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General Instructions :

- (i) All questions are compulsory.
- (ii) Section A contains question numbers 1 to 5, multiple choice questions/assertion and reason of one mark each. Section B contains question numbers 6 to 12, short answer type questions of two marks each. Section C contains question numbers 13 to 21, long answer type I questions of three marks each. Section D contains question numbers 22 to 24, case-based type questions of three marks each. Section E contains question numbers 25 to 27, long answer type II questions of five marks each.
- (iii) There is no overall choice in the question paper. However, internal choices are provided in two questions of one mark, one question of two marks, two questions of three marks and all three questions of five marks.

Time allowed : 3 hours

Maximum marks : 70

SECTION - A

1. The filiform apparatus is present in
 - (a) synergids
 - (b) egg cell
 - (c) antipodals
 - (d) secondary nucleus.
2. The term 'molecular scissors' refers to
 - (a) recombinant DNA
 - (b) restriction enzymes
 - (c) *Taq* polymerase
 - (d) palindromic nucleotide sequences.
3. The genetic material of HIV is

(a) dsDNA	(b) dsRNA
(c) ssDNA	(d) ssRNA.

OR

Which one of the following microorganisms forms symbiotic association with plants and helps them in their nutrition?

- | | |
|-----------------------|-------------------------|
| (a) <i>Glomus</i> | (b) <i>Azotobacter</i> |
| (c) <i>Klebsiella</i> | (d) <i>Azospirillum</i> |
4. RNA interference involves
 - (a) synthesis of cDNA and RNA using reverse transcriptase
 - (b) silencing of specific mRNA due to complementary RNA
 - (c) interference of RNA in synthesis of DNA
 - (d) synthesis of mRNA from DNA.

For question number 5, two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

- (a) Both (A) and (R) are true and (R) is correct explanation of the assertion (A).
- (b) Both (A) and (R) are true but (R) is not the correct explanation of the assertion (A).
- (c) (A) is true but (R) is false.
- (d) Both (A) and (R) are false.

5. Assertion : Offsite collections can be used to restock depleted populations, reintroduce species in the wild and restore degraded habitats.

Reason : *In situ* conservation refers to the conservation of endangered species in their natural habitats.

OR

Assertion : Mycorrhizae represent a mutually beneficial interspecific interaction of fungi with roots of higher plants.

Reason : In a mutualistic relationship, both the organisms enter into some sort of physiological exchange.

SECTION - B

6. Draw the longitudinal section of pistil showing pollen tube.

OR

Draw a well labelled diagram of mammary gland.

7. Why do some women use "Saheli" pills?
8. Describe any one example of incomplete dominance.
9. List the three major functions of the genes.
10. What harm do cancerous cells cause?
11. Differentiate between rDNA and cDNA.
12. What are the useful applications of Bt cotton?

SECTION - C

13. Why is the process of fertilization in a flowering plant referred to as double fertilization? Explain.
14. In which organs are Leydig's cells and Sertoli cells located? Differentiate between these cells with reference to their location in the organ and their functions.
15. Taking the example of ABO blood group types of humans, explain the phenomenon of multiple allelism and codominance.

OR

Explain why the terms 'homozygous' and 'heterozygous' with respect to a X-linked trait are applicable to human females but not to human males.

16. The base sequence of one strand of DNA is TAC TAG GAT.
 - (a) Give the base sequence of its complementary strand.
 - (b) What is the distance maintained between the two consecutive pairs of bases in the DNA molecule?
 - (c) Who contributed the base complementarity rule?
17. What is frameshift mutation? Name the type of mutation that does not affect protein synthesis.
18. Which pathogen causes diphtheria? Why is it dreaded as fatal disease? How can it be prevented?
19. How and why is electroporation done in *E. coli*?

