BIOLOGY (Theory)

Time allowed : 3 hours

Maximum Marks: 70

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 questions number 1 to 5, very short-answer type questions of 1 mark each.

(iii) Section B contains questions number 6 to 10, short-answer type I questions of 2 marks each.

(iv) Section C contains questions number 11 to 22, short-answer type II questions of 3 marks each.

(v) Section D contains question number 23, value based question of 4 marks.

(vi) Section E contains questions number 24 to 26, long-answer type questions. of 5 marks each.

(vii) There is no overall choice in the question paper, however, an internal choice is provided in one question of 2 marks, one question of 3 marks and all the three questions of 5 marks. In these questions, an examinee is to attempt any one of the two given alternatives.
SECTION A

Q 1. Write the dual purpose served by Deoxyribonucleoside triphosphates in polymerisation.

Ans 1. Deoxyribonucleoside triphosphates (dNTPs) serve the dual purpose of
(i) acting as a substrate
(ii) providing energy (from two terminal phosphates)

Q 2. Name two diseases whose spread can be controlled by the eradication of Aedes mosquitoes.

Ans 2. Chikungunya & Dengue fever

Q 3. How do cytokine barriers provide innate immunity in humans?

Ans 3. Cytokine barriers provide innate immunity by releasing proteins called interferons by cells which are virus-infected. Interferons protect non-infected cells from further viral infection.

Q 4. Write the names of the following:
(a) A 15 mya primate that was ape-like
(b) A 2 mya primate that lived in East African grasslands

Ans 4. (a) Ramapithecus
(b) Australopithecus

Q 5. Mention the chemical change that proinsulin undergoes, to be able to act as mature insulin.

Ans 5. Proinsulin contains contains C-peptide which is removed to form a mature functional insulin as post translational modification.

SECTION B

Q 6. Your advice is sought to improve the nitrogen content of the soil to be used for cultivation of a non-leguminous terrestrial crop.
(a) Recommend two microbes that can enrich the soil with nitrogen.
(b) Why do leguminous crops not require such enrichment of the soil?

Ans 6. (a) Rhizobium, Mycorrhiza, Anabaena, cyanobacteria (b) The nodules on the roots of leguminous plants are formed by the symbiotic association of Rhizobium bacteria. These bacteria fix atmospheric nitrogen into leguminous crops so they do not require such enrichment of the soil.

Q 7. With the help of an algebraic equation, how did Hardy-Weinberg explain that in a given population the frequency of occurrence of alleles of a gene is supposed to remain the same through generations?

Ans 7. Hardy-Weinberg explained that in a given population the frequency of occurrence of alleles of a gene is supposed to remain the same through generations i.e. gene pool remains constant. This is called genetic equilibrium or Hardy-Weinberg equilibrium.

He gave the expression for Hardy-Weinberg equilibrium as \[ p^2 + 2pq + q^2 = 1 \]

We consider the sum total of all the allelic frequencies is equal to 1, e.g. in a diploid, if p and q represent the frequency of an allele A and allele a.

The frequency of AA individuals in a population is \( p^2 \), of aa is \( q^2 \) and of Aa is 2pq.

Hence, it can be expressed by the following reaction:

\[ p^2 + 2pq + q^2 = 1 \]

This is called binomial expansion of \((p + q)^2\)
In prokaryotes, such as, E. coli, though they do not have a defined nucleus, the DNA is not scattered throughout the cell. DNA (being negatively charged) is held with some proteins (that have positive charges) in a region termed as ‘nucleoid’. The DNA in nucleoid is organised in large loops held by proteins.

Q 8. How did a citizen group called Friends of Arcata Marsh, Areata, California, USA, help to improve water quality of the marshland using Integrated Waste Water Treatment? Explain in four steps.

