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(1) [Terminology] Please briefly explain or describe the terminology below

(a) **Co-metabolism (4%)**
(b) **Denitrification (4%)**
(c) **Substrate level phosphorylation (4%)**
(d) **Open reading frame (4%)**
(e) **Chemolithoautotrophs (4%)**
(f) **Generation time (4%)**
(g) **Chemotaxis (4%)**

(2) [Microbiological Tools] A graduate student used the reverse osmosis (RO) module for the study of water purification. After running the system for a period, she encountered a biofouling problem, namely accumulation of microorganisms on the surface of the RO membrane. She wants to understand what kinds of microorganisms present on the surface of the RO membrane. Based on the viewpoint of Microbiology, please suggest a studying approach for her (15 %).

(3)[Microbial Catabolism] Lipid is usually a big compound and is frequently utilized as an energy source for the growth of microorganisms. This is because high chemical energy from lipid catabolism can be obtained for the formation of ATP and NADH. In the aerobic microorganisms, lipid can be mineralized to the final products, namely carbon dioxide and water.

(a) Please describe in details how lipid is metabolized through the aerobic respiration (15 %), and
(b) How ATP is generated through the lipid catabolism. (5 %)

(4) [Microbial Cellular Structure] Below are the scientific names of five bacterial genera that are important in the environments. Please draw the cellular morphology of these microbes accordingly. (10 %)

(a) *Lactococcus (b) Methanosarcina (c) Bacillus (d) Methanospirillum (e) Staphylococcus*

(背面仍有題目,請繼續作答)

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(5) [Microbial Genetics and Biotechnology] The functional unit of genetic information is the gene. Physically, genes in the bacterial cell are located on the chromosomes or other large molecules known collectively as genetic elements such as plasmids. The chromosome and plasmid within a bacterial cell play important roles in gene function. They are usually replicated in the living cells; however, nowadays, certain gene within the genetic elements can be obtained *in vitro* for the study using biotechnology.

(a) Please differentiate the chromosomes from the plasmids by indicating the differences in terms of size, structure, gene function, replication and mobility. (15%)

(b) The *in vitro* amplification of a gene can be usually conducted with a biotechnology, polymerase chain reaction. Please describe the theory of polymerase chain reaction technique accordingly. Use the schematic presentation if necessary. (12%)