

PART I. Multiple choice questions – (4 points each, 32 points total). Single best answer!

1. Consider the major biogeochemical cycles. When it comes to nitrogen, unlike carbon or sulfur, where is the largest reservoir found?
 - A. atmosphere
 - B. lithosphere
 - C. hydrosphere
 - D. sediments
 - E. evenly distributed throughout

2. In bioremediation, where compounds such as 2,4-D and DDT are made nontoxic through anaerobic respiration pathways, specifically what type of metabolic process is involved?
 - A. reductive chlorination
 - B. oxidative chlorination
 - C. reductive dechlorination
 - D. oxidative dechlorination
 - E. None of the above

3. Which of the following enzymes caused a modification to the original theory regarding the flow of information as it relates to the central dogma?
 - A. RNA polymerase
 - B. taq polymerase
 - C. aminoacyl-tRNA synthetase
 - D. DNA polymerase
 - E. reverse transcriptase

4. Virulence factors are related to invasiveness. Which of the following virulence factors promotes fibrin clotting causing the localization of a pathogen rather than its spread?
 - A. streptokinase
 - B. collagenase
 - C. hyaluronidase
 - D. coagulase
 - E. hemolysins

5. An organism that is capable of using CO₂ as a carbon source, light as its primary energy source, H₂O as an electron donor, and oxygen as its terminal electron acceptor, would be best described as which of the following:
- A. photoautotroph
 - B. chemoautotroph
 - C. photoheterotroph
 - D. chemoheterotroph
 - E. mixotroph
6. Which part of the aminoacyl-tRNA binds to the mRNA during translation?
- A. acceptor stem
 - B. anticodon stem
 - C. anticodon loop
 - D. TΨC-loop
 - E. D-loop
7. Which of the following microbial species would most likely be considered normal flora when found in association with the human mouth?
- A. *Escherichia coli*
 - B. *Bacteroides vulgatus*
 - C. *Enterococcus faecalis*
 - D. *Streptococcus mutans*
 - E. *Methanococcus vanneilii*
8. A deadly viral disease that has been completely eradicated (except for a couple of top-secret freezers) is which of the following?
- A. lyme disease
 - B. plague
 - C. anthrax
 - D. chicken pox
 - E. small pox

PART II. Matching – (84 points total).

9. (3 points each) Considering the processes involved with the **central dogma**, match the characteristic and/or structure in the left column with the appropriate process in the right column by choosing letters A through D (pick a **single** best answer for each).

_____	Theta structure	A. Replication
_____	Okazaki fragment	B. Transcription
_____	Sigma factor	C. Translation
_____	Rho factor	D. Post-translation
_____	IF-3	
_____	Shine-Dalgarno sequence	
_____	Pribnow Box	
_____	RNA-DNA hybrid	
_____	Chaperones	

10. (3 points each) Name the bio-polymer (i.e., **DNA, RNA, or protein**) that comprises the following structures involved in the regulation and expression of operons:

_____	Promotor
_____	Operator
_____	Polycistronic message
_____	Polymerase
_____	Repressor
_____	Activator

11. (3 points each) Consider the following list of antibiotics: **Polymyxins, Sulfonamides, Vancomycin, Penicillin, Nalidixic acid, & Tetracycline**. Name the specific antibiotic that is associated with the following set of characteristics:

- _____ Considered the last line of defense regarding antibiotic resistance in Gram positive bacteria by inhibiting cell wall synthesis.
- _____ Growth factor analog that impacts folic acid metabolism and were the first ever widely used antibiotics.
- _____ Broad spectrum antibiotic that inhibits protein synthesis in the SSU and can get pumped back out of a resistant cell (efflux).
- _____ Makes the cytoplasmic membrane leaky thereby shutting down PMF in Gram negative bacteria.
- _____ Inhibits DNA gyrase and is a type of quinolone that works on both Gram positive and Gram negative bacteria.
- _____ Inhibits cell wall synthesis by blocking the active site in transpeptidase using β -lactam ring.

12. (3 points each) Certain groups of microorganisms are **physiologically distinct** regarding specific metabolic pathways. Match the microbial group in the left column with the pathway in the right column by choosing letters A through F (pick a **single** best answer for each).

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|-------|--|-------------------------------------|
| _____ | Denitrifiers | A. chemoautolithotrophy |
| _____ | Iron oxidizers | B. anaerobic respiration |
| _____ | Anaerobic pyruvate reducers | C. aerobic respiration |
| _____ | Cyanobacteria | D. anoxygenic photosynthesis |
| _____ | Green Sulfur Bacteria | E. oxygenic photosynthesis |
| _____ | Methanogens (using CO ₂ only) | F. fermentation |
| _____ | Sulfate Reducers (using organic carbon only) | |

PART III. Short answer questions – (Number of points in parentheses, 54 points total).

- 13.** (8 points) Compare and contrast **repressible** and **inducible** operons. What type of control do these operons represent, what types of pathways do they regulate, how does the repressor interact with each, AND give an example of both.
- 14.** (6 points) Briefly, describe what is meant by **attenuation**. What two significant processes are coupled, how does one affect the other AND what types of operons use this mechanism?
- 15.** (6 points) Consider the processes of **DNA replication** and **transcription**. Briefly, discuss these processes in terms of common characteristics and general differences.
- 16.** (6 points) What are three invariant structures shared by all prokaryotic cells?

16. (8 points) Compare and contrast **exotoxins** with **endotoxins** as they relate to virulence and pathogenicity. Describe their respective structures, temperature constraints, toxigenicity, AND relative immunogenic responses.
17. (6 points) Compare and contrast the **tetanus** and **botulinum** enterotoxins. Specifically, what are their mechanisms of action, are they exo or endotoxins, AND what types of bacteria produce them?
18. (8 points) Consider the process of **reverse electron flow** in a photoautotroph. Explain why this process is necessary AND name a specific bacterial photosystem that requires it.
19. (6 points) When considering the **classification of viruses**, what are the major characteristics used to categorize the different kinds?

PART IV. Short Essay – (Number of points in parentheses, 30 points total). Make sure to choose 2 out of the 3 questions to answer!!! As before, the third essay is optional and extra credit.

- 20.** (15 points) Describe in some detail how microorganisms contributed to the development of excess **oxygen in the atmosphere**. **(A)** What was the important key metabolic pathway that led to this situation. **(B)** What conditions had to occur before oxygen could build up in the atmosphere. **(C)** What were the major transition times & events that occurred prior to the present day outcome?

- 21.** (15 points) Consider the steps involved with protein synthesis. **(A)** Describe in some detail each of the major steps involved with the process of elongation during translation. **(B)** What additional elongation factors are used during each of these steps? **(C)** How much and what type of energy is required to complete a polypeptide that is 100 amino acids in length, including the cost to charge each tRNA molecule?

22. (15 points) Consider the metabolic menu of microorganisms. **(A)** Compare and contrast the primary sources of energy, electrons, and carbon for the metabolic processes collectively known as **aerobic respiration** and **oxygenic photosynthesis**. **(B)** Describe why these pathways are considered to be the “best” in terms of efficiency and ATP production AND which one preceded the other in terms of occurrence regarding free-living bacteria. **(C)** What types of bacteria specialize in these pathways that have gone on to become semi-autonomous endosymbiotic organelles in multicellular macroorganisms AND what was the relative order for the jump to endosymbiosis for each?