Group A

1. For three pairs of values of x and y, the values of $x + y$ are -1, 0, 1. x and y have equal variances $\frac{2}{3}$.

   (a) Calculate the correlation coefficient between x and y.

   (b) If $\bar{x} = 2$, find the regression equation of y on x.

   (c) Can you predict x using the above regression equation?

   $$[8 + 6 + 4 = 18]$$

2. A biologist conducting experiments wishes to investigate whether the average blood sugar fasting levels differ between working and non-working males. Meanwhile, another biologist is interested in determining if there is a significant difference in the average blood sugar fasting levels of non-working males before and two hours after taking a specific medicine.

   (a) Would you recommend employing the same statistical test for these distinct scenarios?-Justify your answer.

   (b) State clearly the test statistics and critical region of the test(s).

   (c) Assume that the level of significance is 0.05. What conclusion can you draw if the calculated p-value is 0.67 and 0.0003 for the two tests?

   $$[5 + 8 + 5 = 18]$$

Group B

1. (a) Describe the best model of the plasma membrane.

   (b) Why do cell membranes form a phospholipid bilayer?

   (c) Name two unique enzymes along with their functions that are present on the membrane of lysosomes.

   (d) What is the role of microtubules in cell division?

   (e) What are the components of the cytoskeleton? Why cytoskeleton is present only in eukaryotes?

   (f) Why are gram-negative bacteria more resistant to disinfectants than gram-positive?

   (g) Name the two cells where β-oxidation do not occur and why?

$$[4 + 2 + 3 + 2 + 3 + 2 + 2 = 18]$$

2. (a) What do you mean by omega-3 fatty acid?

   (b) What is the precursor molecule of Glycerol for fatty acid synthesis?

   (c) How is glycerol synthesized from that precursor molecule?

   (d) Which shuttle systems are linked with fatty acid synthesis and fatty acid oxidation?

   (e) Describe the two shuttle systems with diagrammatic sketches.

   (f) How many cycles will be needed for complete oxidation of *Arachidic Acid*?

   (g) How is malonyl-CoA formed from acetyl-CoA?

$$[2 + 1 + 3 + 2 + 6 + 1 + 3 = 18]$$

3. Write short notes on **ANS SIX** of the following:

   (a) Distinction between cytoplasmic and nuclear types of inheritance

   (b) Experimental proof of Okazaki fragments

   (c) Autogenic and allogenic succession

   (d) Terminal Electron transport system

   (e) Isozymes

   (f) Plant pathogenic bacteria

   (g) Succulence under salt stress

   (h) Bacterial plasmids

   $$[3 \times 6 = 18]$$

4. Complete the reactions: (name of enzymes or catalysts involved)

   (a) Fructose to Fructose-1,6-biphosphate

   (b) Citric acid to Isocitric acid

   (c) Succinic acid to Fumaric acid

   (d) 3-phosphoglyceraldehyde to 1,3-diphosphoglyceric acid

   (e) 3-phospho-glycerate to 2-phospho-glycerate

   (f) Conversion of Glutamate to Glutamine

   (g) Action of lipase on triglycerides

   (h) Conversion of Malate to Oxaloacetate

   (i) Pyruvate to acetyl-CoA

   $$[2 \times 9 = 18]$$

5. (a) What are Sacred Groves?

   (b) Which state has the highest number of Sacred Groves in India?

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(c) What is the importance of Sacred Groves in India?

(d) What are the significant threats to Sacred Groves in India?

(e) What are the legal and policy frameworks for protecting sacred groves in India?

(f) What is the role of tribal people in biodiversity conservation?

$$[2 + 1 + 5 + 5 + 3 + 2 = 18]$$

6. (a) What are the Biodiversity Hotspots in India?

(b) Describe different types of ecological pyramids.

(c) Discuss the characteristics of freshwater habitat.

(d) Describe bioremediation strategies.

(e) What are the different sources of water pollution?

(f) Define different methods for control of soil pollution

$$[2 + 3 + 4 + 3 + 3 + 3 = 18]$$

7. (a) Name two sulfur-containing amino acids.

(b) Which amino acid initiated the synthesis of protein in prokaryotic cells?

(c) Name two important transaminase enzymes. Mention their substrates, products, and respective enzymes.

(d) What is the full form of HHH syndrome? What is the main cause of HHH syndrome?

(e) Describe the regulatory mechanism of the urea cycle.

(f) Why does the urea cycle occur only in the liver?

