QUESTION PAPER & SOLUTION
SUBJECT: - BIOLOGY
PAPER-CODE:-56/1
SET-1
SECTION-A

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

Ans. **Cytokines** play a main role in the innate immune response by means of direct mechanisms against the invading agent (inhibiting viral replication) or by activating mechanisms for cells such as macrophages, which upon activation, produce more **cytokines**.

Q.2 Write the dual purpose served by Deoxyribonucleoside triphosphates in polymerisation?

Ans. 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 polymerisation reaction.

Q.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

Ans. (a) Dryopithecus
(b) Australopithecines

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

Ans. In mammals, including humans, insulin is synthesised as a pro-hormone (like a pro-enzyme, the pro-hormone also needs to be processed before it becomes a fully mature and functional hormone) which contains an extra stretch called the C peptide. This C peptide is not present in the mature insulin and is removed during maturation into insulin.

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

Ans. dengue and chikungunya

SECTION-B

Q.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.

Ans. Collaborating with biologists from the Humboldt State University, the townspeople created an integrated waste water treatment process within a natural system.
The cleaning occurs in following stages –

1. The conventional sedimentation, filtering and chlorine treatments are given.
2. After this stage, lots of dangerous pollutants like dissolved heavy metals still remain. To combat this, an innovative approach was taken.
3. The biologists developed a series of six connected marshes over 60 hectares of marshland.
4. Appropriate plants, algae, fungi and bacteria were seeded into this area, which neutralise, absorb and assimilate the pollutants. Hence, as the water flows through the marshes, it gets purified naturally.

Q.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?

Ans.

a) *Azospirillum* and *Azotobacter*
b) Leguminous plants contain rhizobium bacteria in their root nodules. These bacteria convert atmospheric nitrogen to a form which can be used by plants. This decreases nitrogen deficiency in the soil and makes it fertile.

Q.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 generation of the tomato crop.

Ans. Plant breeding is the purposeful manipulation of plant species in order to create desired plant types that are better suited for cultivation, give better yields and are disease resistant.
The main steps in breeding a new genetic variety of a crop are –
Collection of variability, Evaluation and selection of parents, Cross hybridisation among the selected parents, Selection and testing of superior recombinants, Testing, release and commercialisation of new cultivars.
Plants, bacteria, fungi and animals whose genes have been altered by manipulation are called Genetically Modified Organisms. GM plants have been useful in many ways.

Q.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.

Ans.

a) Heroin commonly called *smack* is chemically diacetylmorphine which is a white, odourless, bitter crystalline compound. This is obtained by acetylation of morphine, which is extracted from the latex of poppy plant *Papaversomniferum.*
b) heroin is a depressant and slows down body functions

Q.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?

OR

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

Ans. This principle says that allele frequencies in a population are stableand is constant from generation to generation. The gene pool (total gene sand their alleles in a population) remains a constant. This is called genetic equilibrium. Sum total of all the allelic frequencies is 1.

Individual frequencies, for example, can be named p, q, etc.
In a diploid, p and q represent the frequency of allele *A* and allele *a*.
The frequency of *AA* individuals in a population is simply p2.
This is simply stated in another ways, i.e., the probability that an allele A with a frequency of p appear on both the chromosomes of a diploid individual is simply the product of the probabilities, i.e., p^2. Similarly of aa is q^2, of Aa 2pq.

Hence, $p^2+2pq+q^2=1$.
This is a binomial expansion of $(p+q)^2$. When frequency measured, differs from expected values, the difference (direction) indicates the extent of evolutionary change. Disturbance in genetic equilibrium, or Hardy- Weinberg equilibrium, i.e., change of frequency of alleles in a population would then be interpreted as resulting in evolution.

OR

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.