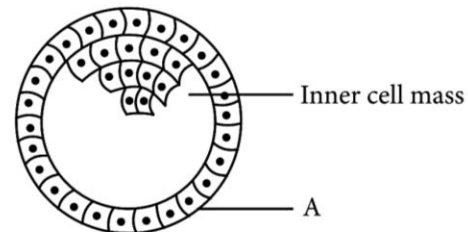
20. What is special of "Flavr Savr" variety of tomato? Why is it preferred to its normal native variety?
21. How do organisms manage with stressful conditions existing in their habitat for short duration? Explain with the help of one example each.

OR

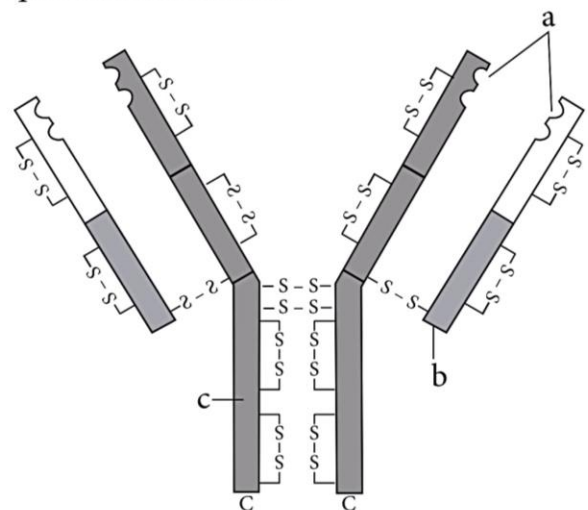
Differentiate between hibernation and aestivation. Give one example of each.

SECTION - D

22. Study the figure given below and answer the questions that follow :

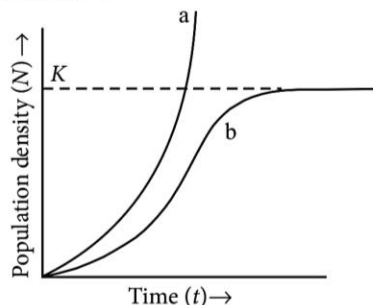


- (a) Name the stage of human embryo the figure represents.
 - (b) Identify 'A' in the figure and mention its functions.
 - (c) Mention the fate of the inner cell mass after implantation in uterus.
23. Identify a, b and c in the schematic diagram of an antibody given below and answer the questions that follow:



- (a) Write the chemical nature of an antibody.
- (b) Name the cells that produce antibodies in humans.
- (c) Mention the type of immune response provided by an antibody.

24. Study the population growth curves in the graph given below and answer the questions which follow :



- (a) Identify the growth curves 'a' and 'b'.
 (b) Which one of them is considered a more realistic one and why?
 (c) If $\frac{dN}{dt} = rN \left(\frac{K - N}{K} \right)$ is the equation of the logistic growth curve, what does K stand for?

SECTION - E

25. What is an operon? In a culture of *E.coli*, what happens when lactose is added? Why does the *lac*-operon switch off after sometime again?

OR

- (a) Draw a well labelled diagram of a nucleosome.

- (b) Differentiate between euchromatin and heterochromatin.

26. (a) Spleen acts as a lymphoid organ. Justify the statement.
 (b) Differentiate between the following :
 (i) Innate and acquired immunity
 (ii) B - lymphocytes and T - lymphocytes

OR

Define biofertiliser. Name different categories of organisms used as biofertilisers with an example each. How do they function in organic farming.

27. (a) Enlist any three characteristic features for animals which enable them to survive in water scarce environment.
 (b) List some adaptations of xerophytic plants to withstand prolonged period of drought.

OR

- (a) Explain the narrowly utilitarian, broadly utilitarian and ethical arguments in favour of conservation of biodiversity.
 (b) How is designation of certain areas as hotspots is a step towards biodiversity conservation? Name any two hotspots in India.

Detailed Solutions

1. (a) : The synergids have special cellular thickenings at the micropylar tip called filiform apparatus, which play an important role in guiding the pollen tube into the synergid.

