

# Solved Paper 2022

## BIOLOGY (TERM-II)

Time : 2 Hours

Class-XII

Max. Marks : 35

### General Instructions :

- This question paper contains 13 questions are compulsory.
- The question paper has **three** sections. Section A, B and C.
- Section-A** has 6 questions of 2 marks each. **Section-B** has 6 questions of 3 marks each; and **Section-C** has a case-based question of 5 marks.
- There is no overall choice. However, internal choices have been provided in some questions A student has to attempt only one of the alternatives in such questions.
- Wherever necessary, neat and properly labeled diagrams should be drawn.

Delhi Set-I,

Series: AAB5/5, 57/5/1

### SECTION - A

Question numbers 1 to 6 carry 2 marks each.

- Ringworm is one of the most common infectious fungal disease in humans. Name any two genera of fungi which cause ringworm and state any of its two symptoms. 2

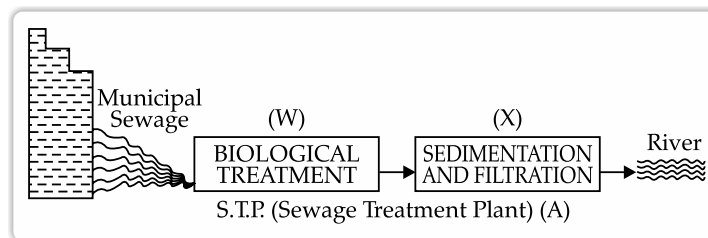
**Ans.** Ringworm is caused by the fungi which belong to the genera *Microsporum*, *Trichophyton* and *Epidermophyton*. (Any two)

Symptoms are appearance of dry, scaly lesions on various parts of the body like skin, nails and scalp.

- Can we use slurry of human excreta instead of cowdung slurry to produce biogas in a typical biogas plant? Support your answer giving reasons. 2

**Ans.** Biogas is a mixture of gases that contain predominantly methane. Certain bacteria, which grow anaerobically on cellulosic material, produce large amount of methane along with CO<sub>2</sub> and H<sub>2</sub>. These bacteria are collectively called Methanogens (*Methanobacterium*). *Methanobacterium* is found in the

- Study the given diagram of Sewage Treatment Plant (S.T.P.) and answer the questions that follow: 2



anaerobic sludge and rumen of cattle (for cellulose digestion), but is absent in human excreta. Hence, we cannot use slurry of human excreta.

- (a) State the mode of action of cocaine on human body. Write the scientific name of the source plant it is obtained from. 2

OR

- (b) Enumerate four most common warning signs of drug and alcohol abuse amongst the youth. 2

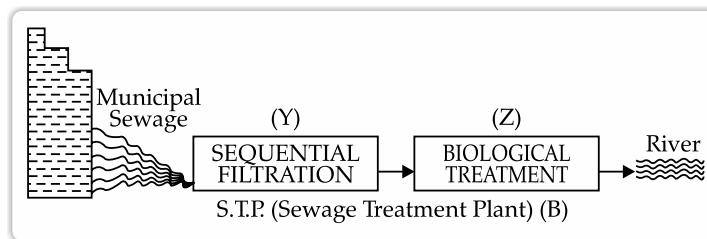
**Ans.** Cocaine is obtained from coca plant, *Erythroxylum coca*.

This drug interferes with the transport of the neurotransmitter dopamine. It is snorted and has potent stimulating action on the nervous system that produces a sense of euphoria and increased energy. The excessive dosage of cocaine causes hallucinations.

OR

Warning signs of drug and alcohol abuse amongst the youth are:

- Drop in their academic performance.
- Lack of interest in personal hygiene
- Loss of interest in hobbies
- Deterioration of relationships with family and friends.



(a) Which one of the two 'S.T.P.' (A) or (B) will be more effective in treating the human excreta in the municipal waste?

(b) Write the steps followed in carrying the treatment of the sewage in step (Z), once the BOD of sewage is reduced significantly till it is passed on the "anaerobic sludge digesters".

Ans. (a) STP (B) will be more effective in treating the human excreta in the municipal waste. It is because the first step in STP involves physical removal of particles from the sewage through filtration and sedimentation. The second STP involves the biological treatment of the sludge.

(b) Once the BOD of sewage water is reduced significantly, the effluent is then passed into a settling tank where the bacterial 'flocs' are allowed to sediment. This sediment is called Activated sludge. A small part of the activated sludge is pumped back into the aeration tank to serve as the inoculum. The remaining major part of the sludge is pumped into large tanks called anaerobic sludge digesters. Here, some anaerobic bacteria digest the bacteria and fungi in the sludge by producing gases like methane, hydrogen sulphide and carbon dioxide. These gases form biogas.