SECTION-C

Q.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

Ans.

a) Homologous structures vs Analogous structures

S. No.	Homologous organs	Analogous organs
1.	Common basic structural plan.	Different basic structural plan.
2.	Common developmental origin.	Different developmental origin.
3.	Perform different functions.	Perform same functions.
4.	Leads to divergent evolution.	Leads to convergent evolution.
5.	E.g. Forelimbs in vertebrates.	E.g. Wings of birds and insects; Sting of honeybee and scorpion.

b) Analogous structures:
The term analogous structures is applied in the concept of convergent evolution(convergence), which pertains to the evolutionary process wherein the organisms evolve bodily parts that are analogous in terms of structure and function despite their ancestors that are very dissimilar or unrelated
(i) Wings of butterfly and birds
(iv) Tubers of sweet potato and potato

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

Ans. Several nematodes parasitise a wide variety of plants and animals including human beings. A nematode *Meloidegynein cognitia* infects the roots of tobacco plants and causes a great reduction in yield.

A novel strategy was adopted to prevent this infestation whichwas based on the process of RNA interference (RNAi).

RNAi takes place in all eukaryotic organisms as a method of cellular defense.

This method involves:

- Silencing of a specific mRNA due to a 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 mobile genetic elements (transposons)that replicate via an RNA intermediate.

Using *Agrobacterium* vectors,

1) Nematode-specific genes wereintroduced into the host plant.
2) The introduction of DNAwas such that it produced both sense and anti-sense RNA in the hostcells. These two RNA's being complementary to each other formed a doublestranded (dsRNA) that initiated RNAi and thus, silenced the specific mRNAof the nematode.
3) The consequence was that the parasite could not survivein a transgenic host expressing specific interfering RNA.

Q.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 organisation.

OR

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

Ans.

a) In our biosphere immense diversity (or heterogeneity) exists not only at the species level but at all levels of biological organisation ranging from macromolecules within cells to biomes. Biodiversity is the term popularized by the sociobiologist Edward Wilson to describe the combined diversity at all the levels of biological organisation.

Ecological *diversity:* At the ecosystem level, India, for instance, with its deserts, rain forests, mangroves, coral reefs, wetlands, estuaries, and alpine meadows has greater ecosystem diversity than a Scandinavian country like Norway.

b) Differences between Genetic Diversity and Species Diversity are given below.

S. No.	Genetic biodiversity	Species biodiversity
1.	It is related to number of genes and their alleles found in organisms.	It is related to number and distribution of species found in an area.
2.	It is the trait of the species.	It is the trait of the community
3.	It influences adaptability and distribution of a species in diverse habitats.	It influences biotic interactions and stability of the community.

OR

Effects on characteristics of a river, when urban sewage is discharged:
Solids are relatively easy to remove, but most difficult to remove are dissolved salts such as nitrates, phosphates, and other nutrients, and toxic metal ions and organic compounds.

1) Domestic sewage primarily contains biodegradable organic matter, which readily decomposes – thanks to bacteria and other micro-organisms, which can multiply using these organic substances as substrates and hence utilise some of the components of sewage. It is possible to estimate the amount of biodegradable organic matter in sewage water by measuring Biochemical Oxygen Demand (BOD).
2) Micro-organisms involved in biodegradation of organic matter in the receiving water body consume a lot of oxygen, and as a result there is a sharp decline in dissolved oxygendownstream from the point of sewage discharge. This causes mortality of fish and other aquatic creatures.

3) Presence of large amounts of nutrients in waters also causes excessive growth of planktonic (free-floating) algae, called an algal bloom which imparts a distinct colour to the water bodies. Algal blooms cause deterioration of the water quality and fish mortality. Some bloom-forming algae are extremely toxic to human beings and animals.

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

Ans. **Mechanism of sex determination in birds:-**
In birds, a different mechanism of sex determination is observed. In this case the total number of chromosome is same in both males and females. But two different types of gametes in terms of the sex chromosomes are produced by females, i.e., female heterogamety.
In order to have a distinction with the mechanism of sex determination described earlier, the two different sex chromosomes of a female bird has been designated to be the Z and W chromosomes. In these organisms the females have one Z and one W chromosome, whereas males have a pair of Z-chromosomes besides the autosomes.

