CBSE 2018

BIOLOGY

Section A (1 marks)

1. How do cytokine barriers provide innate immunity in humans?

Solution: Interferons (IFN-α and IFN-β) and tumor necrosis factor (TNF) secreted by virus-infected cells and interleukins produced by leucocytes protect against viral infection.

2. Write the dual purpose served by Deoxyribonucleoside triphosphates in polymerization.

Solution: Deoxyribonucleoside triphosphates (DNTPs) have dual role in the process of replication.

(i) It acts as substrate.

(ii) It also serves as the source of energy for polymerization reaction.

3. 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

Solution:

(a) *Ramapithecus*

(b) Hominid *Australopithecines*

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

Solution: Preproinsulin is the primary translation product of the insulin gene having 110 amino acids with a signal peptide and an extra stretch called the C peptide. Removal of signal peptide produces proinsulin. Removal of C peptide chain converts proinsulin into insulin. It is followed by the formation of disulphide bonds between the A and B chain components producing biologically active insulin consisting of 51 amino acids.

5. Name two diseases whose spread can be controlled by the eradication of *Aedes* mosquitoes.

Solution:

Dengue and Chickungunya

Section B (2 marks)

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

Solution:

Biologists from Humboldt University and the residents of Arcata developed an integrated wastewater treatment process within a natural system. In this process, the sedimentation, filtering and chlorine treatment process is done in the first stage. In the second stage, heavy metals are removed. For this, six connected marshes spreading over 60 hectares were developed. The plants and microorganisms suitable for such area were allowed to proliferate which readily utilized the harmful heavy metals thereby purifying the water naturally. Besides, this sanctuary with a wide range of biodiversity is maintained by Friends of the Arcata Marsh (FOAM).

7. 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?

Solution:

(a) *Azotobacter, Nostoc, Azospirilluim*

(b) Leguminous plants are cultivated as green manure crop as they possess root nodules where atmospheric nitrogen is fixed by symbiotic bacteria *Rhizobium*. This fixed nitrogen then fertilizes the soil.

8. 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.

Solution:

The technique called micropropagation can be used to produce many plants by plant tissue culture. Clonal propagation or somaclonal propagation refers to the multiplication of genetically identical copies of a plant by micropropagation.

9. (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.

Solution:

(a) Heroin (like opium and morphine) is made from the resin of poppy plants. Milky, sap-like opium is first removed from the pod of the poppy flower. This opium is refined to make morphine, then further refined into different forms of heroin.

(b) Heroin slows down respiratory activity, causes constriction of pupil of eye, decreases glandular secretions, impairs the digestion, and produces nausea, vomiting and sterility. The person may also lose weight, fertility and interest in work.

10. 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?

Solution:

Hardy-Weinberg equilibrium states that the amount of genetic variation in a population will remain constant from one generation to the next if the disturbing factors are absent. The binomial expansion of $(p + q)^2$ is $p^2 + 2pq + q^2 = 1$

where, p = frequency of the *A* allele in the population; q = frequency of the *a* allele in the population; p^2 = frequency of the homozygous genotype *AA*; q^2 = frequency of the homozygous genotype aa and $2pq$ = frequency of the heterozygous genotype *Aa*.

Significance of Hardy-Weinberg Equilibrium

(i) It helps in determining the evolutionary change.

(ii) It ensures polymorphism in the population.

(iii) It prevents rapid evolutionary progress

Or

Although a prokaryotic cell has no defined nucleus, yet DNA is not scattered throughout the cell, Explain.

Solution:

In prokaryotes such as *E. coli*, the DNA must exist in a highly condensed form to fit into the small cell. The condensed state of the DNA in the nucleoid of a bacterial cell is known as folded genome. The DNA is further segregated into domains or loops (40 to 50 loops in E. coli). These loops are held by proteins. Each domain is independently negatively supercoiled.

