

- I. For the following, place a P next to characteristics and/or examples of Procaryotic organisms and an E next to characteristics and/or examples of Eucaryotic organisms, B next to characteristics and/or examples of both, and N next to characteristics and/or examples of neither. (1 point each)

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|--|--|
| a. ____ lipopolysaccharides | k. ____ substrate level phosphorylation |
| b. ____ techoic acids | l. ____ flagella |
| c. ____ mitochondria | m. ____ transcription |
| d. ____ phospholipid bilayer | n. ____ nitrogen storage granules |
| e. ____ nuclear membrane | o. ____ require terminal electron acceptor |
| f. ____ Monod or Andrews growth kinetics | p. ____ $C_5H_7O_2N$ |
| g. ____ <i>Acinetobacter</i> | q. ____ PHB |
| h. ____ <i>Nitrosomonas</i> | r. ____ rods, cocci, and spirilla |
| i. ____ yeast | s. ____ predominant organisms in activated sludge |
| j. ____ EMP pathway | t. ____ predominant organisms in biological nutrient removal |

- II. Directions: Circle the letter corresponding to the best answer (2 points each).

1. Transport of substances into the cell across the procaryotic cell membrane where the inside concentration is higher than the outside concentration is termed:
 - a. facilitated diffusion
 - b. active transport
 - c. simple diffusion
 - d. endocytosis
2. The transport across the procaryotic cell membrane of a small, non-charged molecule such as oxygen occur via:
 - a. facilitated diffusion
 - b. active transport
 - c. simple diffusion
 - d. endocytosis
3. *Bacillus subtilis* is an example of a
 - a. rod
 - b. eucaryotic cocci
 - c. procaryotic cocci
 - d. spirilla
4. Transferases
 - a. are involved in oxidation reduction reactions
 - b. transfer of constituents from one compound to another
 - c. are responsible for hydrolysis of carbohydrates, proteins, and lipids
 - d. catalyze the addition or removal of constituents
 - e. are involved in isomer formation
 - f. join molecules, polymer formation

5. The maximum specific growth rate can be easily determined from the batch growth curve during the:
 - a. lag phase
 - b. exponential phase
 - c. stationary phase
 - d. death phase
 - e. any of the above
6. The carbon to nitrogen ratio for aerobic growth in heterotrophic bacteria is approximately:
 - a. 10:1
 - b. 50:1
 - c. 100:1
 - d. 1:50
7. The phosphorus concentration of bacteria can be estimated as
 - a. five times the nitrogen requirement
 - b. seven times the nitrogen requirement
 - c. one fifth the nitrogen requirement
 - d. one seventh the nitrogen requirement
 - e. equal to the nitrogen requirement
8. Nitrifiers are sensitive to
 - a. DO
 - b. temperature
 - c. pH
 - d. inhibitors
 - e. all of the above
 - f. b. and d. above
9. During denitrification
 - a. ammonia serves as the electron donor
 - b. oxygen serves as the electron acceptor
 - c. carbon dioxide serves as the carbon source
 - d. all of the above
 - e. none of the above
10. During nitrification
 - a. ammonia serves as the electron donor
 - b. oxygen serves as the electron acceptor
 - c. carbon dioxide serves as the carbon source
 - d. all of the above
 - e. none of the above
11. During carbonaceous BOD removal
 - a. ammonia serves as the electron donor
 - b. oxygen serves as the electron acceptor
 - c. carbon dioxide serves as the carbon source
 - d. all of the above
 - e. none of the above

12. During denitrification, nitrous oxide reductase converts:

- a. $\text{NO}_3^- \rightarrow \text{NO}_2^-$
- b. $\text{N}_2\text{O} \rightarrow \text{N}_2$
- c. $\text{NO}_2^- \rightarrow \text{NO}$
- d. $\text{NO}_2^- \rightarrow \text{N}_2\text{O}$

13. The oxidation of 1 mg/L ammonia-nitrogen to nitrate requires:

- a. 7.1 mg/L alkalinity as CaCO_3
- b. 4.57 mg oxygen
- c. an abundance of nitrifying organisms
- c. all of the above

14. During dissimilatory sulfate reduction

- a. sulfate is used as a TEA
- b. low molecular weight organics serve as the electron donors
- c. the prevalence of SRB depends on COD:S ratio
- d. SRB compete with methanogens for substrate
- e. all of the above

15. In general, SRB are favored when

- a. the ratio of readily degradable COD to S ratio is high
- b. the ratio of readily degradable COD to S ratio is low
- c. the oxygen concentration is above 2.0 mg/L
- d. the temperature is above 35°C

III. List the letter that corresponds best to the following (2 points each):

____ exogenous DNA enters the recipient cell and becomes a part of the chromosome

- a. codon
- b. mRNA

____ genetic transfer necessitates cell to cell contact

c. replication

____ transfer of genetic material from donor to recipient using a bacterial phage

- d. operon
- e. transposition

____ plasmid or chromosomal DNA jumps from one position to another in the genome

f. plasmid

____ catalyzes addition of nucleotides

- g. conjugation
- h. DNA polymerase

____ two strands of DNA separate and new complementary strands are formed

i. transduction

____ transfer of information from DNA to RNA

j. transformation

____ each combination of three nucleotides on mRNA

k. transcription

____ circular extra-chromosomal DNA

l. translation

____ segment of DNA encoding for a sequential set of enzymes

II. Short answer (40 points: 10 points each)

1. Using linear regression, calculate the temperature coefficient from the following. What r^2 value do you get? (Note: $k_2 = k_1 \theta^{(T_2 - T_1)}$ and $^{\circ}\text{C}(9/5) + 32 = ^{\circ}\text{F}$)

Temp, $^{\circ}\text{F}$	decay coefficient, h^{-1}
40	0.0015
45	0.0025
50	0.0026
60	0.0040
72	0.006
82	0.015

2. Describe the processes involved in enhanced biological phosphorus removal. Use diagrams as needed.

3. List the 10 growth requirements for microorganisms.

4. Describe the Monod model for bacterial growth. What would the model look like for a compound that is inhibitory to its own biodegradation? (use equations and/or diagrams to assist you in your descriptions as needed)