But the sex determining mechanism in case of humans is XY type. Out of 23 pairs of chromosomes present, 22 pairs are exactly same in both males and females; these are the autosomes.
A pair of X-chromosomes are present in the female, whereas the presence of an X and Y chromosome are determinant of the male characteristic.

During spermatogenesis among males, 50 per cent of the total sperm produced carry the X-chromosome and the rest 50 per cent has Y-chromosome besides the autosomes.
Females, however, produce only ovum with an X-chromosome. In case the ovum fertilises with a sperm carrying X-chromosome the zygote develops into a female (XX) and the fertilisation of ovum with Y-chromosome carrying sperm results into a male offspring.

Q.15 Explain out-breeding, out-crossing and cross-breed husbandry.

Ans. Breeding of animals is an important aspect of animal husbandry. Animal breeding aims at increasing the yield of animals and improving the desirable qualities of the produce.

Out-breeding : Out-breeding is the breeding of the unrelated animals, which may be between individuals of the same breed but having no common ancestors for 4-6 generations (out-crossing) or between different breeds (cross-breeding) or different species (inter-specific hybridisation).

Out-crossing: This is 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. The offspring of such a

mating is known as an out-cross. It is the best breeding method for animals that are below average in productivity in milk production, growth rate in beef cattle, etc. A single outcross often helps to overcome inbreeding depression.

Cross-breeding: In this method, superior males of one breed are mated with superior females of another breed. Cross-breeding allows the desirable qualities of two different breeds to be combined. The progeny hybrid animals may themselves be used for commercial production. Alternatively, they may be subjected to some form of inbreeding and selection to develop new stable breeds that may be superior to the existing breeds. Many new animal breeds have been developed by this approach. *Hisardale* is a new breed of sheep developed in Punjab by crossing Bikaneri ewes and Marino rams.

Q.16 (*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.

(a) Biological control of pests and diseases: In agriculture, there is a method of controlling pests that relies on natural predation rather than introduced chemicals.

A key belief of the organic farmer is that biodiversity furthers health. The more variety a landscape has, the more sustainable it is. The organic farmer, therefore, works to create a system where the insects that are sometimes called pests are not eradicated, but instead are kept at manageable levels by a complex system of checks and balances within a living and vibrant ecosystem.

Contrary to the 'conventional' farming practices which often use chemical methods to kill both useful and harmful life forms indiscriminately, this is a holistic approach that seeks to develop an understanding of the webs of interaction between the myriad of organisms that constitute the field fauna and flora. The organic farmer holds the view that the eradication of the creatures that are often described as pests is not only possible, but also undesirable, for without them the beneficial predatory and parasitic insects which depend upon them as food or hosts would not be able to survive. Thus, the use of biocontrol measures will greatly reduce our dependence on toxic chemicals and pesticides.

(b) Bacteria: *Bacillus thuringiensis*-to control butterfly caterpillars
Fungus: *Trichoderma*- use in the treatment of plant disease
Insect: the Ladybird, and Dragonflies- useful to get rid of aphids and mosquitoes, respectively

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

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

Ans.

a) Small volume cultures cannot yield appreciable quantities of products.
To produce in large quantities, the development of bioreactors, where large volumes (100-1000 litres) of culture can be processed, was required. Thus, bioreactors can be thought of as vessels in which raw materials are biologically converted into specific products, individual enzymes, etc., using microbial plant, animal or human cells. A bioreactor provides the optimal conditions for achieving the desired product by providing optimum growth conditions (temperature, pH, substrate, salts, vitamins, oxygen).

b) The most commonly used bioreactors are of stirring type.
A stirred-tank reactor is usually cylindrical or with a curved base to facilitate the mixing of the reactor contents. The stirrer facilitates even mixing and oxygen availability throughout the bioreactor. Alternatively air can be bubbled through the reactor. the bioreactor has an agitator system, an oxygen delivery system and a foam control system, a temperature control system, pH control system and sampling ports so that small volumes of the culture can be withdrawn periodically.