Ans 8. 
Step 1: sedimentation,
Step 2: filtering
Step 3: chlorine treatments (But even after this stage, heavy metals and toxic pollutants remain in the water.)
Step 4: series of six connected marshes grown with suitable plants, fungi, algae and bacteria. As the water flows through the marshes, the pollutants are neutralised, absorbed or assimilated, by the plants, etc.

Q 9. You have obtained a high yielding variety of tomato. Name and explain the procedure that ensures retention of the desired characteristics repeatedly in large populations of future generations of the tomato crop

Ans 9. We could use tissue culture technique to ensure retention of the desired characteristics repeatedly in large populations of future generations for tomato crop. In this technique we maintain and grow plant cells, tissues or organs in nutrient media under controlled environmental conditions. The plant part taken out to be grown in a test tube in special nutrient media is called explant. They are meristematic tissue which have the the power of totipotency. The nutrient media for the growth of explant must provide a carbon source (such as sucrose), inorganic salts, vitamins, amino acids and growth regulators such as auxins, cytokinins, etc. This way tissue culture is used for the production of a large number of genetically similar plants in a short duration of time.

Q 10. (a) Name the source plant of heroin drug. How is it obtained from the plant?
(b) Write the effects of heroin on the human body.

Ans 10. (a) Heroin is obtained from Papaver somniferum. Heroin is obtained by acetylation of morphine and is a diacetyl morphine chemically.
(b) Heroin acts as depressant and slows down body functions.

SECTION C

Q 11. Draw a diagram of a mature human sperm. Label any three parts and write their functions.

Ans 11.
Q 12. (a) Expand VNTR and describe its role in DNA fingerprinting.
(b) List any two applications of DNA fingerprinting technique.

Ans 12. (a) VNTRs are called Variable Number of Tandem Repeats
(b) Variable Number of Tandem Repeats (VNTRs) belong to a class of satellite DNA called as minisatellite. VNTR are used as probes in DNA fingerprinting.

Q 13. Differentiate between Parthenocarpy and Parthenogenesis. Give one example of each.

Ans 13. In some organisms like rotifers, honeybees, birds (turkey) and even in some lizards, the female gametes (ovum) form new organism without fertilisation. This phenomenon is called parthenogenesis. In animals, morphological and physiological changes occur prior to and post reproductive phase. In honeybees, an interesting phenomenon is seen. The fertilised eggs (zygotes) give rise to queens and worker bees (both female) and unfertilised eggs (ova) develop into drones (males). Parthenocarpy is the production of fruit without fertilisation of ovules, thus resulting in seedless fruit. It may occur naturally or can be induced artificially.

<table>
<thead>
<tr>
<th>Parthenogenesis</th>
<th>Parthenocarpy</th>
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<td>When female gametes (ovum) form new organism without fertilisation phenomenon is called parthenogenesis.</td>
<td>Parthenocarpy is the production of fruit without fertilisation of ovules, thus resulting in seedless fruit. It may occur naturally or can be induced artificially.</td>
</tr>
<tr>
<td>Found in Animals</td>
<td>Found in Plants</td>
</tr>
<tr>
<td>Example: rotifers, honeybees, birds (turkey) and even in some lizards.</td>
<td>Example: Banana, orange, grapes</td>
</tr>
</tbody>
</table>

Q 14. Medically it is advised to all young mothers that breastfeeding is the best for their newborn babies. Do you agree? Give reasons in support of your answer.

Ans 14. Yes I agree that all young mothers that breastfeeding is the best for their newborn babies. Following are the reasons
(i) It is rich in proteins and carbohydrates which help in growth of baby and provide energy
(ii) It also contains antibodies that provide passive immunity to the newborn.

Q 15. Explain the mechanism of ‘sex determination’ in birds. How does it differ from that of human beings?

Ans 15. ZZ - ZW Type of sex determination is found in birds. Here Females have one Z and one W-chromosome along with autosomes whereas males have a pair of Z-chromosomes (i.e. homogametic). It differs from that of human beings as in birds male is homogametic but in human female is homogametic.