5. Write the best method to measure the population density of a single Banyan tree in comparison to *Parthenium* weeds in a forest by an ecologist. Explain and justify your answer. 2

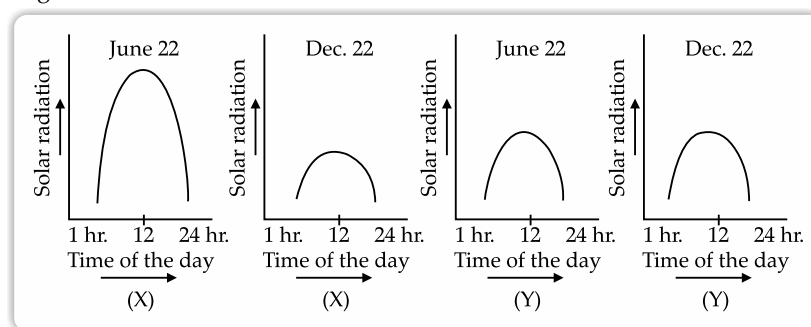
Ans. In an area if there are 200 *Parthenium* plants but only a single huge banyan tree with a large canopy, the population density of banyan is low relative to that of *Parthenium*. The banyan tree plays an enormous role in that community. In such cases, then % cover or biomass is a more meaningful measure of the population size to show the importance of banyan tree.

6. (a) (i) Write the observations made at the end of Connell's field, experiment on barnacles on the rocky sea coasts of Scotland.

(ii) Name any two categories of organisms that in general are adversely affected by competition. 2

OR

\* (b) The graphs (X) and (Y) given below depict the diurnal variations in the solar radiations in the month of the (Summer) and in December (Winters):



(i) Which of the two graphs depicts tropical region and temperate regions respectively?

(ii) Which of the two regions (X) or (Y) will show high biological diversity and why? 2

Ans. (a)(i) Connell's elegant field experiments showed that on the rocky sea coasts of Scotland, the larger and competitively superior barnacle *Balanus* dominates the intertidal area, and excludes the smaller barnacle *Chathamalus*, from that zone. A species whose distribution is restricted to a small geographical area because of the presence of a

competitively superior species is found to expand its distributional range dramatically when the competing species is experimentally removed.

(ii) Plants and herbivores are organisms that are adversely affected by competition.

**SECTION - B**

Question numbers 7 to 12 carry 3 marks each.

7. 'An HIV patient normally doesn't die of 'AIDS', but death is caused due to many other infections, 'Do you agree with the statement? Give explanatory reasons in support of your answer. 3

**Ans.** AIDS, which stands for Acquired Immunodeficiency Syndrome, is caused by the human immunodeficiency virus (HIV). This virus damages our immune system and interferes with our body's ability to fight infection and disease. AIDS leads to a group of symptoms or diseases like the body's immune system weakens, the body is not able to fight with even small infections, or the patient becomes immunodeficient that he/she is unable to protect himself/herself against any kind of infections. As a result, even a small cold leads to pneumonia; a minor infection leads to severe diarrhoea and blood loss and simple skin rashes develop into ulcers.

8. (a) **Why do doctors have to carry many tests for selecting a person to be a suitable donor for someone who is going for an organ transplant and not take the organ from just any body? Explain giving reason.** 3

(b) **Name the drug a patient who has undergone a successful organ transplant, has to take all his/her life.**

**Ans. (a)** It is because grafts from any source would be rejected sooner or later. Tissue matching and blood group matching are essential before undertaking any graft/transplant and even after this, the patient has to take immune-suppressants all his/her life. The body is able to differentiate self from non-self and the cell-mediated immune response is responsible for the graft rejection.

(b) Cyclosporine A, produced by the fungus, *Trichoderma polysporum* is used as an immunosuppressive agent in organ transplant patients.

9. **A cell free method of amplifying DNA first developed in the mid 1980's revolutionised the field of biotechnology, Name the method and explain the basic steps of the technique involved.** 3

**Ans.** Polymerase Chain Reaction (PCR) is a technique in molecular biology to amplify a gene or a piece of DNA to obtain several copies. It is extensively used in the process of gene manipulation. The process involves *in-vitro* synthesis of sequences using a primer, a template strand, and a thermostable DNA polymerase enzyme, obtained from a bacterium called *Thermus aquaticus*. Through continuous DNA replication, the DNA segment is amplified up to 1 billion copies.