Section C (3 marks)

11. (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

Solution:

(a)

Analogous structures	**Homologous structures**
If the structures in organisms are similar and carry out similar functions but do not have same embryological origin or similar anatomy, they are known as analogous structures.	Homologous structures are those which have the same basic structure and developmental origin, but different functions and appearance.
For example, the wings of birds and insects are analogous structures.	For example, thorns of *Bougainvillea* and the tendrils of *Cucurbita*.
Analogy indicates convergent evolution.	Homology indicates divergent evolution.

(b) Wings of butterfly and birds are analogous structure as they are different structures but since they have evolved for the same function, hence they are similar.

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

Solution

Meloidegyne incognitia (a nematode) infects the roots of tobacco plants leading to big losses in crop yield. To prevent this infestation, a novel technique based on the process of RNA interference (RNAi) or post transcriptional gene silencing (PTGS) has been adopted. The steps involved in the process are:

(i) dsRNA is procured from an infection by RNA-viruses which replicate via an RNA intermediate.

(ii) Nematode-specific genes are introduced into the host using *Agrobacterium* vectors.

(iii) After entering the cell, dsRNA are processed by enzyme RNase III into small 21–23 nucleotide long RNAs known as short interfering RNA (siRNA).

(iv) This siRNA binds with the RNA induced silencing complex (RISC) in the cytoplasm. siRNA unwinds into two strands—passenger strand (sense) and guide strand (antisense).

(v) As a result, both sense as well as anti-sense RNA are produced in the host cells which form dsRNA being complementary to each other.

(vi) The RISC-RNAi effector complex consists of an endonuclease that causes the cleavage of the

target mRNA strand of the nematode.

(vii) This prevents the translation of specific mRNA (also called gene silencing). The technique is thus, also called post transcriptional gene silencing (PGTS).

13. (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 organization.

Solution

(a) Ecosystem diversity describes the trophic levels, number of niches and the ecological processes that aid in energy flow and nutrient cycling in the ecosystem besides emphasis on interactions in the ecosystem. Hence, an ecosystem is composed of the floral and faunal communities, as well as the abiotic factors (e.g., nitrogen cycling, maintaining soil moisture, prevention of soil erosion, fire interactions, etc.) associated with specific communities. The number of habitats or ecosystems varies within a geographical area, and thus is a measure of biodiversity. The existence of several ecosystems in India such as deserts, rain forests, mangroves, coral reefs, wetlands, estuaries and alpine meadows makes it richer in ecological diversity than Scandinavian countries like Norway.

(b)

Genetic biodiversity	**Species biodiversity**
It is the total number of genetic characteristics of a specific species, subspecies or group of species.	It is the variety (in terms of their number and richness) of species in a given region or area.
Within a species it increases with environmental variability which results in the formation of polymorphs, races and subspecies in geographically isolated populations. Therefore, it provides the raw material for adaptation and evolution of new life forms (speciation).	It has three qualities: (1) Species richness (the total number of species), (2) species evenness (the relative abundance of species) and (3) species dominance (the most abundant). It is the sum total of relative chance of seeing species as well as the actual number of species present.

Or

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

Solution:

The main effects of water pollutants are:

(i) Due to addition of sewage and waste, oxygen levels are depleted, which are reflected in terms of increase in BOD (biological oxygen demand) values of water. The number of microbes as *Escherichia coli* also increases tremendously and these also consume most of the oxygen. The number of *Escherichia coli* in unit water is also taken as parameter of water pollution.

(ii) Domestic sewage contains pathogens like virus, bacteria, parasitic protozoa and worms. Contaminated water, therefore, can carry the germs of water-borne diseases, such as cholera, typhoid, amoebiasis, jaundice etc. Such contamination may make the water unsuitable for drinking, bathing and swimming, and even for irrigation.

(iii) The accumulation of nutrients in a lake or landlocked body of water causes availability of excess nutrients resulting in profuse growth of algae (algal bloom), especially the blue–green algae. Such algal blooms may totally cover the water surface, often releasing toxins in water, and sometimes causing deficiency of oxygen in the water. Thus, in bloom-infested water body the growth of other algae may be

inhibited due to toxins, and aquatic animals (e.g., fish) may die due to toxicity or lack of oxygen. The process of nutrient enrichment of water and consequent loss of species diversity is called eutrophication.