Q 16. (a) How has the development of bioreactor helped in biotechnology?
(b) Name the most commonly used bioreactor and describe its working.

Ans 16. (a) A bioreactor provides the optimal conditions for achieving the desired product by providing optimum growth conditions like temperature, pH, substrate, salts, vitamins and oxygen which help us to process large volumes of culture for commercial production of the product.
(b) The most commonly used bioreactors are of stirring type. Stirring type bioreactors are further of two types, i.e. simple and sparged. A simple stirred-tank bioreactor is usually cylindrical or with a curved base to facilitate even mixing of reactor contents. The sparged-stirred-tank bioreactor also facilitates the mixing of components and ensures oxygen availability throughout the bioreactor. Alternatively, air is bubbled through the reactor.
Q 17. Explain the roles of the following with the help of an example each in recombinant DNA technology:
(a) Restriction Enzymes
(b) Plasmids

**Ans 17.** Restriction enzymes (restriction endonucleases) Recognise the specific sequence in DNA and cut within that recognition sequence. These enzymes help cutting the genes and plasmids and produce sticky or blunt ends.

For example Eco RI cuts the DNA between bases G and A only when the sequence GAATTC is present in the DNA.

Q 18. Explain out-breeding, out-crossing and cross-breeding practices in animal husbandry.

**Ans 18.** Out breeding is the Breeding of unrelated animals either of the same breed but not having common ancestors for 4-6 generations (outcrossing) or of different breeds (cross-breeding) or even different species (interspecific hybridisation) is called outbreeding. This can be further classified as follows:

**Out crossing**
The practice of mating of animals, within the same breed but having no common ancestors on either side of their pedigree up to 4-6 generations is called outcrossing. The offspring (resulting of such mating) is known as an outcross. It is known to be the best breeding method for animals that are below average in the production of milk and growth rate of beef in cattle, etc. A single outcross may help to overcome inbreeding depression.

**Cross-breeding**
The mating of superior males of one breed with the superior female of another breed is called cross-breeding. This is done to combine the desirable qualities of two breeds into a single individual. The hybrid progeny may be used for commercial production or they may be subjected to some form of inbreeding and selection.

Q 19. (a) Organic farmers prefer biological control of diseases and pests to the use of chemicals for the same purpose. Justify.
(b) Give an example of a bacterium, a fungus and an insect that are used as biocontrol agents.

**Ans 19.** (a) In modern agricultural system, the farmers have took to increased use of chemicals such as insecticides, weedicides etc., to control plant diseases and pests. These chemicals however, are harmful and toxic for human beings, animals and have been polluting environment (soil, groundwater), fruits, vegetables and crop plants, with their increased use. Thus, it is better to use biological agents to save our crop plants from pests, etc. Biocontrol refers to the use of biological methods for controlling plant diseases and pests. It is a method of controlling pests in agriculture that relies on natural predation and not on chemicals. Organic farmers believes that 'biodiversity furthers health'. The more diversity a landscape has, the more sustainable it is. Therefore, they work to create a system where the insects (pests) are not eradicated, but infact are
kept at manageable levels by a complex system of checks and balances within a living and vibrant ecosystem.

(b) (i) Insect dragonflies are useful to get rid of mosquitos.
(ii) Bacteria: To control butterfly caterpillars, bacteria such as Bacillus thuringiensis are used in the form of sprays or sachets as dry spores.
(iii) Fungi: Trichoderma species are free-living fungi that are very common in the root ecosystems.

