotropin Releasing Hormone (GnRH)	A hypothalamic hormone which acts at anterior pituitary gland and stimulates secretion of two gonadotropins - LH and FSH.
(ii)	Luteinising Hormone (LH)	It acts at the Leydig cells and stimulates synthesis and secretion of androgens.
(iii)	Follicle Stimulating Hormone (FSH)	It acts on the Sertoli cells and stimulates secretion of some factors which help in the process of spermiogenesis.

[1 + 1 = 2]

OR

(a) In angiosperms, two types of fusion i.e. syngamy and triple fusion occurs in an embryo sac, which is termed as double fertilization.

(i) Syngamy : Fusion of a male gamete and egg cells is called syngamy. This results in the formation of a diploid cell i.e. zygote.



(ii) Triple fusion : In triple fusion second male gamete fuses with nucleus of central cell (secondary nucleus) to produce a triploid primary endosperm nucleus (PEN). The central cell after triple fusion becomes primary endosperm cell (PEC) which divides and develops into endosperm.



[1 + 1 = 2]

(b) Endosperm development precedes embryo development because cell of endosperm are filled with reserve food material and are used for the nourishment of the developing embryo [1]

(c) A typical dicot embryo consists of

(i) An embryonal axis : It is further divided into two parts.

- ♦ Epicotyl : The portion of embryonal axis above the level of cotyledons and terminates into plumule.
- ♦ Hypocotyl : The portion of embryonal axis below the level of cotyledons and terminates into radicle.

(ii) Two cotyledons : These are lateral structures of the embryo usually contains reserve food material. [1 + 1 = 2]

26. (a) What is "population" according to you as a biology student? [1 + 2 + 2 = 5]

(b) "The size of a population for any species is not a 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 succession faster than that of primary succession?

- Sol. (a) A population is a group of individuals of same species inhabiting a given area. [1]
 (b) The size of a population for any species is not a static parameter but it is ever changing depending upon various factors including food availability, predation pressure and adverse weather. [2]

The density of a population in a given area during a period fluctuates due to changes in four basic processes

- (i) **Natality** : Number of births during a given period in the population that are added to the initial density.
- (ii) **Mortality** : Number of deaths in the population during a given period.
- (iii) **Immigration** : Number of individuals of the same species that have come into the habitat from elsewhere during given time period.
- (iv) **Emigration** : Number of individuals of the population who had left the habitat and gone elsewhere during given time period.

Natality and immigration contribute to an increase in population density while mortality and emigration decreases the population density. [2]

OR

- (a) **Hydrarch succession** : The succession in aquatic habitat like freshly formed pond is called hydrarch succession. [1]

(b) [1 + 1]

Species	Xerarch succession	Hydrarch succession
(i) Pioneer	Lichens e.g. Graphis	Phytoplanktons e.g. Diatoms
(ii) Climax Community	Forest / Trees	Forest / Trees

- (c) ♦ Factors on which invading pioneer species depend in a secondary hydrarch succession are
- (i) Condition of soil
 - (ii) Presence of seeds or propagules in the environment
 - (iii) Availability of Water [1]
- ♦ Rate of secondary succession is faster than that of primary succession because in area of secondary succession some soil and nutrients were already available because of which climax reaches more quickly. [1]

27. Differentiate between incomplete dominance and co-dominance. Substantiate your answer with one example of each. [4 + 1 = 5]

OR

- (a) Write the contributions of the following scientists in deciphering the genetic code.

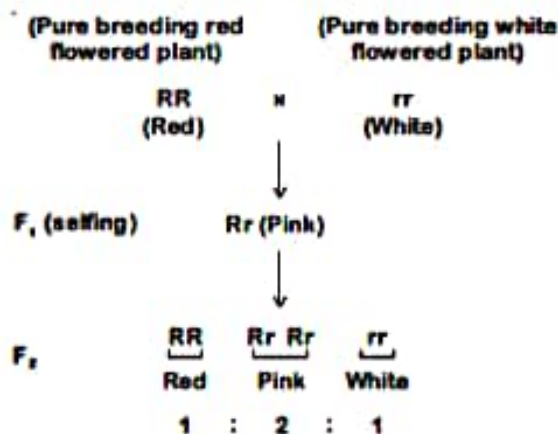
George Gamow ; Hargobind Khorana ; Marshall Nirenberg ; Severo Ochoa

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

Sol. **Incomplete Dominance** :

When a cross is made between a recessive and a dominant parent then sometimes the phenotype of F_1 does not resemble either of the two parents and is between the two. This is called incomplete dominance.

The inheritance of flower colour in the dog flower is a good example of incomplete dominance which we can understand with the help of given cross [1]

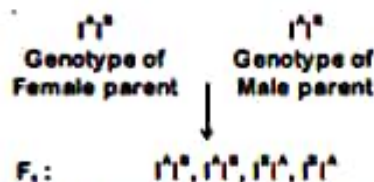


[1½]

Co-dominance :

When two parents are crossed then if the F_1 generation resembles both parents, it is called co-dominance. [1]

A good example of co-dominance is ABO blood group in human beings. A cross is made to understand co-dominance better.



All of the above offspring in F_1 generation will have AB blood group as both alleles A and B are co-dominant and express equally. [1½]

OR

(a) **George Gamow :** George Gamow coined the term genetic code and argued that since there are only 4 bases and if they have to code for 20 amino acids, the code should constitute a combination of bases. He suggested that in order to code for all the amino acids the genetic code should be made up of 3 nucleotides. [1]

Hargobind Khorana : Hargobind Khorana developed chemical method that was instrumental in synthesising RNA molecules with defined combination of bases. Using synthetic DNA, he prepared polynucleotide with known repeating sequence, e.g., CUCUCUCUCUCU. [1]

Marshall Nirenberg : Nirenberg used a synthetic poly U RNA and deciphered the code by translating this as polyphenylalanine. [1]

Severo Ochoa : Severo Ochoa discovered the enzyme named Severo Ochoa enzyme which is a polynucleotide phosphorylase. This enzyme is helpful in polymerising RNA with defined sequences in a template-independent manner. [1]

(b) The genetic code is the set of rules by which information encoded in genetic material is translated into proteins by living cells. The genetic code is nearly universal language that encodes directions for cells. Their arrangement as codons, store the blueprint for amino acid chain. This chain in turn form proteins which comprise or regulate the biological processes in every living beings. [1]