14. Explain the mechanism of 'sex determination' in birds. How does it differ from that of human beings?

Solution

In birds, females are heterogametic with autosomes and ZW allosomes; while males are homogametic with autosomes and ZZ allosomes. The male gametes are similar with allosome Z, while the female gametes are dissimilar and of two types—one half have allosome Z and the other half have allosome W. The offspring is female or male depends on the fertilizing ovum.

In humans, XX-XY type of sex-determination is followed, whereas in birds ZW-ZZ type of sex determination is followed. This implies that females are homogametic and males are heterogametic, while in birds, females are heterogametic and males are homogametic. Thus, in humans, the sperm used for fertilization determines the sex of the zygote, while in birds the egg getting fertilized determines the sex of the zygote.

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

Solution:

The breeding of unrelated individuals is called out-breeding. It is of three types: Out-crossing, Cross-breeding and Interspecific hybridization.

(i) Out-crossing: It refers to the mating of individuals having no common ancestors for 4-6 generations in the same breed. The motive of out-crossing is to retain the good traits already present in one strain and to capture the good ones from the other strain.

(ii) Cross-breeding: It refers to the mating of individuals of two different breeds. In this, the superior male of one breed is mated with the superior female of the other breed to produce offspring that will have desirable characteristics. The hybrid animals so produced are used directly for further commercial production or are used in inbreeding experiments to produce further superior and stable breeds.

16. (a) Organic farmers prefer biological control of diseases and pest 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.

Solution:

(a) Organic farming is a method of farming which is aimed at cultivation of land in such a way so as to sustain the health of soil and ecosystem by the usage of organic wastes (animal wastes, such as manure), crop rotation or biological material containing beneficial microbes (biofertilizers). It does not cause any disruption to local ecosystem, helps in procuring sustained yield at low costs and adopts intercropping and crop rotation.

(b) Biological control refers to the use of biological methods (by using predators and parasites) to control pests and diseases.

(i) Bacterium: *Bacillus thuringiensis* (Bt) is an important microbial biocontrol agent that produces a toxin called thurioside. This toxin causes a disease that affects caterpillars and the larvae of other insect pests including gypsy moths.

(ii) Fungus: *Trichoderma* are present in the soil and mainly associated with the plant roots. They serve as a common biocontrol agent to treat plant diseases by acting as parasites on other fungi and obtaining nutrition from them.

(iii) Insect: Ladybirds or ladybugs beetles (e.g., the ladybird and dragonflies) are conspicuous because of their red and black markings, are effective predators as they feed on aphids and other insects. Some species can also feed on caterpillar larvae. They are available at the garden stores and can be released in the garden.

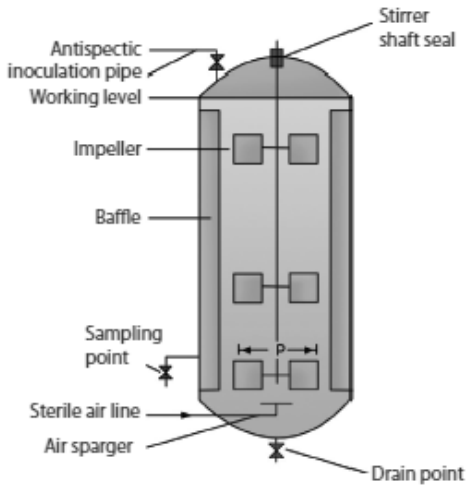
17. (a) How has the development of bioreactor helped in biotechnology?

(b) Name the most commonly used bioreactor and describe its working.

Solution:

(a) A bioreactor is a vessel in which generally a substrate of lower value (raw material) is utilized by cells to produce products that are of higher commercial value such as specific enzymes, etc., human, animal, plant, fungal or bacterial cells. A product would be useful to the mankind only if it is produced in large quantities and is made available on a large scale. This is the reason why, it was important to have bioreactor by which largescale production (100–1000 liters) can be achieved. Several techniques have been developed to achieve this. The cells can be multiplied by continuous culture techniques, making use of a fermenter, from which samples can be continuously drawn off, providing a non-stop supply of the product. A bioreactor offers optimum growth conditions for maximum product production.