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

(*a*) Restriction Enzymes

(*b*) Plasmids

Ans.

a) Restriction enzymes belong to a larger class of enzymes called nucleases. These are of two kinds; exonucleases and endonucleases.
Exonucleases remove nucleotides from the ends of the DNA whereas, endonucleases make cuts at specific positions within the DNA. Each restriction endonuclease functions by 'inspecting' the length of a DNA sequence. Once it finds its specific recognition sequence, it will bind to the DNA and cut each of the two strands of the double helix at specific points in their sugar -phosphate backbones. Each restriction endonuclease recognises a specific palindromic nucleotide sequences in the DNA Restriction enzymes cut the strand of DNA a little away from the centre of the palindrome sites, but between the same two bases on the opposite strands. This leaves single stranded portions at the ends. There are overhanging stretches called sticky ends on each strand. These are named so because they form hydrogen bonds with their complementary cut counterparts. This stickiness of the ends facilitates the action of the enzyme DNA ligase. Restriction endonucleases are used in genetic engineering to form 'recombinant' molecules of DNA, which are composed of DNA from different sources/genomes.

b) Plasmids: The construction of the first recombinant DNA emerged from the possibility of linking a gene encoding antibiotic resistance with a native **plasmid** (autonomously replicating circular extra-chromosomal DNA) of *Salmonella typhimurium*. Stanley Cohen and Herbert Boyer accomplished this in 1972 by isolating the antibiotic resistance gene by cutting out a piece of DNA from a plasmid which was responsible for conferring antibiotic resistance. The cutting of DNA at specific locations became possible with the discovery of the so-called 'molecular scissors'– restriction enzymes. The cut piece of DNA was then linked with the plasmid DNA. These plasmid DNA act as **vectors** to transfer the piece of DNA attached to it.
The linking of antibiotic resistance gene with the plasmid vector became possible with the enzyme DNA ligase, which acts on cut DNA molecules and joins their ends. This makes a new combination of circular autonomously replicating DNA created *in vitro* and is known as recombinant DNA.

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

Ans. The key difference between parthenogenesis and parthenocarpy is**,** parthenogenesis is shown by animals and plants while parthenocarpy is shown only by plants**.**
Parthenogenesis can be defined simply as a reproduction without fertilization. It occurs when a female gamete develops into a new individual without being fertilized by a male gamete. Parthenogenesis is a normal process seen in many plants, vertebrates, invertebrates, etc.

Parthenocarpy is a process which produces fruits without the fusion of ovule with sperm cell in flowering plants. It occurs due to unsuccessful pollination and fertilization. Also, it can happen due to nonfunctional ovules and sperms. These are the differences between parthenogenesis and parthenocarpy.

Parthenogenesis vs Parthenocarpy	
Parthenogenesis is a type of reproduction in which unfertilized egg or ovule is developed into a new organism.	Parthenocarpy is a process in which unfertilized ovule is developed into a seedless fruit.
Parthenogenesis produces haploid organisms.	Parthenocarpy always produces seedless fruits.
Parthenogenesis is common in plants and animals.	Parthenocarpy is common in flowering plants.

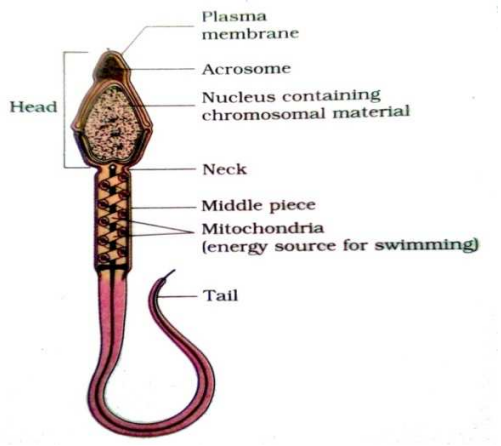
Q.20 Medically it is advised to all young mothers that breastfeeding is the best for their newborn babies. Do you agree? Give reasons in support of your answer.

Ans. The mammary glands of the female undergo differentiation during pregnancy and starts producing milk towards the end of pregnancy by the process called **lactation**. This helps the mother in feeding the newborn.