2. (b) : The restriction endonuclease enzyme inspects the length of a DNA sequence. Once it recognises specific sequence, it binds to the DNA and cuts each of the two strands of the double helix at specific points in their sugar phosphate back bone. Restriction endonuclease enzymes are also known as molecular scissors or biological scissors or chemical knives or chemical scalpels.

3. (d) : HIV which causes AIDS is a retrovirus that contains single stranded RNA (ssRNA) as its genetic material.

OR

(a) : Several fungi are known to form symbiotic associations with plants, i.e., mycorrhiza. The most common fungal partners of mycorrhiza are *Glomus* species.

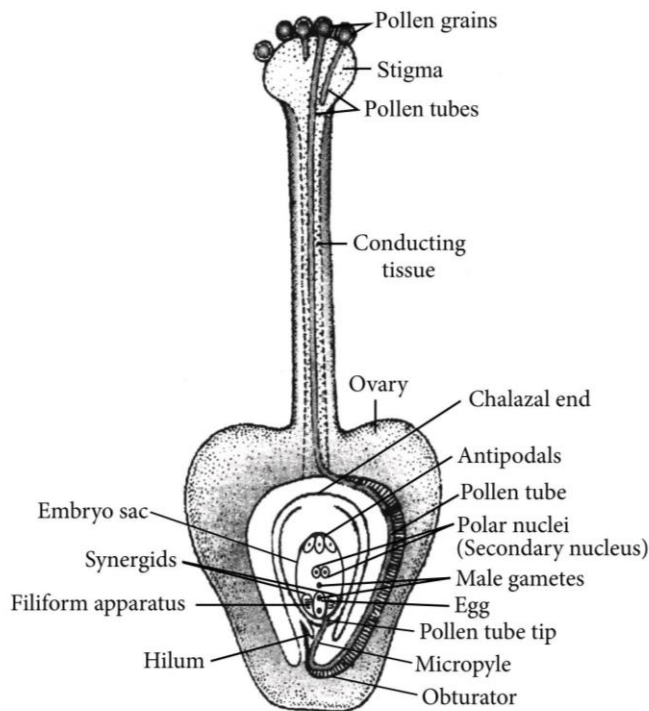
4. (b)

5. (b)

OR

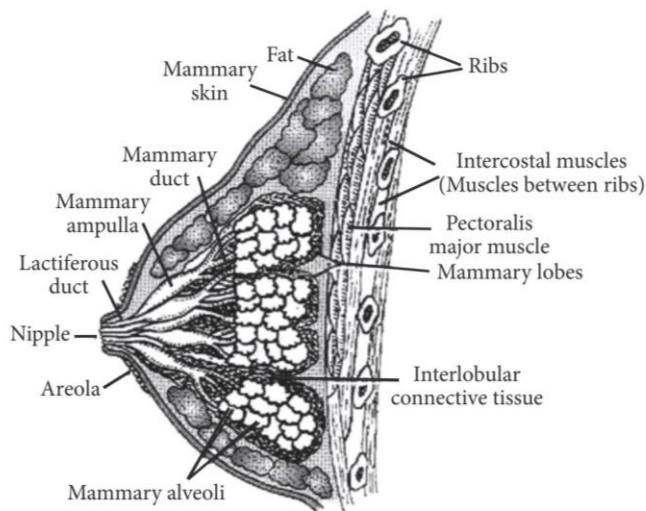
(b) : Mycorrhizae refer to the symbiotic association of fungal hyphae with the roots of higher plants. In this association, the two symbionts are in close contact and are physiologically interdependent on each other. Mycorrhizae increase the ability of the plant to extract minerals from the soil. In return, fungi are provided with shelter and products of photosynthesis by the plant.

6. Longitudinal section of pistil showing growth of pollen tube is shown below.



OR

The labelled diagram of a mammary gland is as follows :



7. "Saheli" pills are used by women as oral contraceptive pills. It is a 'once a week' pill having high contraceptive value and very few side-effects.