(b) Stirred-tank bioreactors are the most commonly used bioreactors. It consists of a vessel with a vertical rotating shaft with agitator blades. The schematic representation is shown in Figure. The sterilization of the reactor is carried out using steam under pressure, so the reactor must meet the requirements of a pressure reactor. It is thus constructed using 4-5 mm thick stainless steel which is also resistant to acids produced during fermentation process. The height to diameter (H/D) ratio of the reactors varies from 1 in small reactors to 3 in big reactors. Reactors with high H/D ratio are easy to construct and better at mixing due to bigger agitator blades. The bioreactor is fitted with systems that help monitor the temperature, pH and pressure, a system to control foam and sampling ports from which samples can be withdrawn for testing at regular intervals.



18. Explain the roles of the following with the help if an example each in recombinant DNA technology.

(a) Restriction enzymes

(b) Plasmids

Solution:

(a) Restriction enzymes belong to class nucleases (Hydrolases). They are used in the construction of recombinant DNA molecules. When cut by the same restriction enzyme, the resultant DNA fragments have the same sticky ends which can be joined together end-to-end by use of DNA ligases. The restriction endonucleases function by first inspecting the length of a DNA sequence and finding its specific recognition sequence at which the DNA molecule is to be cut. For example, *Pvu*I, a restriction endonuclease from *Proteus vulgaris*, cuts DNA at the hexanucleotide CGATCG.

(b) Plasmids are circular molecules of DNA that lead an independent existence in a bacterial cell either as closed circular or supercoiled and nicked or open circular. They act as cloning vectors. The size and copy number (the number of molecules of an individual plasmid that are normally found in a single bacterial cell) of a plasmid are very important in gene cloning. Some plasmids are stringent (specially the larger ones) and have a low copy number (one or two per cell) while others are relaxed and are present in multiple copies of 50 or more per cell. One of the first vectors to be developed was pBR322 (where p stands for plasmid, BR stands for Boliver and Rodriguez, the two researchers who developed pBR322 and 322 distinguishes this plasmid from other plasmids such as pBR325, pBR327 also developed in the same laboratory). It is the most widely used plasmid vector in gene cloning.

19. Differentiate between Parthenocarpy and Parthenogenesis. Give one example of each.

Solution:

Parthenocarpy	**Parthenogenesis**
Parthenocarpy It is the formation of seedless fruits without pollination or fertilization	Parthenogenesis is the process of formation of an embryo from an unfertilized egg.
It is done in some fruits to obtain seedless varieties (e.g., grapes, banana, pineapple, guava, watermelon, lemon, etc.)	It occurs in both plants and animals, but rarely observed in angiosperms. In plants, it can be of two types: • Haploid parthenogenesis: In this, the unfertilized haploid egg develops into an embryo. Such plants are always sterile, e.g., *Datura*, *Solanum nigrum*, etc. • Diploid parthenogenesis: In this, the cells of the embryo sac are diploid (apospory). The diploid egg develops into a diploid embryo by diploid parthenogenesis. For example, *Taraxacum.*

20. 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.

Solution:

Breast-feeding has nutritional benefit. Human milk is a sterile solution that contains amounts of fatty acids, lactose, amino acids, minerals, vitamins and water that are ideal for the baby's digestion, brain

development and growth. Apart from this, breast-feeding also benefits the infants by providing the following:

(i) Beneficial cells: Several types of white blood cells are present in breast milk that directly or indirectly help mobilize other defenses.