The milk produced during the initial few days of lactation is called **colostrums** which contains several antibodies absolutely essential to develop resistance for the new-born babies. Breast-feeding during the Initial period of infant growth is recommended by doctors for bringing up a healthy baby.

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

Ans.



It is a microscopic structure composed of a **head**, **neck,** a **middle piece** and a **tail**.

A plasma membrane envelops the whole body of sperm. The sperm head contains an elongated haploid nucleus, the anterior portion of which is covered by a cap-like structure, **acrosome**.

The acrosome is filled with enzymes that help fertilisation of the ovum. The middle piece possesses numerous mitochondria, which produce energy for the movement of tail that facilitate sperm motility essential for fertilisation.

The human male ejaculates about 200 to 300 million sperms during coitus of which, for normal fertility, at least 60 per cent sperms must have normal shape and size and at least 40 per cent of them must show vigorous motility.

Q.22 (*a*) expand VNTR and describe its role in DNA fingerprinting.

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

Ans.

a) **VNTR**-Variable Number of Tandem Repeats
The VNTR belongs to a class of satellite DNA referred to as mini-satellite.
A small DNA sequence is arranged tandemly in many copy numbers. The copy number varies from chromosome to chromosome in an individual.
The numbers of repeat show very high degree of polymorphism. As a result the size of VNTR varies in size from 0.1 to 20 kb. Consequently, after hybridisation with VNTR probe, the autoradiogram gives many bands of differing sizes. These bands give a characteristic pattern for an individual DNA. It differs from individual to individual in a population except in the case of monozygotic (identical) twins. The sensitivity of the technique has been increased by use of polymerase chain reaction (PCR). Consequently, DNA from a single cell is enough to perform DNA fingerprinting analysis.

b) In addition to application in forensic science, it has much wider application, such as
1. In determining population
2. Genetic diversities

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

Ans.

a) **Causes of Air Pollution:**
Smokestacks of thermal power plants, smelters and other industries release particulate and gaseous air pollutants together with harmless gases.

Automobiles are a major cause for atmospheric pollution at least in the metro cities.

b) **Harmful effects of Air Pollution:**
To plants: They reduce growth and yield of crops and cause premature death of plants.
To animals: Air pollutants also deleteriously affect the respiratory system of humans and of animals.

c) As a captain of my school eco-club, I will suggest following 2 programmes for awareness among students:

1. An assessment should be completed, which would tell us the exact levels of air pollutants that are present in the school's atmosphere and also what is considered a safe count for those particular pollutants.

   Once the level of exposure has been determined, the next step should be to develop a prevention action plan. This will lower and also prevent the exposure levels in the school area. The prevention techniques will depend on what kinds of pollutants are present. Some prevention guidelines should include:

- Restricting smoking around the entire school area.
- Inspecting building material for harmful substances if construction is taking place.
- Installing proper and efficient ventilation systems throughout the school

2. Once most conventional causes of the air pollution are addressed, the lesser known culprits, such as mold, will remains at large. The reason this goes unnoticed is because this microbe hides in places people generally won't be looking. Yet this also causes breathing problems and is one of the causes of asthma.

SECTION-E

Q.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?

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.

Ans.

a) ***-Drosophila melanogaster***

-Morgan carried out several dihybrid crosses in *Drosophila* to study genes that were sex-linked. The crosses were similar to the dihybrid crosses carried out by Mendel in peas. For example Morgan hybridised yellow-bodied, white-eyed females to brown-bodied, red-eyed males and intercrossed their F1 progeny. He observed that the two genes did not segregate independently of each other and the F2 ratio deviated very significantly from the 9:3:3:1 ratio (expected when the two genes are independent). Morgan and his group knew that the genes were located on the X chromosome and saw quickly that when the two genes in a dihybrid cross were situated on the same chromosome, the proportion of parental gene combinations were much higher than the non-parental type. Morgan attributed this due to the physical association or linkage of the two genes and coined the term **linkage** to describe this physical association of genes on a chromosome and the term **recombination** to describe the generation of non-parental gene combinations.