Q 20. (a) Differentiate between analogous and homologous structures.
(b) Select and write analogous structures from the list given below.
   (i) Wings of butterfly and birds
   (ii) Vertebrate hearts
   (iii) Tendrils of bougainvillea and cucurbita
   (iv) Tubers of sweet potato and potato

Ans 20. Differences between analogous and homologous structures

<table>
<thead>
<tr>
<th>Analogous structures</th>
<th>Homologous structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>In analogy, the organs are functionally similar but anatomically different</td>
<td>Show similarity on the basic structure and embryonic development, but have different functions</td>
</tr>
<tr>
<td>Convergent evolution is the evolution where different structures evolve for the same function and hence have similarity.</td>
<td>Homology in organs indicates common ancestry. It is based on divergent evolution.</td>
</tr>
<tr>
<td>Eg. Eyes of Octopus and mammals.</td>
<td>Eg. Thorns of Bougainvillea and tendrils of Cucurbita.</td>
</tr>
</tbody>
</table>

(b) Analogous structures are
   (i) Wings of butterfly and birds
   (iv) Tubers of sweet potato and potato

Q 21. (a) "India has greater ecosystem diversity than Norway. " Do you agree with the statement? Give reasons in support of your answer.
(b) Write the difference between genetic biodiversity and species biodiversity that exists at all the levels of biological organisation.

OR

Explain the effect on the characteristics of a river when urban sewage is discharged into it.

Ans 21. (a) India has greater ecosystem diversity than Norway because India has deserts, rain forests, mangroves, coral reefs, wetlands, estuaries, and alpine meadows.
(b) Difference between genetic biodiversity and species biodiversity

<table>
<thead>
<tr>
<th>Genetic biodiversity</th>
<th>Species biodiversity</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is the diversity within a species</td>
<td>It is the diversity at the species level</td>
</tr>
<tr>
<td>e.g. There are more than 20,000 species of ants, 3,000,000 species of beetles, 28,000 species of fishes and nearly 20,000 species of orchids</td>
<td>e.g. Western Ghats have more amphibian species diversity than Eastern Ghats.</td>
</tr>
</tbody>
</table>

OR

Effects of sewage discharge on river are:
   (i) A sharp decline in dissolved oxygen and increase in BOD. Low oxygen levels in the water cause
(i) Death of fish and other aquatic creatures.
(ii) Algal bloom which results from the presence of organic matter in water. It causes:
   (a) Deterioration of the water quality.
   (b) Fish mortality.
   (c) Toxicity to humans and animals.
(iii) Biological magnification of a few toxic substances, as DDT causing harmful effects in living species.
(iv) Accelerated eutrophication, i.e. ageing of lakes and other water bodies due to human activities.

Q 22. How has the use of *Agrobacterium* as vectors helped in controlling *Meloidegyne incognita* infestation in tobacco plants? Explain in correct sequence.

**Ans 22.** A nematode *Meloidegyne incognita* infects the roots of tobacco plants which reduces the production of tobacco.

- The strategy adopted to prevent this infection is based on the process of RNA interference (RNAi). RNAi takes place in all eukaryotic organisms as a method of cellular defense.
- RNAi method involves silencing of a specific mRNA due to complementary dsRNA molecule that binds to and prevents translation of the mRNA (silencing).
- The source of this complementary RNA could be from an infection by viruses having RNA genomes or transposons (mobile genetic elements) that replicate via an RNA intermediate.
- *Agrobacterium* vectors are used to introduce nematode-specific genes into the host plant. It produced both sense and antisense RNA in to the host cells.
- These two RNAs are complementary to each other and form a double-stranded RNA (dsRNA) that initiates RNAi and hence, silence the specific wRNA of the nematode.
- The parasite cannot survive in a transgenic host, therefore the transgenic plant gets itself protected from the parasite.

**SECTION D**

Q 23. Looking at the deteriorating air quality because of air pollution in many cities of the country, the citizens are very much worried and concerned about their health. The doctors have declared health emergency in the cities where the air quality is very severely poor.

(a) Mention any two major causes of air pollution.
(b) Write any two harmful effects of air pollution to plants and humans.
(c) As a captain of your school Eco-club, suggest any two programmes you would plan to organise in the school so as to bring awareness among the students on how to check air pollution in and around the school.

