

Part I (50%)

I. 1. What is the difference between microbicidal and microbistatic effects on microbes (2%). 2. Describe factors that influence the action of antimicrobial agents (3%). 3. Describe four models of action of antimicrobial agents, and provide examples of how they work (5%).

II. Define and explain the following terms: (10%)

1. amphibolism, 2. active transport, 3. anaerobic metabolism, 4. methanotrophs, 5. psychrophile.

III. 1. Define an operon and describe the functions of regulators, promoters, and operators (5%). 2. What are the roles of special types of RNA in gene regulation? Including micro RNA, small interfering RNA, antisense RNA and riboswitches (5%).

IV. Explain the following terms: (10%)

1. origin of replication, 2. shuttle vectors, 3. DNA ligase, 4. *Taq* polymerase, 5. site-directed mutagenesis

V. Describe how to quantify viruses in a sample, including directly counting particle numbers and indirectly measure an observable effect of the virus. (10%)

Part II (50%)

I. Definition and comparison. Please explain the items below and describe the difference between each pair. (10%)

1. Purple sulfur and purple nonsulfur bacteria; 2. Cellular and acellular slime molds; 3. Opportunistic and frank pathogens; 4. Exotoxin and endotoxin; 5. Type I and type II hypersensitivities

II. Complement is a heat-labile component of human blood plasma with activity to boost phagocytosis. Complement proteins are synthesized in an inactive form and become active after enzymatic cleavage. We now know that complement system can be activated through three different pathways, and the production of the C3 convertase is where the three pathways converge. (10%) 1. What are these pathways? 2. How is each pathway initiated? 3. What is the outcome of complement activation?

III. Please choose one best answer from (A) to (H) for each bacterium. (10%)

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| (A) quorum sensing and bioluminescence | (B) nitrogen fixation |
| (C) exospores and substrate mycelia | (D) oxygenic photosynthesis |
| (E) anoxygenic photosynthesis | (F) lack cell walls |
| (G) swarmer cells and stalked cells | (H) plant transformation |

- _____ 1. *Mycoplasma*; Class Mollicutes
- _____ 2. *Anabaena spiroides*; Phylum Cyanobacteria
- _____ 3. *Frankia sp.*; High G+C Gram positives
- _____ 4. *Agrobacterium tumefaciens*; Family Rhizobiaceae
- _____ 5. *Streptomyces coelicolor*; Actinomycetes

IV. T-cells originating from CD34+ stem cells in the bone marrow migrate to the thymus for further differentiation. After the procedure to destruct cells which recognize self antigen, the surviving naïve cells will be activated by antigen presentation. Cytotoxic T cells (Tcs) are inactive CD8+ T cells that can mature into cytotoxic lymphocytes (CTL). (10%)

- How are cytotoxic T cells activated into the CTL?
- After maturation, how does CTL kill the targeted cells?

V. Fungi are saprophytes, which include six major groups: the *Chytridiomycota*, *Zygomycota*, *Glomeromycota*, *Ascomycota*, *Basidiomycota*, and *Microsporidia*. (10%)

- Please briefly describe the unique features of each group which can be used to distinguish one from the other.
- Which group do the following fungal species belong to?

(1) *Saccharomyces cerevisiae* (2) Mycorrhizal fungi (3) Truffle (4) *Rhizopus sp.*