

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

1. 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

2. 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

3. During which of the following phases of bacterial growth can the process of *cryptic growth* occur when considering a batch culture?
 - A. Lag
 - B. Exponential
 - C. Death
 - D. Transitory
 - E. Stationary

4. Louis Pasteur is recognized as the scientist who finally refuted which hypothesis using experiments involving microorganisms and swan-necked flasks?
 - A. Germ Theory
 - B. Spontaneous generation
 - C. Natural selection
 - D. Ontogeny recapitulates phylogeny
 - E. Pasteurization principle

5. An organism that is capable of fixing carbon using only CO_2 , using H_2S as its sole electron donor (an energy source), and O_2 as its sole electron acceptor, would be best described as which of the following:
- A. photoautotroph
 - B. chemoautotroph
 - C. photoheterotroph
 - D. chemoheterotroph
 - E. mixotroph
6. An organism that is capable of using acetate as a carbon source, using light as its primary energy source, sulfide and/or thiosulfide as an electron donor, and SO_4^{2-} as its electron acceptor, would be best described as which of the following:
- A. photoautotroph
 - B. chemoautotroph
 - C. photoheterotroph
 - D. chemoheterotroph
 - E. mixotroph
7. High energy thioester bonds such as that used in acetyl-CoA are also known as sulfoanhydride (aka thioester) bonds. Which of the following metabolic processes are capable of using this type of bond?
- A. pyruvate oxidation
 - B. fermentations
 - C. citric acid cycle
 - D. hydroxypropionate carbon fixation
 - E. All of the above
8. Which of the following is NOT a characteristic or function of the cytoplasmic membrane?
- A. Semi-permeable barrier
 - B. Anchor to amphipathic proteins
 - C. Facilitator of PMF (conserves energy)
 - D. A fluid mosaic
 - E. Structural integrity due to turgor pressure

PART II. Matching – (90 points total with one free miss).

9. (3 points each) Considering normal microflora for humans, match the type of bacteria in the right column with the appropriate body location/habitat in the left column (pick a **single** best answer for each).

_____	Skin	A. <i>Staphylococcus sp.</i>
_____	Mouth	B. <i>Bacteroides sp.</i>
_____	Blood	C. <i>Streptococcus sp.</i>
_____	Stomach	D. <i>Lactobacillus sp.</i>
_____	Urine	E. <i>Helicobacter sp.</i>
_____	Nasal passage	F. None, usually sterile
_____	Small intestine (upper)	
_____	Lower respiratory tract	
_____	Large intestine	

10. (3 points each) Indicate if the following characteristics describe exotoxins only (**eXo**), endotoxins only (**enDo**), or both exotoxins and endotoxins (**Both**).

_____	Toxins that are more easily inactivated by heat.
_____	Toxins that are comprised of the lipid A component of the LPS layer.
_____	Toxins that are among the most lethal substances known.
_____	Toxins is capable of producing general systemic effects including fever.
_____	AB toxins are an example of these.
_____	True enterotoxins are an example of these.

11. (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).

_____ 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)	
_____ Animals (you!)	
_____ & _____ Plants (two answers here, they are special!)	

12. (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 quinoline 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.

PART III. Short answer questions – (Number of points in parentheses, 48 points total).

13. (6 points) Consider the various mechanisms of pathogenicity. Briefly, compare and contrast **invasiveness** and **toxigenicity** as they relate to the concept of virulence. Also, what is it that “in the end makes you sick” (i.e., causes disease)?
14. (6 points) Name two different enzymes that help **detoxify** when using O₂ as a terminal electron acceptor (make sure to include which **reactants AND products** that are used for each enzyme you choose)?
15. (6 points) The fastest growing bacterium is *E. coli*, which can divide as fast as every ~20 minutes. Under optimal growth conditions, the fastest *E. coli* can replicate an entire genome in ~40 minutes. Briefly, how is ~20 min cell division possible?
16. (6 points) Calculate the **generation time** (or doubling time) for *E. coli* cells that are growing exponentially at a growth rate (μ) of 2.1 hr⁻¹ and make sure to include units. Is this a reasonable generation time for *E. coli*?

17. (6 points) Briefly, what is the mode of action for the **cholera** toxin. What type of therapy is most effective in treating this disease?
18. (6 points) Under most circumstances a **chemostat** runs at steady state, however, at a very low or very high dilution rates this rule is violated. Briefly, what happens under these two extreme situations?
19. (6 points) On a global scale, does **chemoautotrophy** or **chemoorganotrophy** generate the most methane? For the process you picked, what is the **electron donor**?
20. (6 points) What is the most “**elegant**” mechanism of gene regulation and what two cellular processes are “**coupled**” through this mechanism?

PART IV. Short Essay – (30 points total).

- 21.** (15 points) Consider the oldest known fossils (~3.5 bya), which are thought to represent stromatolites. What is known for sure is that these oldest fossils represent a diverse assemblage of relatively complex photosynthesizers. Your textbook states that these were, “perhaps relatives of the green non-sulfur bacterium *Chloroflexus*” and your instructor tells you that based upon morphological considerations they were most likely filamentous cyanobacteria. (A) Based on what you now know about photosynthesis, which specific type would be associated with *Chloroflexus*? (B) Based on your knowledge of banded-iron formations and the “Rust-the-Crust” theory, which scenario seems more plausible and why? (C) Based only on the “Impact Frustration” theory, which scenario seems plausible and why?

22. (15 points) Consider the metabolic menu of microorganisms. (A) What are the primary sources of energy, electrons, and carbon for the metabolic processes collectively known as **fermentation** AND anaerobic **chemo(auto)lithotrophy**? (Please use ethanol fermentation and hydrogen-oxidation as the representative pathways for your discussion.) (B) Describe what types of habitats might support each of these types of metabolic processes in nature. (C) In general, when it comes to the physical amounts of substrates that must get processed for a given amount of microbial growth, which of these two mechanisms is more efficient, i.e., requires less substrate?