(g) Name two amino acids that are never found in protein structure due to lack of codons.

(h) Which ion concentrations are responsible for assembling the subunits of ribosomes during protein synthesis?

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(i) What type of RNA polymerase synthesizes t-RNA in eukaryotes?

$$[2 + 1 + 4 + (1 + 1) + 4 + 1 + 2 + 1 + 1 = 18]$$

8. (a) In what direction do DNA polymerases add new complementary nucleotides in the synthesizing DNA strand?

(b) What is the function of SSB protein in DNA replication?

(c) Describe the Post-transcriptional RNA processing in eukaryotic cells.

(d) How the disease hemophilia is inherited in the progeny of an unaffected father and carrier mother?

(e) Which law of Mendelian genetics can be considered universal?

(f) Define "bacteria as vectors for amplifying foreign DNA."

(g) A purple flower (PP) and round seeded (RR) pea plant crossed with white flower (pp) and wrinkle seeded (rr) pea plant - Make a punnet square and find out the genotypic and phenotypic ratios of $F1$ and $F2$ generations in the progeny.

(h) Which type of mutation causes sickle cell anemia?

$$[1 + 1 + 3 + 3 + 1 + 3 + 5 + 1 = 18]$$

Group C

1. (a) Define extremophile. If glucose and lactose are both present in the medium, how will bacteria respond to them? What is geosmin?

    (b) In what context should enrichment medium be used for the isolation of organisms? Is there any relation between GC% of DNA and T_m value?

    (c) Is Gram's staining a differential staining? Justify your answer with a suitable explanation. What is the importance of heat fixation in staining?

    (d) What do you mean by anaerobic ammonium oxidation? Give one example.

    $$[(2 + 2 + 1) + (2 + 2) + (1 + 3 + 2) + (2 + 1) = 18]$$

2. (a) What are the edaphic factors that influence soil microbial community? What is the role of arbuscular mycorrhizal in plant nutrition?

    (b) Classify the ecological interactions between communities. What kind of association lichen show?

    (c) Define metagenomics? What is its significance in research?

    (d) What is the role of IF and EF in protein synthesis?

    $$[(3 + 2) + (4 + 2) + (2 + 2) + 3 = 18]$$

3. (a) Define oligotrophs and mixotrophs. How can extremophiles be a promising candidate for new-age biotechnology?

    (b) What are microbial preservation techniques? What is MFC? What is the significance of MFC?

    (c) How is mutagenesis different from mutation? What is the function of peptidyl transferase?

    $$[(2 + 4) + (3 + 2 + 3) + (2 + 2) = 18]$$

4. (a) Briefly state the effect of pesticides on soil microorganisms.

   (b) What are cross-inoculation groups?

   (c) What is intercalation? Does it lead to mutation?

   (d) What are the different types of mutation? Describe each briefly.

   (e) What are Allosteric Enzymes? Give examples.

   (f) Define isoenzymes and state their importance.

$$[3 + 1 + (2 + 1) + (2 + 3) + (2 + 1) + (2 + 1) = 18]$$

5. Write short notes (**ANY FOUR**)

   (a) Phytoremediation

   (b) Eutrophication

   (c) Biofertilizer

   (d) Biosensor

   (e) Symbiotic nitrogen fixation

   (f) Nitrification and denitrification

   (g) PGPR

$$[4.5 \times 4 = 18]$$

6. (a) What is Systemic Acquired Resistance in Plants?

   (b) What are the indicators enzymes should be studied to measure plant ROS generation?

   (c) Xerophthalmia caused by deficiency of which vitamin? Give an example of iodine fortification.

   (d) What are the four biological control methods of controlling pests?

   (e) What is Flavr Savr tomato?

   (f) What is transcriptomic?

(g) What is bioaugmentation?

(h) Discuss about the Plant secondary metabolites.

(i) Chloramphenicol is a broad-spectrum antibiotic in prokaryotes. Describe its mode of action.

$$[2 \times 9 = 18]$$

7. (a) What are keystone species?

(b) Define endophytes?

(c) What do you mean by ecological niche?

(d) What are K- and R- selected species?

(e) How to measure bacterial growth in broth?

(f) What are selective and differential media?

(g) What is the unit of bacterial count?

(h) During a field survey, disease symptoms observed on a rice plant suggest infection by *Xanthomonas oryzae*. Briefly outline the steps for the isolation, identification, and confirmation of its infection.

$$[2 + 2 + 2 + 1 + 2 + 2 + 2 + 5 = 18]$$

8. (a) Why many *Bacillus thuringiensis* strains produce during sporulation that have insecticidal action?