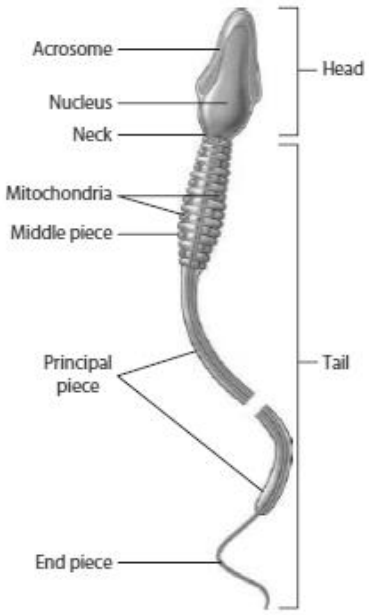
(ii) Beneficial molecules: Maternal IgA antibodies in breast milk bind to microbes in the baby's alimentary canal and prevent their migration into other body tissues. Additionally, two milk proteins bind to nutrients that many bacteria need to grow and survive: B12-binding protein ties up vitamin B12 and lactoferrin ties up iron.

(iii) Decreased incidence of diseases later in life: Breast-feeding provides children with a slight reduction in risk of lymphoma, heart disease, allergies, respiratory and gastrointestinal infections, ear infections, diarrhea, diabetes mellitus and meningitis.

(iv) Miscellaneous benefits: Breast-feeding supports optimal infant growth, enhances intellectual and neurological development and fosters mother–infant relations by establishing early and prolonged contact between them. Finally, a baby is less likely to have an allergic reaction to its mother's milk than to milk from another source.

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

Solution:



(i) Acrosome is filled with enzymes such as hyaluronidase and proteases that help the sperm to penetrate a secondary oocyte to bring about fertilization.

(ii) Nucleus contains 22 highly condensed chromosomes and one sex chromosome (X or Y) to stores the genetic information.

(iii) The middle piece contains several mitochondria which provide energy (ATP) for locomotion of sperm to the site of fertilization and for sperm metabolism.

22. (a) Explain VNTR and describe its role in DNA fingerprinting.

(b) List any two applications of DNA fingerprinting technique.

Solution:

(a) The human genome contains many short DNA sequences that are present as tandem repeats of varied lengths at several chromosomal locations. These Variable Number of Tandem Repeats (VNTR) are important components of DNA fingerprints. When DNA is cut with restriction endonucleases, a pattern of bands is produced. It can be visualized by Southern blot hybridization using radiolabeled VNTR sequences as probes. This pattern is known as DNA fingerprints.

(b) The applications of DNA fingerprints are as follows:

(i) Forensic applications: The DNA fingerprints are very valuable in forensic investigations when a small amount of tissue can be obtained from site of crime. By careful analysis of the DNA fingerprints obtained from DNA as evidence with the suspect's DNA, many cases can be solved. Hence, DNA fingerprints can provide a much-needed and powerful tool in crime investigations and will prevent wrongful convictions.

(ii) Paternity tests: To determine paternity, previously blood types of the child, the mother and possible fathers were compared based on the logic that a man with a particular blood-type could not have fathered the child. However, the results were often misleading and the positive identity of the father could not be ascertained.

Section D (4 Marks)

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 organize in the school so as to bring awareness among the students on how to check air pollution in and around the school.

Solution:

(a) The main causes of air pollution are automobile exhaust and industrial processes:

(i) Automobile exhausts: The important components of automobile exhaust are carbon monoxide, nitrogen oxides, hydrocarbons and volatile organic compounds (VOCs) and ozone.

(ii) Industrial processes: The main pollutants released from industrial processes are sulphur dioxide, fluorides and particulate matter.

(b)

(i) The ultrafine particles, in animals, including humans, cause inflammation (cell and tissue damage by oxidation), leading to clogging in the arteries that can result in heart attack and stroke. Particulates that enter lungs may lodge there, with chronic effects on respiration.

(ii) In plants, they interfere with absorption of carbon dioxide and oxygen and transpiration.

(c) As a captain of school Eco-club, I would like to organize following activities in my school to bring awareness among students to check air pollution:

(i) Organize seminars, debates, lectures and popular talks on environmental issues in the school.

(ii) Organize tree plantation programs, awareness programs such as Quiz, essay, painting competitions, rallys, nukkad natak etc., regarding air pollution and aware children about its serious consequences.

Section E (5 Marks)

24. (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?

