Part A (50 points)

I. (4 points; 2 points for each) If "A" in DNA sequence is mutated to "G", it is (transition mutation/ transversion mutation). This kind of mutation is (common / rare). (Please select the correct answers)

II. (6 points; 2 points for each) Here are several DNA mutagens. Please indicate its type (A) base analogues (B) DNA modifying agents (C) intercalating agents.

(1) 5-bromouracil; (2) ethidium bromide (EtBr); (3) UV light

III. (3 ponits) Please indicate if the bacteria contain superoxide dismutase (SOD) or catalase

(1) Facultative anaerobe (with/without SOD; with/without catalase)

(2) Aerotolerant anaerobe (with/without SOD; with/without catalase)

(3) Strict anaerobe (with/without SOD; with/without catalase)

IV. (2 points) Please rank the temperature ranges for microbial growth of the bacteria below from **HIGH to LOW**.

(A) thermophiles (B) psychrophiles (C) heperthermophiles (D) medophiles (E) psychrotolerants

V. (10 points) Antibiotics could inhibit bacterial growth. (1) Please select two antibiotic drugs and explain how they block the growth (4 points) (2) Drug resistance in bacteria is an important issue. There are several mechanisms of drug resistance. Please select three mechanisms and describe in details. (6 points; 2 points for each.)

VI. (4 points) Microbes use mechanism other than mutation to create genetic variability, for example, bacterial conjugation. Please use $F^+ \times F^-$ mating to explain "bacterial conjugation" in details.

VII. (5 points) Eukaryotes use RNA interference (RNAi) to regulate gene expression. Please explain the differences between microRNA (miRNAs) and small interfering RNAs (siRNAs).

VIII. (10 points) There are several methods to control microorganisms in the environment. (1) Please explain these terms: (A) disinfection (B) sterilization (C) antisepsis (4 points) (2) Please list 2 methods for each: (A) physical control methods (B) chemical control methods (C) biological methods (6 points; 1 point for each answer)

IX. (6 points; 2 points for each) Please explain the terms below

(A) Swarming (B) Endospore (C) Prion

Part B (50 points)

I. (4 points) Several countries, including Taiwan, have set up goals to achieve net-zero emissions by 2050. In this scenario, it is inevitable to consider the microorganisms involved in the biogeochemical cycles. Please specify a group of microorganisms important for a biogeochemical cycle and explain how it contributes to greenhouse gas emission.

II. (12 points) Antibody-based techniques can be used to detect microbial infections. Please explain the principle and how to interpret the results for each of the following techniques.

(1) Immunoprecipitation; (2) Single radial immunodiffusion assay; (3) Direct immunofluorescence;

(4) Indirect enzyme-linked immunosorbent assay (ELISA)

III. (6 points) Please assign one of the following fungal characteristics (A)~(H) to each category of fungi below.

(A) Their sexual spores are enclosed in a sac-like structure (B) Form coenocytic hyphae (C) The only group being called "dikaryotic fungi" (D) Also known as club fungi (E) A group of zoosporic fungi, which produces spores with a single, whiplash flagellum (F) The only conidia-producing fungi (G) They are obligate endoparasites (H) They are mycorrhizal symbionts

(1) Chytridiomycota (2) Zygomycetous fungi (3) Ascomycota (4) Basidiomycota (5) Glomeromycota (6) Microsporidia

IV. (6 points) Why are the microorganisms below important for food industry or food security/safety?

(1) *Aspergillus spp.* (2) *Sacchromyces spp.* (3) Lactic acid bacteria (4) *Escherichia coli* (5) *Claviceps purpurea* (6) Noroviruses

V. (12 points) Based on the information below, how does each virus replicate its genome and produce the proteins required for completing its life cycle after infection of a cell?

(1) Influenza virus, a negative-strand RNA virus belonging to *Orthomyxoviridae*.

(2) Lambda phage which can infect *Escherichia coli*.

(3) Hepatitis B virus, which belongs to Group VII in a Baltimore system

VI. (10 points) Below are organelles or structures related to the functions of certain microorganisms. Please explain their functions and indicate which kind of microorganism(s) is related to each term.

(1) chlorosome (2) infection thread (3) pseudopodia (4) cyst (5) stigma

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