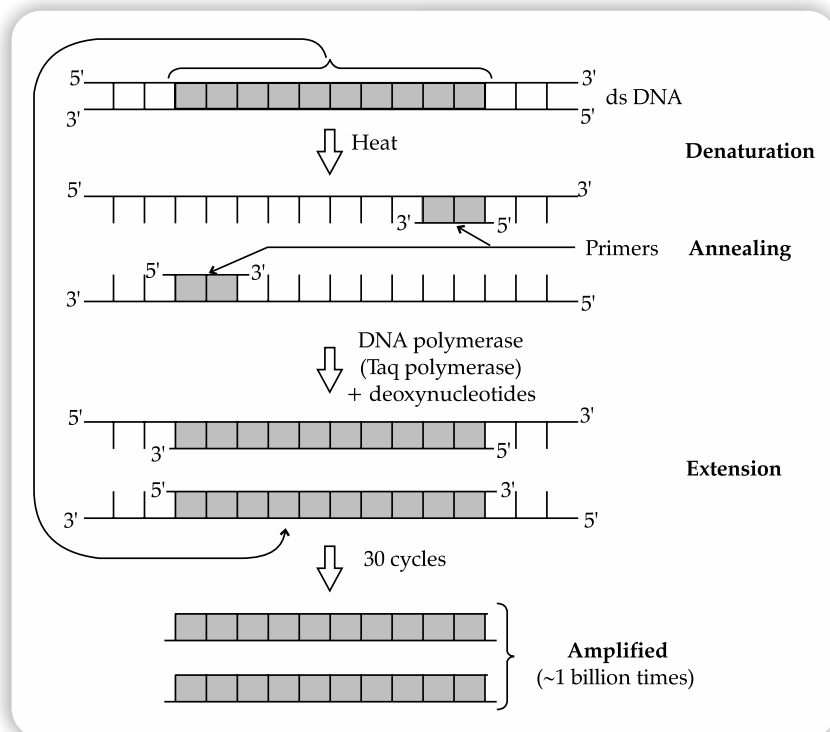
Each cycle has three steps: Denaturation, primer annealing and extension of primers.

(i) **Denaturation:** The double stranded DNA molecules are heated to a high temperature (94°C) so that the two strands separate into a single stranded DNA molecule. This process is called denaturation. Each strand acts as a template for DNA synthesis.

(ii) **Annealing:** In this step, the two oligonucleotide primers anneal (hybridise) to each of the single stranded DNA template, since the sequence of the primers is complementary to the 3' ends of the template DNA. This step is carried out at a lower temperature depending on the length and sequence of the primers. This results in the duplication of the original DNA molecule.

(iii) **Extension of primers:** DNA polymerase (Taq polymerase) extends the primers using the nucleotides provided in the reaction. The optimum temperature for this polymerisation step is 72°C.

This process is repeated over several cycles to obtain multiple copies of rDNA fragment. The amplified fragment can be used to ligate with a vector for further cloning. This results into recombinant DNA (rDNA).

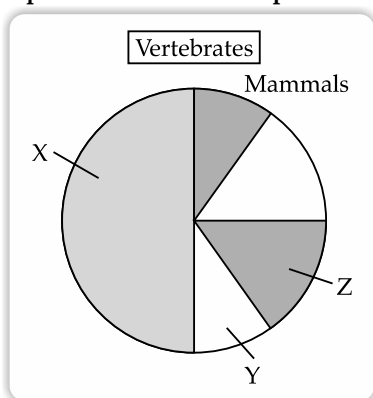


10. (a) Given below is an equation describing the Species-Area relationship between species richness and area for a wide variety of taxa as angiosperm plants, birds, bats etc.  
 $S = CA^z$  3

- (i) Give a graphical representation of the given equation showing Species-Area relationship.
- (ii) What does 'S' represent in the given equation?
- (iii) What is the value of 'Z' (regression coefficient) for frugivorous birds and mammals in the tropical forests of different continents?

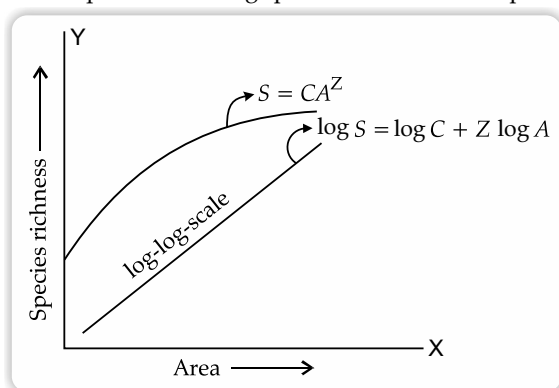
OR

(b) Given below is a 'pie chart' representing the global biodiversity : proportionate number of species of major taxa.



- (i) Identify (X) and (Y) in the given 'pie chart'.
- (ii) "Extinction of species across taxa are not random." Which group amongst the vertebrates is more vulnerable to extinction.
- (iii) Give one example each of recent extinctions of species in Russia, Mauritius and Australia. 3

Ans. (i) The graphical representation of the given equation showing species-area relationship is:



- (ii) S represents the species richness in the given equation.
- (iii) Z represents the slope of line (regression coefficient). For frugivorous (fruit eating) birds

and mammals in the tropical forests of different continents, the slope is found to be 1.15.