Solution

(a) T.H. Morgan was an American geneticist and embryologist, who was considered as the father of Experimental Genetics for his discovery of linkage, crossing over, sex-linked inheritance, criss-cross inheritance, linkage maps, etc. He explained the mechanism of linkage through his studies on the fruit fly *Drosophila melanogaster*. Along with Castle, Morgan proposed chromosomal theory of linkage. According to this theory:

(i) Genes are attached to one another like beads on a string in a linear organization.

(ii) Genes that are physically attached to the same chromosome should travel as a unit through meiosis. This implies that genes present on the same chromosome should act as if they are linked to each other, that is, they are part of the same linkage group.

(iii) Genes present on the same chromosome could be separated during meiosis and new combinations of genes could be formed. This phenomenon is called recombination of genes.

(iv) During meiosis, when homologous chromosomes paired, the separated and recombined genes physically exchange of material at a crossover point called chiasma. This phenomenon of exchange between paired chromosomes at the chiasma is called crossing over.

(v) The distance between the linked genes indicates the strength of linkage.

(b) On the basis of recombination of alleles, chromosomal maps of linked genes can be drawn. These maps provide important information such as frequency of cross over, location of genes in a chromosome (i.e., distance between the genes), number of chiasmata appearing during prophase I of meiosis, which subsequently gives the average number of crossovers occurring in a chromosome. Genetic map distance is based on average number of crossovers. When the points are far apart, there will be more number of crossovers between them than between points close together. Now, the chance for a crossover occur between two points may be low for far apart genes, but that crossover will occur several times but in a large population of cells. Therefore, the genetic map distance is based on average number of crossovers. T.H Morgan along with his student Sturtevant found that frequency of recombination of genes by crossing over is inversely proportional to the distance between the genes in a chromosome. He created linked maps for better understanding of crossover of genes during meiosis. A map unit is called a centiMorgan (cM) in his honor. 100 centiMorgan equal one Morgan (M). The understanding of sex-linked

inheritance was a direct inference of his work with white-eyed mutant in the fruit fly. This led him to believe that gene of eye color was located on X chromosome and propose existence of criss-cross inheritance.

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 characterization (nature) of "Transforming Principle' was determined, which was not defined from Griffith's experiments.

Solution:

(a) The central dogma in molecular biology proposed by Watson and Crick stated that the flow of information is from DNA → RNA → Protein. The genetic information usually flows from DNA to DNA during its replication and from DNA to protein during its phenotypic expression in an organism. The transfer of genetic information from DNA to protein involves two steps:

(i) Transcription: It is the transfer of the genetic information from DNA to RNA (mRNA).

(ii) Translation: It is the transfer of information from RNA (mRNA) to protein.

The transfer of genetic information from DNA to RNA is sometimes reversible, whereas the transfer of information from RNA to protein is always irreversible.

In some viruses (retroviruses) and related transposable elements (retrotransposons), RNA is used as a template to synthesize DNA. This process is called reverse transcription. It is catalyzed by the enzyme reverse transcriptase. Hershey-Chase experiment clearly demonstrated that the genetic material was DNA and not protein. With further identification of viruses, it was found that many of them contain RNA and proteins, but no DNA. These RNA viruses store their genetic information in nucleic acids which is RNA and not in proteins. The establishment of RNA as the genetic material in RNA viruses was demonstrated by the reconstitution experiment of Heinz Fraenkel-Conrat and coworkers in 1957.

(b) Frederick Griffith, while studying pneumococcal infections in mice discovered bacterial transformation in 1928. Hence, it is also called Griffith effect. Transformation is the change in an organism's characteristics because of the transfer of genetic information. The experiment was conducted using bacterium *Streptococcus pneumoniae* that causes pneumonia and since mice are quite sensitive to pneumococci, they are used as test animals. Pneumococci with capsules produce smooth (S), shining colonies as they have mucus (polysaccharide coat), while those lacking capsules produce rough (R) colonies with a coarse appearance. Only the encapsulated *S. pneumoniae* (S strain) caused pneumonia as it was virulent. The transforming principle was initially considered to be proteins. Oswald Avery, Colin MacLeod and Maclyn McCarty conducted a series of experiments to determine the exact biochemical nature of transforming principle. These experiments were based on Griffith's work and involved the following steps:

(i) They removed the nucleic acids from bacteria (heat-killed S cells) and purified the proteins, RNA and DNA from the extract to test which of these caused transformation.