(b) What do you mean by host plant resistance?

(c) What is a nematode?

(d) What is the major symptom of *Meloidogynae* sp. infection in plants?

(e) Which is the most economically important plant parasitic nematode of rice?

(f) Define Integrated Pest Management.

(g) Name an inhibitor of the electron transport system (ETS).

(h) A biodiversity study has revealed that the diversity and evenness of microarthropod communities in site $'A'$ are significantly higher than those in site $'B'$. Provide a brief inference about the ecological conditions of the two sites that influence such a result.

(i) When different DNA forms or molecules or fragmented DNA are run on agarose gel, then what will be the movement order of the following DNA forms towards the cathode?
i. Circular DNA
ii. Linear DNA
iii. Super coiled DNA
iv. Fragmented DNA

(j) What is amyloplast?

$$[1 + 2 + 1 + 1 + 1 + 2 + 1 + 5 + 3 + 1 = 18]$$

9. (a) What is chemical ecology?

(b) Plants are known to release volatile chemicals from leaves, which act as cues to insects. How do you think these volatile chemicals influence insect behavior?

(c) Besides volatile compounds, plant root exudates are also known to contain unique chemical compounds. Do you think these compounds could play a role in the chemotaxis of below-ground organisms like nematodes? Please explain briefly.

(d) A bacterial culture filtrate claims to show insecticidal effects. Answer the following questions:
(i) Design an experiment to test the dose-dependent response of the culture filtrate on insect mortality.
(ii) What are the potential challenges associated with applying biopesticides in the field?

(e) Design an experiment to test the dose-dependent response of the culture filtrate on insect mortality.

(f) What are the potential challenges associated with applying biopesticides in the field?

(g) What are coenzyme, apoenzyme and holoenzyme?

(h) Differentiate between competitive and non-competitive enzyme inhibition mechanisms, providing examples of each.

$$[1 + 3 + 2 + 3 + 1 + 3 + 3 + 2 = 18]$$

10. (a) What do you mean by epimer?

(b) What are the differences between D-glucose and D-mannose with respect to epimer?

(c) Name the most abundant enzyme on Earth.

(d) State the principle of RT-PCR with a diagram.

(e) What is CT value?

(f) How do you think climate change would influence plant-insect interaction? Provide a brief explanation.

(g) What is the role of ethidium bromide in the DNA isolation process?

(h) Name the causative organisms of
   i. Potato late blight
   ii. Rice Sheth blight

$$[2 + 3 + 1 + 3 + 2 + 3 + 2 + 2 = 18]$$

Group D

1. (a) Discuss the natural and human drivers of climate change.

   (b) Discuss the effects of climate change on biodiversity.

$$[10 + 8 = 18]$$

2. (a) What is temperature inversion?

   (b) Illustrate with a diagram.

   (c) Discuss the effect of temperature inversion on pollution dispersal and weather conditions.

$$[4 + 4 + 10 = 18]$$

3. (a) What is the Air Quality Index (AQI)?

   (b) What are non-criteria air pollutants?

   (c) What are primary and secondary air pollutants?

   (d) Discuss the effects of air pollution on plants and human beings.

   (e) How is air pollution related to visibility degradation?

$$[4 + 4 + 2 + 4 + 4 = 18]$$

4. (a) What are bioaerosols?

   (b) Discuss the types of bioaerosols.

   (c) What are the human health effects?

   (d) Discuss sampling methods for bioaerosols

$$[2 + 4 + 4 + 8 = 18]$$

5. (a) What is global warming potential?

   (b) Discuss the sources and effects of methane in the environment.

(c) What are the mitigation strategies for reducing methane emissions?

$$[2 + 10 + 6 = 18]$$

6. (a) What is agrometeorology?

(b) Distinguish between humidity and relative humidity?

(c) Discuss the formation and mitigation strategies of tropospheric ozone.

(d) Discuss the effects of tropospheric ozone on crops.

$$[3 + 4 + 6 + 5 = 18]$$

7. (a) What are persistent organic pollutants?

(b) Give three examples.

(c) Differentiate between bioaccumulation and biomagnification?

(d) Distinguish between exposure and dose.

$$[5 + 3 + 8 + 2 = 18]$$

8. (a) Discuss the various functions of wetlands.

(b) Discuss constructed wetlands and their applications.

$$[9 + 9 = 18]$$