OR

- (i) The given pie chart depicts the proportionate number of species of major taxa vertebrates. Here X represents fishes while Y represents amphibians.  $\frac{1}{2} + \frac{1}{2}$
- (ii) Amphibians, among the vertebrates are more vulnerable to extinctions.
- (iii) One example of recent extinctions of species are:
  - Stellar's sea cow in Russia
  - Dodo in Mauritius
  - Thylacine in Australia

11. (a) How does a gene therapy involving direct modification of the cells, in order to achieve a therapeutic goal is used in the treatment of ADA deficiency? Explain.

(b) A host cell must be made competent, before it is able to receive an rDNA. Justify. 3

Ans. (a) Gene therapy is used to cure adenosine deaminase (ADA) deficiency in individuals. The disorder is caused due to the deletion of the gene for adenosine deaminase, the enzyme crucial for the immune system to function. The individual suffering from this disorder can be cured by transplantation of bone marrow cells. The first step involves the extraction of lymphocyte from the patient's bone marrow. Then, a functional gene for ADA is introduced into lymphocytes with the help of retrovirus. These treated lymphocytes containing ADA gene are then introduced into the patient's bone marrow.

Thus, the gene gets activated producing functional T-lymphocytes and activating the patient's immune system. But these cells are not immortal; the patient requires the periodic infusion of such genetically engineered lymphocytes. So the permanent cure of this disease involves the gene isolated from marrow cells producing ADA is introduced at early embryonic stages.

(b) DNA molecules are hydrophilic molecules and they cannot pass through the cell membranes. For recombinant DNA to be integrated into vector or host genome, it is necessary for the DNA to be inserted in the cell. Thus, making the host cells competent is important to receive the rDNA.

12. (a) Enlist two criteria that are used to identify a region for maximum protection as 'Biodiversity hotspots'.

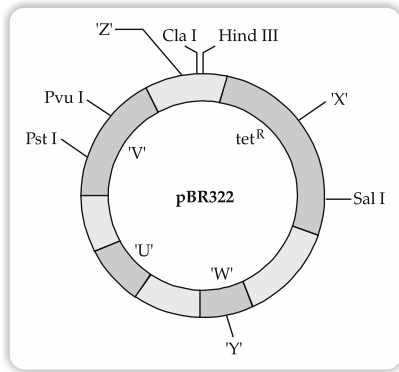
(b) Name any two "hotspot" regions in our country. 3

Ans. (a) Two criterias are:

- (i) High levels of species richness
  - (ii) High degree of endemism
- (b) Western Ghats and Sri Lanka and Indo Burma and Himalayas are the two hotspot regions in our country.

## SECTION - C

13. (a) Cloning of genes, play a very significant role in genetic engineering, helping the transfer of desirable foreign genes into different hosts. The scientists, to make this process easier and effective are creating engineered vectors in such a way that they help easy linking of foreign DNA and selection of recombinants from non recombinants. 'pBR322' is one such engineered vectors developed by scientists. A diagram of an engineered vector pBR322 is given below: 5



- Name the host for this cloning vector.
- Identify 'Rop' and 'Ori' in the diagram from 'U', 'V', 'W', 'X', 'Y' and 'Z'. Write their functions.
- Draw the fragments that will be formed by the action of 'Z' (marked in the diagram) on the specific site of the DNA segment given below:



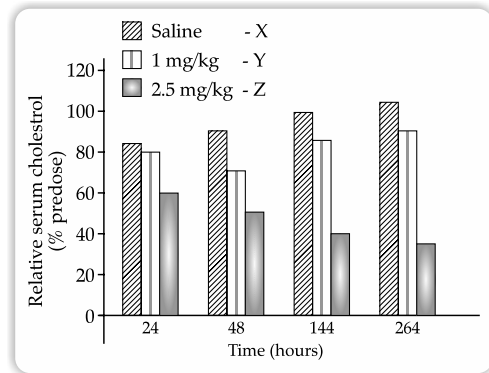
OR

- \* (b) RNA interference (RNAi) holds great potential as a therapeutic agent for the treatment of human diseases and as biocontrol agents in controlling pests in the field agriculture. An experiment was carried to study the use of 'RNAi' for the potential treatment of disorders of cholesterol metabolism. Some people possess genetic mutations with elevated levels of ApoB gene which predisposes them to coronary artery diseases. Lowering the amount ApoB can reduce the number of lipoproteins and lower the blood cholesterol.

Tracy Zimmerman and her colleagues used RNAi in 2006 to reduce the level of ApoB in non human primates *Cynomolgus* monkeys.