(ii) The highly purified DNA from S cells was treated with the following enzymes:

- Deoxyribonuclease (DNase) which degrades DNA,

- Ribonuclease (RNase) which degrades RNA, or
- Proteases which degrade proteins.

(iii) The DNA was then tested for its ability to transform R cells to S cells.

(iv) It was found that only DNA was responsible for transformation because when DNA was treated with DNase (which degraded DNA), transformation was not possible. This result strongly suggested that DNA is the hereditary material. However, their work could not convince many biologists. This work was continued by Alfred Hershey and Martha Chase in 1952.

25. (a) Following are the responses of different animals to various abiotic factors. Describe each one with the help of an example.

(i) Regulate

(ii) Conform

(iii) Migrate

(iv) Suspend

(b) If 8 individuals in a population of 80 butterflies die in a week, calculate the death rate of population of butterflies during that period.

Solution:

(a) (i) Regulate: Some organisms maintain homeostasis through physiological and/or behavioral means. The organisms, which are regulators, have the tendency to regulate either their body temperature or osmotic concentration. All birds and mammals as well as few lower vertebrate and invertebrate species are capable of thermoregulation and osmoregulation. Human beings exhibit thermoregulation by maintaining a constant body temperature of 37°C. In summers, when the outside temperature is more, the body sweats and the resulting evaporation causes cooling. In winters when the outside temperature is lower, the body shivers and this motion produces heat to raise the temperature of the body.

(ii) Conform: Organisms that live in relatively stable environments are often conformers. Most of the animals and almost all plants fall under this category. They allow some conditions within their body to vary with external changes. Many species are conformers under certain environmental conditions but can regulate only to some extent under others. For a conformer, the internal environment to a degree matches with the external environment. For example, temperature regulation would require lizard *Anolis cristatellus* to travel long distances to find an exposed sunny area. Hence its body temperature conforms to that of the environment. However, this same species thermoregulates in open habitats where it can bask in the sun. Increased body size maintains core body temperature (Bergmann's rule).

(iii) Migrate: Organisms can move away temporarily from the stressful habitat to a favorable habitat and return with the onset of favorable conditions in their original habitat. They can move long or short distances. Arctic tern is a sea bird which makes a round trip between its north Atlantic and Arctic breeding grounds to the Antarctica every year. Siberian birds migrate from Siberia during winter to Keoladeo National Park located in Bharatpur, Rajasthan, India. This is a mechanism of escape in space.

(iv) Suspend: The spores formed in bacteria, fungi and other lower plants germinate under favorable conditions. They help these organisms to tide over unfavorable conditions. Protists, like *Amoeba*, protect themselves from unfavorable conditions by encystation that is, enclosing itself in a cyst. Sponges produce

gemmules (dormant cluster of embryonic cells) in the unfavorable conditions for protection develop in more favorable conditions.

(b)

$$\text{Death rate} = \frac{\text{Number of individual died}}{\text{Total number of individual}}$$

$$= \frac{8}{80} = 0.1 \text{individual/week}$$

Death rate will be 0.1 individual per week.

Or

(a) What is a tropic 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?

Solution

(a) Trophic level is a step of food chain which is characterized by the method of obtaining its food. The examples of organisms are:

- First trophic level: Grass, trees, phytoplanktons.
- Second trophic level: Cow, grasshopper, zooplanktons.
- Third trophic level: Birds, animals and fish.