8. Incomplete dominance is the phenomenon in which neither of the two alleles of a gene is completely dominant over the other. When a cross is made between a red flowered plant with a white flowered plant of snapdragon, the F_1 hybrid has pink flowers. When the F_1 individual was self

pollinated, F_2 individuals were obtained bearing red, pink and white flowers in the ratio 1 : 2 : 1. It is not a case of blending inheritance because the parental characters appear in the F_2 generation without any change.

9. The three major functions of the genes are :
 (i) Genes are components of genetic material and are thus units of inheritance.
 (ii) Genes control the morphology or phenotype of individuals.
 (iii) Reshuffling of genes at the time of sexual reproduction produce variations.

10. Cancerous cells compete with normal cells for nutrients, depriving them and ultimately killing them. They increase in number and size and thus disrupt the functioning of normal cells.

11. Differences between rDNA and cDNA are as follows :

	rDNA	cDNA
(i)	rDNA stands for recombinant DNA.	cDNA stands for complementary DNA.
(ii)	It is formed by isolating DNA with desirable genes and then introducing these genes into host.	It is obtained from mRNA template by using the enzyme reverse transcriptase.

12. The useful applications of Bt cotton are:

- (i) pest resistance
- (ii) herbicide tolerance
- (iii) high yield
- (iv) resistant to bollworm infestation.

13. In angiosperms, one of the male gametes fuses with the egg cell to form the zygote (syngamy). The other male gamete fuses with the two polar nuclei to produce a triploid primary endosperm nucleus (triple fusion). Since two types of fusions, syngamy and triple fusion takes place in an embryo sac, this phenomenon is termed as double fertilization.

14. Leydig's cells and Sertoli cells are located in testis.

Differences between Leydig's cells and Sertoli cells are as follows :

	Leydig's cells (Interstitial cells)	Sertoli cells (Sustentacular cells)
(i)	They are present in between the seminiferous tubules.	They are present in between the germinal epithelial cells of the seminiferous tubules.
(ii)	They are found in small groups and are round in shape.	They are found singly and are elongated.
(iii)	They secrete androgens (e.g., testosterone).	They provide nourishment to the developing spermatozoa (sperms). They also secrete ABP (Androgen Binding Protein) that concentrates testosterone in the seminiferous tubules. It also secretes another protein inhibin which suppresses FSH synthesis.

15. In the ABO system, there are four blood groups A, B, AB and O. ABO blood groups are controlled by gene *I*. The gene *I* has three alleles I^A , I^B and *i*. This phenomenon is known as multiple allelism. I^A and I^B are completely dominant over *i*. When I^A and I^B are present together they both express themselves and produce blood group AB. This phenomenon is known as codominance.

OR

Human females possess two homomorphic sex chromosomes XX. A X-linked trait like haemophilia can affect females only if both the X-chromosomes carry the gene for haemophilia. Such females are called homozygous for haemophilia. If the gene for haemophilia is present only in one X-chromosome such females are called heterozygous for haemophilia. Human males contain two heteromorphic sex chromosomes XY. In males any X-linked trait will be able to express itself as males possess only one X-chromosome.

16. (a) ATG ATC CTA

(b) The distance between two consecutive pairs of bases in the DNA molecule is 0.34 nm (or 3.4 Å).

(c) Chargaff contributed the base complementarity rule.

17. Frameshift mutations are those mutations in which the reading of the frame of base sequence shifts laterally either in the forward direction due to addition of one or more nucleotides or in backward direction due to removal of one or more nucleotides.

Silent mutation does not affect protein synthesis.