One group of monkeys were given RNAi treatment (small interfering RNAs, SiRNAs) (doses 1 mg/kg, SiRNAs), second group of monkeys were given RNAi treatment (doses 2.5 mg/kg, SiRNAs) and third group of monkeys were injected with saline.

The results of the study are depicted in the graph below:



- How does the treatment with 2.5 mg/kg brings an effect on cholesterol metabolism when compared from 24 hours and 144 hours.
  - Write any two natural sources from where dsRNA molecule could be obtained for silencing the specific mRNA.
  - How is RNAi used in controlling the infection on the roots of tobacco plants by the nematode *Meloidogyne incognita*.
- Ans. (i) *E.coli* is the host of this cloning vector.

- (ii) Rop is W and Ori is U.

Function of Rop = To code for proteins that are involved in the replication of plasmid.  
Function of Ori = It is the sequence from where replication starts and any piece of DNA when linked to this sequence can be made to replicate within the host cells. ½

- (iii) Z is EcoRI. It cuts between G and A bases at the 5' end within the recognition sequence. 5' -GAATTC-3'. So if the given sequence is treated with EcoRI, then the fragments generated will be:



## Delhi Set-II

Series: AAB5/5, 57/5/2

Note: Except these, all other Questions are from Set-I.

## SECTION - A

1. State the most important contribution of the following microbes for human welfare: 2

- (a) *Monascus purpureus*  
(b) *Trichoderma Polysporum*

Ans. *Monascus purpureus*: Produces statin, which is used as blood-cholesterol lowering agents. It inhibits the enzymes responsible for synthesis of cholesterol.

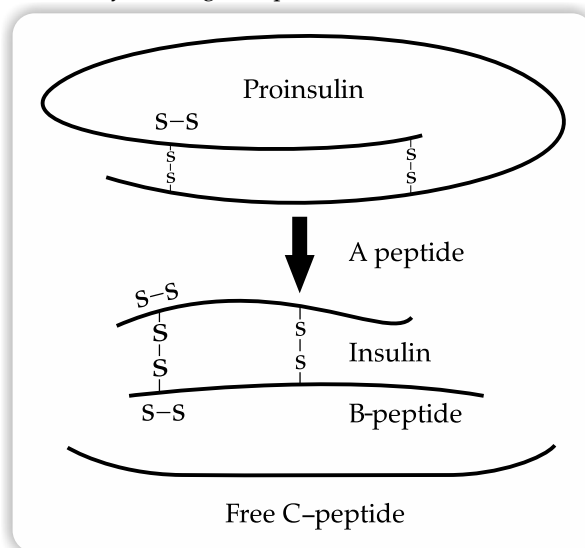
*Trichoderma polysporum*: Produces Cyclosporine A, which is used as an immunosuppressive agent in organ transplant patients.

6. What would be the best method to measure the total population density of a dense bacterial culture in a petridish and why? 2

Ans. The best method to measure the total population density of a dense bacterial culture in a petridish is to measure the biomass or percent cover and not number. This is because, the population of a dense bacterial culture is very huge and counting of this would be impossible or time consuming.

10. Explain how recombinant human insulin was prepared in 1983 by Eli Lilly an American company. 3

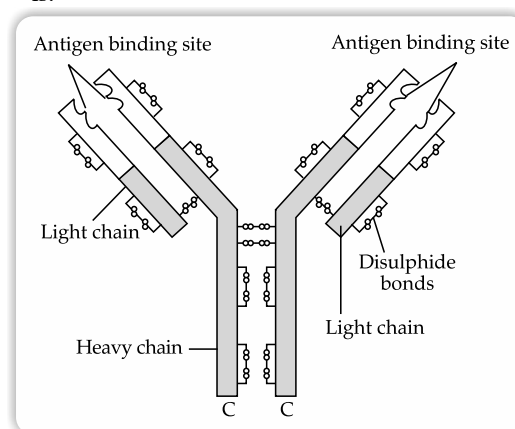
Ans. In 1983, Eli Lilly an American company prepared two DNA sequences corresponding to A and B chains of human insulin and introduced them in plasmids of *E. coli* to produce insulin chains. Chains A and B were produced separately, extracted and combined by creating disulphide bonds to form human insulin.



## SECTION - B

7. Different types of antibodies are produced in our body by the B-lymphocytes in response to a pathogen that enters in our blood. Name any two antibodies produced and draw a schematic representation of an antibody molecule and label its four parts. 3

Ans. Two antibodies produced are IgA and IgM.  $\frac{1}{2} + \frac{1}{2}$   
Schematic representation of an antibody molecule is:



## Delhi Set-III,

Series: AAB5/5,57/5/3

## SECTION - A

Note: Except these, all other Questions are from Set-I.