**Ans 23.** (a) Major causes of air pollution

(i) Excessive use of fossil fuels by automobiles.
(ii) Smokestacks of thermal power plants, smelters, etc.
(iii) Particulate and gaseous air pollutants released by various industries.
(iv) Garbage decomposition also releases air pollutants.
(v) Use of leaded petrol and diesel.

(b) Effects of Air Pollutants

**On Plants**

(i) Causes fruit damage and various leaf diseases like chlorosis, necrosis and mottled spots on leaves.
(ii) Decreases the growth yield of crops and causes premature death of plants.
(iii) Weakens plants and increases infestation by pests.

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(iv) Acid rain damages the aerial parts and also acidifies the soils. It leads to the production of free radicals thus, decreases photosynthesis and productivity.

On Animals and humans

(i) These fine particulates cause breathing and respiratory symptoms, irritation, inflammations and damage to the lungs and premature death.
(ii) About 40% of human deaths occur due to air pollution.
(iii) Causes increase in susceptibility to diseases.
(iv) Causes cancer and genetic mutations.
(v) Causes respiratory ailments like asthma, hay fever and other allergic diseases.
(vi) Causes cardiovascular diseases and damage to CNS resulting in premature death.
(vii) Causes immediate effects like inflammation, nausea, headache, irritation to the eyes and nose.

(c) Programmes we would plan to organise in the school so as to bring awareness among the students on how to check air pollution in and around the school would
(i) Go green programmes to plant more and more plants
(ii) Programme to initiate renewable sources of energy
(iii) Programme to initiate students to come by bicycles
(iv) Firework free Diwali festival

SECTION E

Q 24. (a) Describe any two devices in a flowering plant which prevent both autogamy and geitonogamy.
(b) Explain the events upto double fertilisation after the pollen tube enters one of the synergids in an ovule of an angiosperm.

(a) Explain menstrual cycle in human females.
(b) How can the scientific understanding of the menstrual cycle of human females help as a contraceptive measure?

Ans 24. (a) any two devices in a flowering plant which prevent both autogamy and geitonogamy are as follows
(i) Dichogamy In some plant species receptivity of stigma and pollen release is not synchronised, i.e. often the pollen is released before the stigma becomes receptive (protandry) or stigma becomes receptive before the release of pollen (protogyny). The condition is called dichogamy.
(ii) Heterostyly In some other species, the anther and stigma are placed at different positions, so that the pollen cannot come in contact with the stigma

(b) After entering one of the synergids, the pollen tube releases the two male gametes into the cytoplasm of the syngamy. One of the male gametes moves towards the egg cell and fuses with its nucleus thus completing the syngamy. This results in the formation of a diploid cell, the zygote. The other male gamete moves towards the two polar nuclei located in the central cell and fuses with them to produce a triploid primary endosperm nucleus (PEN) (Figure 2.13a). As this involves the fusion of three haploid nuclei it is termed triple fusion. Since two types of fusions, syngamy and triple fusion take place in an embryo sac the phenomenon is termed double fertilisation, an event unique to flowering plants. The central cell after triple fusion becomes the primary endosperm cell (PEC) and develops into the endosperm while the zygote develops into an embryo.
(a) In human females, menstruation is repeated at an average interval of about 28/29 days, and the cycle of events starting from one menstruation till the next one is called the menstrual cycle. One ovum is released (ovulation) during the middle of each menstrual cycle. Stages of menstrual cycle

1. **Menstrual phase:** The cycle starts with the menstrual phase, when menstrual flow occurs and it lasts for 3-5 days. The menstrual flow results due to breakdown of endometrial lining of the uterus and its blood vessels which forms liquid that comes out through vagina. Menstruation only occurs if the released ovum is not fertilised.

2. **Follicular phase:** The menstrual phase is followed by the follicular phase. During this phase, the primary follicles in the ovary grow to become a fully mature Graafian follicle and simultaneously the endometrium of uterus regenerates through proliferation. These changes in the ovary and the uterus are induced by changes in the levels of pituitary and ovarian hormones. The secretion of gonadotropins (LH and FSH) increases gradually during the follicular phase, and stimulates follicular development as well as secretion of estrogens by the growing follicles.