Morgan and his group also found that even when genes were grouped on the same chromosome, some genes were very tightly linked (showed very low recombination) (Cross A) while others were loosely linked (showed higher recombination) (Cross B).

b) His student Alfred Sturtevant used the frequency of recombination between gene pairs on the same chromosome as a measure of the distance between genes and 'mapped' their position on the chromosome. Today genetic maps are extensively used as a starting point in the sequencing of whole genomes as was done in the case of the Human Genome Sequencing Project.

OR

a) **Central dogma as proposed by** Francis Crick:

"DNA makes RNA makes proteins, which in turn facilitate the previous two steps as well as the replication of DNA", or simply "DNA → RNA → protein".

Exceptions to the central dogma

The biggest revolution in the central dogma was the discovery of retroviruses, which transcribe RNA into DNA through the use of a special enzyme called reverse transcriptase has resulted in an exception to the central dogma; RNA → DNA → RNA → protein. Also, some virus species are so primitive that they use only RNA → proteins, having not developed DNA. With the discovery of prions, a new exception to the central dogma has been discovered, Protein → Protein. That is, proteins directly replicating themselves by making conformational changes in other proteins. Although retroviruses, certain primitive viruses, and prions may violate the central dogma, they are technically not considered "alive", and thus the rule that "all cellular life follows the central dogma" still holds true.

b) **Biochemical Characterisation of Transforming Principle**

Prior to the work of Oswald Avery, Colin MacLeod and Maclyn McCarty (1933-44), the 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, but not all biologists were convinced.

Q.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.

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.

a) Responses of different animals to various abiotic factors:

Regulate: Some organisms are able to maintain homeostasis by physiological (sometimes behavioural also) means which ensures constant body temperature, constant osmotic concentration, etc.

All birds and mammals, and a very few lower vertebrate and invertebrate species are indeed capable of such regulation (thermoregulation and osmoregulation). Evolutionary biologists believe that the 'success' of mammals is largely due to their ability to maintain a constant body temperature and thrive whether they live in Antarctica or in the Sahara desert.

Conform: Majority of animals and nearly all plants cannot maintain a constant internal environment. Their body temperature changes with the ambient temperature. In aquatic animals, the osmotic concentration of the body fluids changes with that of the ambient water osmotic concentration.

This is particularly true for small animals like shrews and humming birds. Heat loss or heat gain is a function of surface area. Since small animals have a larger surface area relative to their volume, they tend to lose body heat very fast when it is cold outside; then they have to expend much energy to generate body heat through metabolism.

***Migrate*:** The organism can move away temporarily from the stressful habitat to a more hospitable area and return when stressful period is over. Many animals, particularly birds, during winter undertake long-distance migrations to more hospitable areas. Every winter the famous Keolado National Park (Bharatpur) in Rajasthan host thousands of migratory birds coming from Siberia and other extremely cold northern regions.

Suspend: In bacteria, fungi and lower plants, various kinds of thick walled spores are formed which help them to survive unfavourable conditions.

In higher plants, seeds and some other vegetative reproductive structures serve as means to tide over periods of stress besides helping in dispersal.They do so by reducing their metabolic activity and going into a state of 'dormancy'.

In animals, the organism, if unable to migrate, might avoid the stress by escaping in time. The familiar case of bears going into *hibernation* during winter is an example of escape in time.

b) If 8 individuals in a population of 80 butterflies die in a week,

Death rate in the population during that period is 8/80 = 0.1 individuals per butterfly per week.

OR

a) Organisms occupy a place in the natural surroundings or in a community according to their feeding relationship with other organisms. Based on the source of their nutrition or food, organisms occupy a specific place in the food chain that is known as their **trophic level**.