1. Many members of genus *Glomus* form a mycorrhizal association with plants. Elaborate how is this association beneficial to the plants. 2

Ans. Mycorrhiza is a symbiotic association of fungi (e.g., the genus of *Glomus*) with plants. The fungus gets food from the plant while the fungal symbionts absorb phosphorous from soil and passes it to the plant. Also, they give resistance to root-borne pathogens and tolerance to salinity and draught.

Hence, they give an overall increase in plant growth and development.

6. **What would be the best method to measure the total population density of the number of fishes in river and why ?** 2

**Ans.** Total number is a difficult measure for a huge population. In such cases, relative population density (without knowing absolute population density) is used. For e.g., the number of fish caught per trap is enough to measure the total population density of fishes in a lake.

### SECTION - B

7. **Many people experience allergic symptoms of sneezing or wheezing on exposure to certain substances in the environment. Give two examples of such substances. Which type of antibodies are produced by the body in response to these**

### Outside Delhi Set-I

### SECTION - A

1. **A boy developed some allergic reactions when he straight entered into his air conditioned room after a game of football outside his house. Write any two symptoms that could be noticed in such condition. How does our body combat such conditions?** 2

**Ans.** Symptoms: Sneezing, watery eyes, running nose, difficulty in breathing, etc. (Any two)  
Drugs like anti-histamine, adrenaline and steroids quickly reduce the symptoms of allergy.

2. (a) (i) **Write the Scientific name of the plant from where natural cannabinoids are obtained.**  
(ii) **Mention the parts of the plant that are used for extracting the drug.**  
(iii) **How does the drug affect human body?** 2

OR

(b) **Epithelial lining of our intestine is considered as secondary lymphoid organ. Justify the statement.**

**Ans.** (a) (i) Natural cannabinoids are obtained from *Cannabis sativa* (Hemp plant).  
(ii) Its flower tops, leaves and resin are used to produce *bhang*, *ganja*, *charas* (*hashish*), *marijuana* etc.  
(iii) It affects cardiovascular system.

OR

(b) Mucosa-associated lymphoid tissue (MALT) is a type of secondary lymphoid organs and is found close to the epithelial linings of major systems, including the respiratory, digestive and urogenital tracts. MALT makes up nearly half of the lymphoid tissue in the body, and allows lymphocytes to interact with antigens. It is the site where proliferation and differentiation of lymphocyte takes place. The matured lymphocytes migrate to these organs,

**substances ? Mention the role of mast cells in this kind of allergic response.** 3

**Ans.** Allergy is an exaggerated response of the immune system to some antigens called allergens that are present in the environment. Examples of allergens are pollens, animal dander, and mites in the dust.

IgE antibodies are produced during allergic reactions.

Mast cells release chemicals called histamine and serotonin during allergic reactions.

11. **Non viral and non vector methods are sometimes used to transfer genes or alien DNA into a plant cell. Explain one such method used in genetic engineering.** 3

**Ans.** Non-viral and non vector methods used to transfer genes or alien DNA into a plant cells is bolistics or gene gun method. In this, cells are bombarded with high velocity micro-particles of gold or tungsten coated with DNA. This is accomplished by using compressed helium gas as a propellant.

### Series: AABB4/3,57/3/1

interact with the antigens and then proliferate to become effector cells.

3. **Farmers are often suggested to use the following organisms in their crop land so as to improve the soil fertility.**

(i) *Rhizobium*, (ii) *Anabaena* 2

**Explain.**

**Ans.** (i) *Rhizobium* is a symbiotic bacteria found in the root nodules of leguminous plants that has the ability to fix atmospheric Nitrogen.

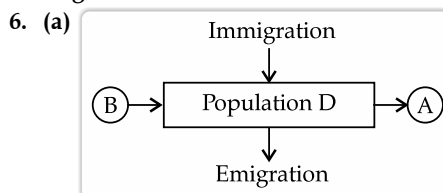
(ii) *Anabaena* has the ability to fix the atmospheric nitrogen. They are free-living nitrogen fixing bacteria. Hence, they are used as biofertilizers in the field of rice.

4. **Organic farmer use *Trichoderma* and *Baculovirus* as biological control agents. Explain.** 2

**Ans.** *Trichoderma s.p.* are free living fungi. They live in the roots of higher plants and protect them from various pathogens. They are effective biocontrol agents of several plant pathogens.

*Baculoviruses* (Especially genus *Nucleopolyhedrovirus*) attack insects and other arthropods. These are suitable for species-specific, narrow spectrum insecticidal applications. This is desirable in IPM (Integrated pest management) program to conserve beneficial insects.