The standing crop is the amount of organic matter or biomass in a trophic level at any given time. A small standing crop of phytoplanktons can support large standing crop of zooplanktons. Recycling of chemical elements must also be done by converting them into a reusable form. The release of nutrients into the atmosphere depends on many factors such as temperature, pH, moisture, soil, etc. The deficit caused due to imbalance by the influx and efflux is catered to by the reservoir. The amount of nutrients present in the soil at a given point in time is called standing state. The wastes are converted into food, which is again converted into wastes, which must be converted once again into food, with the cycling going on indefinitely, if the ecosystem is to remain viable. If the rate of uptake of nutrient is more than the amount recycled, then a part of nutrient gets stored in the standing crop. This is known as retention of nutrients. It can be calculated as:

Nutrients Retained = Nutrient Up taken – Nutrients Recycled

(b) The concept of trophic level was introduced in 1942 by Raymond L. Lindeman. It comes from the Greek word trophein, meaning to nourish. A trophic level is thus a nourishing level. It consists of all those organisms in a food web (described in Section 14.7) that are the same number of feeding levels away from the original source of energy. The original source of energy in most ecosystems is the Sun. In other cases, it is the energy in certain inorganic compounds. Green plants, algae and certain bacteria produce carbohydrates by photosynthesis, using only the energy of the Sun and carbon dioxide (CO_2) from the air, so they are grouped into the first trophic level. These organisms in the first trophic level, which make their own food and inorganic chemicals and a source of energy, are called autotrophs or producers. All organisms that feed on autotrophs are heterotrophs or consumers. Herbivores, organisms that feed on

plants, algae, or photosynthetic bacteria, are members of the second trophic level and are primary consumers.

26. (a) Describe any two devices in a flowering plant which prevent both autogamy and geitonogamy.

(b) Explain the events upto double fertilization after the pollen tube enters one of the synergids in an ovule of an angiosperm.

Solution:

(a) (i) Self-sterility or self-incompatibility: In some plants, the pollen grains of a flower are not effective on the stigma of the same flower or that of flower of the same plant (e.g., tea, tobacco, etc.). In such cases, there is genetic incompatibility and xenogamy is favored. Thus, self-pollination is prevented despite occurrence of fully viable pollen grains and ovules.

(ii) Herkogamy: It is a condition in which a physical barrier is present between the anther and the style. They are arranged in such manner that the pollen grain does not fall on stigma of the same flower. For example, in orchids, pollen grains are present in special structures called pollinia and insects are required for pollination.

(b) Double fertilization is observed only in angiosperms. It involves two types of fusions in the embryo sac:

(i) Fusion of sperm cell (male gamete) with egg cell (female gamete) to form a diploid zygote. This process is known as syngamy or generative fertilization.

(ii) Fusion of the other sperm cell with two polar nuclei to form primary endosperm cell containing triploid nucleus also known as primary endosperm nucleus (PEN). This process is known as triple fusion as it involves fusion of three haploid nuclei. The zygote gradually develops into an embryo and central cell becomes primary endosperm cell (PEC) and eventually develops into endosperm.

Or

(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?

Solution

(a) The duration of the female reproductive cycle typically ranges from 24 to 36 days.

(i) The menstrual phase, also called menstruation or menses (month), lasts for roughly the first 3-5 days of the cycle. (By convention, the first day of menstruation is day 1 of a new cycle.)

(ii) Ovulation, the rupture of the mature (Graafian) follicle and the release of the secondary oocyte into the pelvic cavity, usually occurs on day 14 to 16 in a 28-day cycle. During ovulation, the secondary oocyte remains surrounded by its zona pellucida and corona radiata. With reference to menstrual cycle, ovulation happens during ovulatory phase.

(iii) The postovulatory phase of the female reproductive cycle is the time between ovulation and onset of the next menses. In duration, it is the most constant part of the female reproductive cycle. It lasts for 14 days in a 28-days cycle, from day 15 to day 28.

(b) A couple can use their knowledge of the physiological changes that occur during the female reproductive cycle to decide either to abstain from intercourse on those days when pregnancy is a likely result, or to plan intercourse on those days if they wish to conceive a child. In females with normal and regular menstrual cycles, these physiological events help to predict the day on which ovulation is likely to occur. The couple should abstain from intercourse between day 10–17 of the menstrual cycle if they want to prevent pregnancy.