Each trophic level has a certain mass of living material at a particular time called as the **standing crop**. The standing crop is measured as the mass of living organisms (**biomass)** or the number in a unit area. The biomass of a species is expressed in terms of fresh or dry weight.

b) Producers belong to the first trophic level.
The most important trophic level within the ecosystem is the first level: primary producers. This is the basic unit; these organisms can live without feeding off of another level. The only thing that these organisms need to survive is sunlight and water, which they can turn into energy themselves. We as humans as well as the other organisms feed off of this level; we need them to help the other levels produced which in turn help up stay afloat.

c) 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, grazing food chain (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 grazing food chain (GFC). Detritus food chain may be connected with the grazing food chain at some levels: some of the organisms of detritus food chain (DFC) are prey to the grazing food chain (GFC) animals, and in a natural ecosystem, some animals like cockroaches, crows, etc., are omnivores.

Q.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.

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?

Ans.

a) In several species such as papaya, male and female flowers are present on different plants, that is each plant is either male or female (dioecy). This condition prevents both autogamy and geitonogamy. Maturity of the stamens and carpels in a bisexual flower is not synchronised (Dichogamy) i.e., male or female flowers mature at different time e.g., Cotton, Ficus etc.

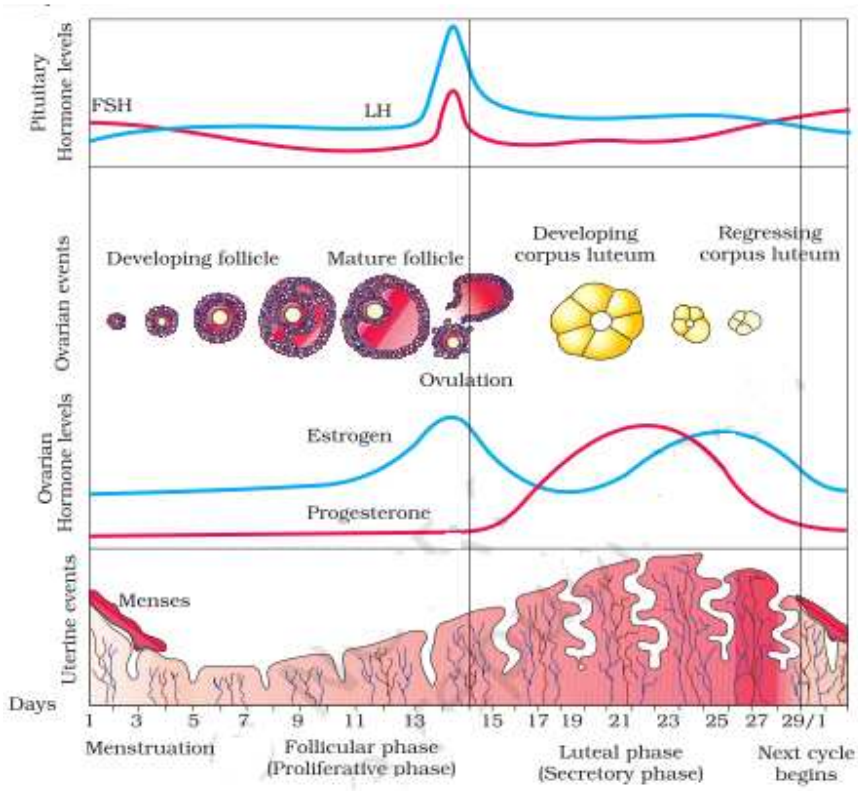
b) After entering one of the synergids,

- The pollen tube releases the two male gametes into the cytoplasm of the synergid.
- 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).
- 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.

OR

a) The reproductive cycle in the female primates (e.g. monkeys, apes and human beings) is called menstrual cycle.
The first menstruation begins at puberty and is called **menarche**.
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.
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.
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. 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**). 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.

In the absence of fertilisation, the corpus luteum degenerates. This causes disintegration of the endometrium leading to menstruation, marking a new cycle. In human beings, menstrual cycles ceases around 50 years of age; that is termed as **menopause**. Cyclic menstruation is an indicator of normal reproductive phase and extends between menarche and menopause.

Periodic abstinence is one such method in which the couples avoid or abstain from coitus from day 10 to 17 of the menstrual cycle when ovulation could be expected. As chances of fertilisation are very high during this period, it is called the fertile period. Therefore, by abstaining from coitus during this period, conception could be prevented.