18. Diphtheria is caused by a bacterial strain, *Corynebacterium diphtheriae*. This disease is dreaded because at later stage, a soft grey membrane forms across the throat, constricting the air passage and causing difficulty in breathing and swallowing. Bacteria multiply at the site of infection and release a toxin into the blood stream which damages heart and nerves. Death from heart failure or general collapse can follow within four days. The disease is spread by direct contact with a patient or carrier or by contaminated milk. It can be prevented by taking DPT (Diphtheria Pertussis Tetanus) vaccine.

19. Electroporation is a method of vectorless gene transfer. In this method, the electrical impulses induce transient pores in the cell membrane through which DNA molecules are incorporated into cells. This is done because DNA is a hydrophilic molecule, it cannot pass the cell membrane. So by electroporation pores are created through which DNA can enter the cell.

20. Flavr Savr, a variety of tomato is a genetically modified plant. In this variety one gene, which produces polygalactouronase enzyme is inactivated. The non availability of this enzyme prevents over ripening. Thus, fruit remains fresh for long time and it also retains flavour, superior taste and higher quantity of total soluble solids. So it prevents post harvest and over ripening losses. Thus, it is preferred over normal native variety.

21. Physiological and behavioural adaptations help to manage with stressful conditions. These include migration, hibernation, aestivation, camouflage, mimicry, water scarcity and prevention of freezing.

Caribou migrate during winter to warmer places in search of food. Endothermal mammals, undergo hibernation during winter to avoid low temperature, snails and fish undergo aestivation to escape summers.

Viceroy butterfly mimics unpalatable toxic monarch butterfly in order to get protection against predator. Many zooplanktons and larvae of some insects suspend their development in periods of stress, a condition known as diapause.

OR

The differences between hibernation and aestivation are as follows :

	Hibernation	Aestivation
(i)	It is winter sleep in which animal passes the winter period in dormant conditions.	It is summer sleep.
(ii)	It is of longer duration.	It is of shorter duration.
(iii)	Northern ground squirrels undergo hibernation during winter and rest in warm place.	Squirrels of South-Western deserts undergo aestivation and lie in torpid state inside the burrows.

22. (a) Blastocyst

(b) A is trophoblast. It helps in attachment of the blastocyst to the endometrium of uterine wall, help to provide nutrition to the embryo and later forms extra embryonic membranes namely chorion and amnion and parts of placenta.

(c) After implantation in uterus, inner cell mass gives rise to germ layers.

23. In the given structure of an antibody molecule, 'a' is the antigen binding site, 'b' is constant region of light chain and 'c' is constant region of heavy chain.

(a) Antibodies are proteinous in nature.

(b) B-cells produce antibodies.

(c) Humoral immune response is an antibody mediated immune response.

24. (a) Growth curve 'a' represents the J-shaped or exponential growth; 'b' represents S-shaped or logistic growth.

(b) The logistic growth is more realistic since resources for growth for most animal populations become limiting sooner or later.

(c) *K* denotes the carrying capacity.

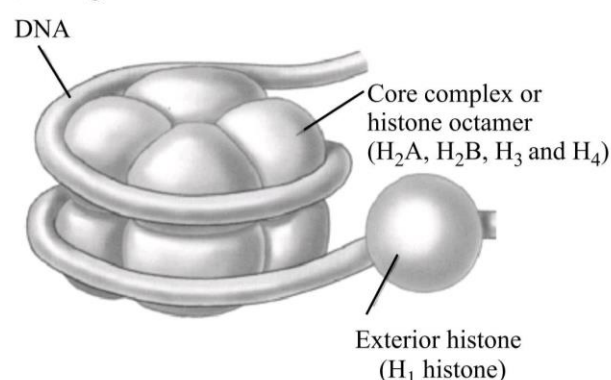
25. An operon is a part of genetic material (or DNA), which acts as a single regulated unit having one or more structural genes, an operator gene, a promoter gene, a regulator gene, a repressor and an inducer or corepressor (from external source). Operons are of two types : Inducible and repressible.