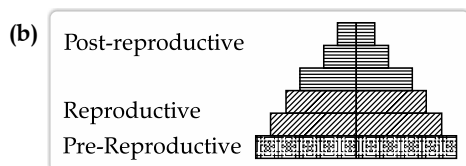
- \* 5. **Mammals are capable of maintaining homeostasis. But, very few smaller animals can survive in polar regions. Give reasons.** 2



**Observe the schematic representation given above and answer the following questions:** 2

- (i) Identify A and B.  
 (ii) Calculate the growth rate of bacteria in a curd sample, where 1 million bacteria increased to two million, within a period of one hour.

OR



Identify the type of pyramid given above. Write the identifying feature on the basis of which you identified it.

- Ans. (a) (i) B = Natality, A = Mortality  
 (ii) Growth rate = No. of individuals added/ Total population =  $1/2 = 0.5$

OR

- (b) Expanding age pyramid because the given age pyramid have larger percentage of people in younger age groups. Populations with this shape usually have high fertility rates with lower life expectancies.

### SECTION - B

7. (a) Write the complete name of the diagnostic test for AIDS. Explain the principle it works on.

- (b) Name the type of genetic material present in AIDS causing pathogen. 3

Ans. (a) Enzyme Linked Immuno-sorbent Assay (ELISA) is often used as a diagnostic test to determine exposure to a particular infectious agent, such as the AIDS virus, by identifying antibodies present in a blood sample.

Infection by pathogen can be detected by the presence of antigens (proteins, glycoproteins, etc.) or by detecting the antibodies synthesised against the pathogen. It is a sensitive immunoassay that uses an enzyme linked to an antibody or antigen as a marker for the detection of a specific protein, especially an antigen or antibody.

- (b) RNA is the genetic material present in AIDS causing pathogen.

8. A patient complains of suffering from constipation, stomach ache, stool with blood clots and excess mucous. The physician diagnosed it as amoebiasis, after stool test. 3

- (a) Write the scientific name of the microbe identified in the stool sample.  
 (b) How do you think, the patient must have contracted it?  
 (c) Write your suggestions to the patient to avoid infection in future.

Ans. (a) Pathogen: *Entamoeba histolytica*.

- (b) It is a vector-borne disease that spreads by means of contaminated food and water. The

vector involved in the transmission of disease is houseflies (mechanical carriers).

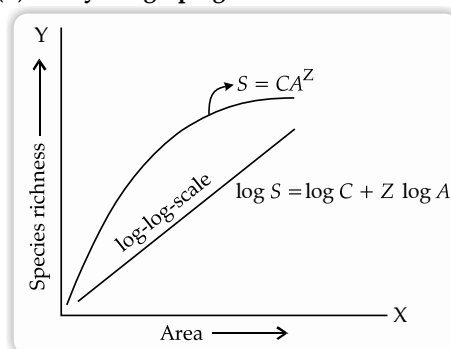
- (c) Personal hygiene: This measure includes maintaining a clean body, consumption of healthy and nutritious food, drinking clean water etc.

9. What are cry-proteins? With the help of a suitable example, explain how it acts as a biological pesticide. 3

Ans. Cry proteins are poisonous proteins called insecticidal proteins which are secreted in crystal form by *Bacillus thuringiensis* during a specific growth process. The toxin is coded by a gene called cry. The genes which encode cry proteins called Bt-toxin genes have been isolated from *B.thuringiensis* and incorporated in many crop plants such as Bt cotton, Bt corn etc. to provide insect pest resistance. There are three different types of cry genes they are cry IAB, cry IAC and cry IIAB. The IAB gene cry is responsible for managing borer pests in the corn. The genes IAc cry and IIAB cry are responsible for regulating the bollworms that damage the cotton plant.

10. (a) Write the inference drawn by Alexander von Humboldt after his extensive explorations of South American jungle. 3

- (b) Study the graph given below:



As per Alexander von Humboldt, what do the symbols S, A, Z and C in the graph stand for, in respect of a species and area relationship?

Ans. (a) Alexander Von Humboldt has observed that within a region, species richness gets increased when explored area is increased, but only up to a limit. The relation between species richness and area for a wide variety of taxa gives a rectangular hyperbola.

- (b) On a logarithmic scale, the relationship is a straight line and the equation is described as  $\log S = \log C + Z \log A$

Where,

S = Species richness

A = Area

C = Y-intercept

Z = slope of the line (regression co-efficient)



11. (a) Explain the concept of "co-extinction: by taking two examples. 3

OR

- (b) "Forests provide intangible benefits to us." Explain by taking three different areas, how. 3

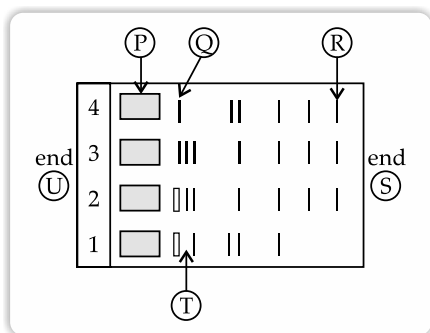
Ans. (a) Co-extinction refers to the extinction of a plant or animal species with the extinction of species that they are dependent on.