3. **Ovulation:** Both LH and FSH attain a peak level in the middle of cycle (about 14th day). Rapid secretion of LH leading to its maximum level during the mid-cycle called LH surge induces rupture of Graafian follicle and thereby the release of ovum (ovulation).

4. **Luteal phase:** The ovulation (ovulatory phase) is followed by the luteal phase during which the remaining parts of the Graafian follicle transform as the corpus luteum. The corpus luteum secretes large amounts of progesterone which is essential for maintenance of the endometrium. Such an endometrium is necessary for implantation of the fertilised ovum and other events of pregnancy. During pregnancy all events of the menstrual cycle stop and there is no menstruation. In the absence of fertilisation, the corpus luteum degenerates.

(b) Scientific understanding of the menstrual cycle of human females help as a contraceptive measure because if we are aware of the menstrual cycle and hence the ovulatory phase we could avoid fertilization during that particular duration of time and this way it could work as a contraceptive measure.

**Q 25.**

(a) Write the scientific name of the organism Thomas Hunt Morgan and his colleagues worked with for their experiments. Explain the correlation between linkage and recombination with respect to genes as studied by them.

(b) How did Sturtevant explain gene mapping while working with Morgan?

OR

(a) State the ‘Central dogma’ as proposed by Francis Crick. Are there any exceptions to it? Support your answer with a reason and an example.
(b) Explain how the biochemical characterisation (nature) of 'Transforming Principle' was determined, which was not defined from Griffith’s experiments.

**Ans 25. (a)** Morgan worked with the tinyfruit files, Drosophila melanogaster. Linkage is a phenomenon of genic inheritance in which genes of a particular chromosome show their tendency to inherit together. Morgan and his group also found that even when genes were grouped on the same chromosome, some genes were tightly linked, i.e. linkage is stronger between two genes, if the frequency of recombination is low.

Whereas, the frequency of recombinations is higher, if genes are loosely linked, i.e. linkage is weak between two genes. Recombination of linked genes is by crossing over (exchange of corresponding parts between the chromatids of homologous chromosomes).

Fig. 5.7 Linkage : Results of two dihybrid crosses conducted by Morgan. Cross ‘A’ shows crossing between genes y and w; Cross ‘B’ shows crossing between genes w and m. Here, dominant wild type alleles are represented with **.
OR
(a) Francis Crick proposed the Central dogma in molecular biology, which states that the genetic information flows from DNA->RNA->Protein.

Some viruses are the exceptions to it. In those viruses the flow of information is in reverse direction, that is, from RNA to DNA by the process of reverse transcription. Example is HIV virus.

(b) Biochemical characterisation (nature) of ‘Transforming Principle’ was determined by to the work of Oswald Avery, Colin MacLeod and Maclyn McCarty. Prior that genetic material was thought to be a protein. They worked to determine the biochemical nature of ‘transforming principle’ in Griffith’s experiment. They purified biochemicals (proteins, DNA, RNA, etc.) from the heat-killed S cells to see which ones could transform live R cells into S cells. They discovered that DNA alone from S bacteria caused R bacteria to become transformed. They also discovered that protein-digesting enzymes (proteases) and RNA-digesting enzymes (RNases) did not affect transformation, so the transforming substance was not a protein or RNA. Digestion with DNase did inhibit transformation, suggesting that the DNA caused the transformation. They concluded that DNA is the hereditary material.

Q 26. (a) Following are the responses of different animals to various abiotic factors. Describe each one with the help of an example.
(i) Regulate: In this process organisms maintain an internal environment despite the changes in external environment. Homeostasis is maintained by ensuring constant body temperature and constant osmotic concentration, etc., byphysiological and sometimes behavioural means. All birds, mammals, few lower vertebrates and invertebrates are endotherms as they have the mechanism of thermoregulation and osmoregulation for maintaining their homeostasis.