Inducible operon is an operon, which remains switched off normally, but becomes operational in the presence of an inducer (a chemical substance or substrate) e.g. lactose as in the case of *lac*-operon.

In the culture medium of *E.coli*, when lactose was added, *Lac* operon is switched on, as lactose acts as inducer, and inactivates the repressor. Due to this switching on of the *lac* operon system, β -galactosidase is formed, which converts lactose into glucose and galactose. As soon as the lactose is consumed, the repressor again becomes active and causes switching off, of the system.

OR

(a) Diagram of nucleosome is as follows :



(b) The differences between euchromatin and heterochromatin are as follows :

	Euchromatin	Heterochromatin
(i)	These are the regions where chromatin is loosely packed.	These are the regions where chromatin is densely packed.
(ii)	It stains lighter.	It stains darker.
(iii)	This is transcriptionally active.	It is transcriptionally inactive or late replicating.

26. (a) Spleen acts as a secondary lymphoid organ where mature B and T lymphocytes undergo proliferation and differentiation. In spleen, lymphocytes develop immune response and become effector cells.

(b) (i) Differences between innate and acquired immunity are as follows :

	Innate immunity	Acquired immunity
(i)	This includes all the defence elements with which an individual is born.	This immunity is acquired after the birth.
(ii)	It consists of various types of barriers that prevent the entry of foreign agents.	It consists of specialised cells (T-cells and B-cells) and antibodies that circulate in the body fluid.
(iii)	It remains throughout life.	It can be short lived or long - lived.

(ii) Differences between the role of B-lymphocyte (B-cells) and T-lymphocytes (T-cells) in generating immune responses are :

	B-Lymphocytes (B-cells)	T-Lymphocytes (T-cells)
(i)	B-cells form humoral or antibody mediated immune system (AMIS).	T-cells form cell-mediated immune system (CMIS).
(ii)	They defend against viruses and bacteria that enter the blood and lymph.	They defend against pathogens including protists and fungi that enter the cells.
(iii)	Plasma cells formed by division of B-cells produce antibodies and provide immunity against foreign substances.	T - l y m p h o c y t e s produce different types of T-cells, e.g., killer T-cells react against cancer cells, suppressor cells inhibit immune system.

OR

Biofertilisers are organisms which bring about nutrient enrichment of the soil by enhancing the availability of nutrients like nitrogen and phosphorus to the crops. Some of the important biofertilisers recommended for the use in agriculture are :

(i) Microphos biofertilisers : They release phosphate from bound and insoluble states,

e.g., *Bacillus polymyxa*, *Pseudomonas striata*, *Aspergillus*, etc.

(ii) Free living nitrogen fixing bacteria : These bacteria fix atmospheric nitrogen in the soil and make it available for the higher plants. The best example is *Azotobacter*.

(iii) Symbiotic nitrogen fixing bacteria : They form a mutually beneficial association with the plants. The most important of the symbiotic nitrogen fixing bacteria is *Rhizobium* that occurs freely in the soil but fails to fix nitrogen in the free state. It multiplies as soon as it gets to rhizosphere of leguminous plants, enters into their roots and forms specialised structures called root nodules. The bacteria fix atmospheric nitrogen only in the root nodules and that too when present in the bacteroid forms.

(iv) Loose association of nitrogen fixing bacteria : Certain nitrogen fixing bacteria like *Azospirillum* live around the roots of higher plants without developing any intimate relationship. It is often called rhizosphere association.

(v) Mycorrhiza : It is a mutually beneficial or symbiotic association of a fungus with the roots of a higher plant. The most common fungal partners of mycorrhiza are *Glomus* species. Other categories such as free living nitrogen fixing cyanobacteria and symbiotic nitrogen fixing cyanobacteria are used as biofertilisers.

