

**PART I. Multiple choice questions – (4 points each, 32 points total).**

1. Louis Pasteur is recognized as the scientist to finally refute 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
  
2. Which of the following types of macromolecules has the fewest *different kinds* in a typical prokaryotic cell?
  - A. RNA
  - B. Lipid
  - C. DNA
  - D. Protein
  - E. Polysaccharide
  
3. Who introduced the concept of vaccination using cow pox infected materials to prevent small pox?
  - A. Hooke, 1665
  - B. Leeuwenhoek, 1684
  - C. Jenner, 1798
  - D. Lister, 1867
  - E. Koch, 1876
  
4. Which of the following is NOT a category used in microbial taxonomy descriptions?
  - A. Serological
  - B. Morphological
  - C. Biochemical
  - D. Phylogenetic
  - E. Physiological

5. During the latter 1600's, through serendipity, Anton van Leeuwenhoek finds a better way to access the quality of fabrics and winds up describing "wee animalcules." This period of microbiology can best be described as?
- A. The age of diagnoses
  - B. The age of sanitation
  - C. The age of biotechnology
  - D. The age of discovery
  - E. The age of discontent
6. Peptidoglycan is an integral part of most bacterial cells. Which of the following compounds is NOT used in the construction of the polymer peptidoglycan?
- A. Diaminopimelic acid (DAP)
  - B. D-amino acids
  - C. N-acetylglucosamine (NAG)
  - D. N-acetylmuramic acid (NAM)
  - E. Dipicolinic acid
7. When comparing prokaryotic cells, which of the following is NOT a *variant structure*?
- A. Cell wall
  - B. Cell membrane
  - C. Flagella
  - D. Capsules
  - E. Endospores
8. The current designation for the highest level of systematic and phylogenetic hierarchical categorization for life is the *domain*. Which of the following descriptors best fits this designation?
- A. Prokaryotes and Eukaryotes
  - B. Eubacteria, Archaeobacteria, and Eukaryotes
  - C. *Bacteria*, *Archaea*, and *Eucarya*
  - D. Plants, Animals, Fungi, Protozoa, and Monera
  - E. Plantae, Protista, Animalia

**PART II. Short answer questions – (Number of points in parentheses, 88 points total).**

9. (6 points) Arrange the following terms in the order they would appear if you were traveling *from* the center of the cytoplasm of a Gram-negative cell *to* the external environment?
- A. Slime layer
  - B. LPS layer
  - C. Capsule
  - D. Periplasmic space
  - E. Ribosomes
  - F. Cell membrane
- \_\_\_\_\_ -> \_\_\_\_\_ -> \_\_\_\_\_ -> \_\_\_\_\_ -> \_\_\_\_\_ -> \_\_\_\_\_
10. (12 points) *Aeromonas salmonicida* (aka salmon killer) is a bacterium that causes “furunculosis” disease. This is a disease that has now spread to the entire world, and is most commonly encountered during the freshwater aquiculture of salmonids. Furunculosis is the most common disease found in fish hatcheries, where fish develop characteristic lesions or boils prior to an untimely death. If you were a fish pathologist, how would you **prove** that *A. salmonicida* is the causative agent of the disease **furunculosis**?

11. (8 points) **(A)** What is the major structural difference between the flagella found in Gram-positive and Gram-negative *Bacteria*? **(B)** What is the name of the protein polymer that the flagella's filament is made of? **(C)** What feature do the bacterial flagella and mitochondrial ATPase share in common?
12. (6 points) Consider the lessons that can be learned by examining the BIG TREE OF LIFE. **(A)** What types of characteristics does the general topology of the tree point towards as the earliest cellular life forms emerged? **(B)** Even though the branch lengths tend to be shorter for the *Archaea*, why do we NOT consider them to be primitive, but instead just less complex?
13. (6 points) Name **3** types of compounds that *Bacteria* can store in their **inclusion bodies**. Since fats and lipids are NOT on your list, include at least one bacterial carbon storage compound.

**14.** (24 points) Briefly discuss the importance and the function for each of the following variant compounds as they relate to microbial cells. Please indicate if the structure is found exclusively in Gram-positive *Bacteria*, Gram-negative *Bacteria*, or *Archaea*.

**A.** Lipoteichoic acids –

**B.** Diaminopimelic acid –

**C.** Biphytanyl tetraether lipids –

**D.** Pseudopeptidoglycan –

**E.** Lipid A region –

**F.** Dipicolinic acid –

**15.** (4 points) What variant compound do *Thermoplasma* and *Mycoplasma* have in common and what is their major difference?

- 16.** (12 points) Compare and contrast the structures involving the Gram-positive and Gram-negative bacterial cell wall. **(A)** What is the major function of the cell wall? **(B)** Which version would you consider to be the “specialist” and why? (A drawing of each would be most useful here.) **(C)** What do autolysins and lysozyme have in common with respect to cell walls?
- 17.** (6 points) Specifically, how does the **rate** of solute entry into the cell change as the external solute concentration increases when comparing carrier-mediated transport (integral proteins) with simple diffusion?
- 18.** (4 points) What is the claim to fame of *Gemmata obscuriglobus* (i.e., key unusual variant structure)?

**PART III. Short Essay – (Number of points in parentheses, 30 points total). Make sure to choose only 2 out of the 3 questions to answer!!!**

- 19.** (15 points) Now that you know a bit about the variant and invariant structures and some key characteristics of prokaryotic cells, describe “5” specific characteristics that you would use to design a **useful** taxonomy. Justify your taxonomic key by placing each of the chosen characteristics into a hierarchy of importance, i.e., which one you would look for first, etc. Design your classification system so that it might be used by other microbiologists to differentiate among the prokaryotes they might potentially run into out in the real world. Describe the reasoning behind your choices.

- 20.** (15 points) Phylogenetic inference is based on the assumption that certain macromolecules retain ancestral information or act as “semantides.” **(A)** Of the following macromolecules, which have the **potential** to contain phylogenetic information: nucleic acids, lipids, proteins, polysaccharides? **(B)** Explain the choices you made, i.e., why do these macromolecules function as documents of evolutionary history with respect to the other macromolecules listed? **(C)** What are **three** additional features that make a good semantide?



- 21.** (15 points): Recently, from a Martian meteorite found in Antarctica, evidence has been described which MAY indicate previous life on Mars. **(A)** What are three major lines of evidence for this conclusion? **(B)** If this conclusion turns out to be true, what would this say about the surface area to volume ratios for these putative microorganisms? **(C)** Does this evidence convince you? If not, what type of evidence would YOU like to see before being convinced that there were/are microorganisms living on Mars?