For e.g., When a species becomes extinct, then plants and animals which were obliquely dependent on it also become extinct in due course of time. This phenomenon is called co-extinction. If a fish becomes extinct, then many parasites which got sustenance from the fish become extinct. Many predators for which this fish was the main source of food would also become extinct. The mutualistic relationship of the plant-pollinator is also an example, where extinction of one will ultimately cause the extinction of the other.

OR

- (b) Forests provide many intangible or indirect benefits such as:
- Improvement of climate:** Forests improves climate influencing temperature, rainfall, humidity, wind etc. They regulate temperature, O<sub>2</sub>, CO<sub>2</sub> balance in the atmosphere and water cycle.
  - Control of flood:** Forests control flood through decreasing erosion on the up hills, reducing silting up in lakes, rivers and such other reservoirs.
  - Aesthetic, recreational and development of tourism facilities:** Forests refreshes the monotonous life of any person specially living in urban areas.
  - Conservation and development of wildlife including birds:** Forests are best habitat for wildlife in terms of shelter, breeding place and as food sources. (Any three)

12. (a) Given below is the stepwise schematic representation of the process of electrophoresis. Identify the 'alphabets' representing (i) Anode end (ii) smallest/lightest DNA strand in the matrix (iii) Agarose gel



- (b) What is elution? State the importance of elution in this process. 3

- Ans. (a) (i) Anode = S  
(ii) Smallest/lightest DNA Strand = R  
(iii) Agarose gel = T 2
- (b) Elution refers to the process of extracting DNA from a gel piece. These DNA fragments are used in recombinant DNA by joining them with cloning vectors.  $\frac{1}{2} + \frac{1}{2}$

### SECTION - C

13. (a) Read the paragraph given below and answer and questions that follow:

Enzyme Taq polymerase, is extracted from a eubacterial microorganism *Thermus aquaticus* from Yellowstone National Park in Montana, USA and isolated by Chien *et al.* (1976). Taq polymerase successfully replaced the DNA polymerase from *E.coli* that was being used in PCR earlier and this shift revolutionised the PCR technique.

- Taq polymerase after its discovery replaced *E.coli* DNA polymerase in PCR technique. Explain giving reasons why was the need felt for the change?
- What is a primer and its importance in PCR?
- Write the importance of PCR as a diagnostic tool. 5

OR

- (b) Read the following paragraph and answer the questions that follow:

Biotechnology revolves around the "gene of interest", with an objective to open various avenues for human welfare in health, medicine, pharma, agriculture etc. using different techniques, tools and processes. One of the breakthroughs of biotechnology in medicine is the gene therapy.

- Name the human disease for which the gene therapy was used for the first time.
- Explain the steps of gene therapy carried to cure the disease using the lymphocytes of the patient. Why is this therapy not a permanent cure of the disease ?
- Write the possible permanent cure of the disease by the gene therapy that is in progress. 5

- Ans. (a) (i) Taq polymerase was identified as an enzyme able to withstand the protein-denaturing conditions (high temperature) required during PCR. Therefore, it replaced the DNA polymerase from *E. coli* originally used in PCR.
- Primers are necessary to start the functioning of DNA polymerase enzyme and therefore are necessary in polymerase chain reaction.
  - PCR tests are an accurate and reliable method for identifying many infectious diseases and because they are often able

to make diagnoses before symptoms of infection occur, PCR tests play a crucial role in preventing the spread of diseases.

**OR**

- (b) (i) First clinical gene therapy was given in 1990 to a 4-year old girl with adenosine deaminase (ADA) deficiency.
- (ii) The disorder is caused due to the deletion of the gene for adenosine deaminase, the enzyme crucial for the immune system to function.

**Treatment:**

- The individual suffering from this disorder can be cured by transplantation of bone marrow cells.
  - The first step involves the extraction of lymphocyte from the patient's bone marrow. Then, a functional gene for ADA is introduced into lymphocytes with the help of retrovirus.
- (b) (i) (continued)
- These treated lymphocytes containing ADA gene are then introduced into the patient's bone marrow.
  - Thus, the gene gets activated producing functional T-lymphocytes and activating the patient's immune system.
  - However as these cells are not immortal the patient requires periodic infusion of such genetically engineered lymphocytes.
- (ii) If a functional ADA gene is isolated from bone marrow cells and is introduced at early embryonic stages, the deficiency could be a permanent cure.