27. (a) Some of the adaptations seen in animals which enable them to survive in water scarce environment are as follows:

- Desert lizards keep their body temperature fairly constant by behavioural means. They enjoy in the sun and absorb heat when their body temperature drops below the comfort zone but move into shade when the surrounding temperature starts increasing.
- The Kangaroo rat conserves water by excreting nearly solid urine and can live from birth to death without even drinking water.
- The camels show tolerance to wide fluctuations in body temperature and are able to maintain blood stream moisture even during extreme heat stress.

(b) Many species of plants show adaptation to dry habitats and high temperature conditions e.g., plants of hot deserts. They are termed as xerophytes. The xerophytes have special adaptations to withstand prolonged period of drought. These are of four types:

(i) Ephemerals (drought escapers) evade dry conditions by remaining in the form of seeds but live for a brief period and complete their life cycle during the rains. Common examples are *Euphorbia prostrata*, *Tribulus terrestris*, *Argemone mexicana*.

(ii) Annuals (drought evaders) continue to live for a few months even after rains in hot dry conditions and show modifications to reduce transpiration. Common examples are *Echinops echinatus*, *Solanum surattense*.

(iii) Succulents (drought resistant) have fleshy organs to store large amount of water. Plants like *Opuntia*, *Euphorbia*, *Asparagus*, have fleshy stems which are green and photosynthetic. Succulents possess very thick cuticle and sunken stomata which open during night only. Root succulents include *Asparagus*.

(iv) Non-succulent perennials (drought endurers) are true xerophytes and have many morphological modifications to withstand dry conditions. These have extensive root system that spreads along the soil surface to absorb maximum amount of water. Examples include *Acacia nilotica*, *Ziziphus jujuba*, *Calotropis procera*, *Prosopis*, etc.

OR

(a) There are a number of reasons to conserve biodiversity which can be grouped as:

(a) Narrow utilitarian : Human derive a major part of their requirement from organisms. Their direct benefits are countless, like (i) Food cereals : Pulses, fruits, vegetables, milk, egg, meat comes from plants and animals. (ii) Fats and oils are obtained from plants and animals. (iii) Firewood as a source of energy for cooking and heating. (iv) Fibres, e.g., cotton, flax, silk, wool. (v) Industrial products like tannins, lubricant dyes, resins, and perfumes. (vi) Drugs: Nearly 25% of drugs being used by us are directly coming from plants.

(b) Broadly utilitarian : Biodiversity is fundamental to ecosystem services of nature. For example (i) Oxygen : Through their photosynthetic

activity plants are replenishing oxygen of the atmosphere. Amazon rainforest is estimated to contribute 20% of it. (ii) Pollination: Bees, bumble bees, butterflies, moths, beetles, birds and bats are engaged in pollination of plants which are essential for formation of fruits and seeds. (iii) Climate regulation : Forest and oceanic systems regulate global climate. (iv) Aquifers: Plant cover is essential for retention of rain water, its percolation and storage in aquifers and reservoirs. (v) Flood and erosion control: Plant cover protects the soil from wind and water erosion. Run off of rain water is reduced so that flood water is rarely formed. (vi) Nutrient cycling : It is essential for continued availability of nutrients to plants without which there would be no photosynthetic activity.

Ethical human beings share the biosphere with over a million species of plants, animals and microbes. They have evolved just as we have evolved. Every living species has an intrinsic value though it may not have any direct economic value. It is therefore, our moral and ethical duty not to destroy them. Instead we should take care of their well being so as to pass the rich biological legacy to future generations.

(b) 'Biodiversity hotspots' are the regions which are characterised by very high levels of species richness and high degree of endemism. India has three hotspots – Indo-Burma (North-East India), Himalayas, and Western Ghats.

Importance of hotspots are as follows :

- Maintaining genetic diversity of all present species and varieties.
- Maintaining viable populations of native species, subspecies and varieties.
- Maintaining resilience in species/habitats/ ecosystems to adapt to environmental changes.
- Maintaining the various types of communities/ecosystems/habitats both in number and distribution.
- Checking human aided introduction of alien/exotic species.