(ii) Conform: In this process organism can’t maintain their internal environment. About 99% of animals and almost all plants cannot maintain a constant internal environment. Their body temperature changes with the ambient temperature, i.e. they are ectotherms. Examples are all invertebrates, fishes, amphibians and reptiles.

(iii) Migrate: If an organism move away temporarily from a stressful habitat to a more hospitable area and return, when the stressful period is over, the process is called migration. Birds undertake long distance migrations during winter, e.g., the Keoladeo National Park in Bharatpur (Rajasthan).

OR
(a) What is a trophic level in an ecosystem? What is ‘standing crop’ with reference to it?
(b) Explain the role of the ‘first trophic level’ in an ecosystem.
(c) How is the detritus food chain connected with the grazing food chain in a natural ecosystem?

Ans 26. (a) (i) Regulate: In this process organisms maintain an internal environment despite the changes in external environment. Homeostasis is maintained by ensuring constant body temperature and constant osmotic concentration, etc., byphysiological and sometimes behavioural means. All birds, mammals, few lower vertebrates and invertebrates are endotherms as they have the mechanism of thermoregulation and osmoregulation for maintaining their homeostasis.

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(iii) Migrate: If an organism move away temporarily from a stressful habitat to a more hospitable area and return, when the stressful period is over, the process is called migration. Birds undertake long distance migrations during winter, e.g., the Keoladeo National Park in Bharatpur (Rajasthan).
hosts thousands of migratory birds coming from Siberia and other extremely cold Northern regions every winter.

(iv) **Suspend**: Some organisms suspend their metabolic functions during the stressful period and resume their functions at the return of favourable conditions. Such organisms are unable to migrate so they might avoid the stress by escaping in time. For example, the winter sleep of animals such as bear called hibernation and summer sleep of certain animals like few snails and fish known as aestivation.

**OR**

(a) Based on the relationship among the organisms and the source of their nutrition or food, organisms occupy a specific place in the food chain that is known as their trophic level. Standing crop is measured as the mass of living organisms (biomass) or the number in an unit area. The biomass is expressed in terms of fresh or dry weight.

(b) First trophic level is occupied by producers (Plants). Plants trap sunlight and fix sun's radiant energy to make food from simple inorganic molecules. Thus, all organisms are dependent on producers either directly or indirectly for their food. Thus they help in introducing the energy into an ecosystem. Energy flows from the sun to producers and then to consumers and thus, maintains the first law of thermodynamics. Further, there is a constant need of supply of energy to synthesise the molecules which are synthesized by plants.

(c) The detritus food chain and grazing food chain are connected with each other. The consumers that feed on these herbivores are carnivores, or more correctly primary carnivores (though secondary consumers). Those animals that depend on the primary carnivores for food are labelled secondary carnivores. A simple grazing food chain (GFC) is depicted below:

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Grass ----> Goat ----> Man
(Producer)  (Primary Consumer)  (Secondary consumer)
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The organisms when die, enter into the detritus food chain. DFC begins with dead organic matter. It is made up of decomposers which are heterotrophic organisms, mainly fungi and bacteria. They meet their energy and nutrient requirements by degrading dead organic matter or detritus. These are also known as saprotrophs (sapro: to decompose). Decomposers secrete digestive enzymes that breakdown dead and waste materials into simple, inorganic materials, which are subsequently absorbed by them.

In an aquatic ecosystem, GFC is the major conduit for energy flow. As against this, in a terrestrial ecosystem, a much larger fraction of energy flows through the detritus food chain than through the GFC. Detritus food chain may be connected with the grazing food chain at some levels: some of the organisms of DFC are prey to the GFC animals, and in a natural ecosystem, some animals like cockroaches, crows, etc., are omnivores. These natural interconnection of food chains make it a food web.