BIOLOGY 345   Name _____
Midterm I - 05 February 2007
PART I. Multiple choice questions – (4 points each, 36 points total).

1.   Which of the following metals was used in the construction of pipes in early Rome and may have contributed to the fall of the Roman emprire?

   A.   Iron
   B.   Bronze
   C.   Gold
   D.   Lead
   E.   Silver

2.   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

3.   Cell walls are important features in both bacteria and archaea. Which of the following componds best describes the biomolecular subunits one might find exclusively in an archaeal cell wall?

   A.   Diaminopimelic acid (DAP) & D-alanine interbridge
   B.   L-lysine & pentaglycine interbridge
   C.   N-acetylglucosamine (NAG) & N-acetylmuramic acid (NAM) glycan
   D.   N-acetylglucosamine (NAG) & N-acetyltalosaminuronic acid (NAT) glycan
   E.   Dipicolinic acid & Ca^{++}

4.   Considering the multitude of potential metabolic processes available to prokaryotes, which of the following are used to describe specific types of **chemotrophic** metabolisms?

   A.   Energy source
   B.   Carbon source
   C.   Electron source
   D.   Hydrogen source
   E.   Electron acceptor

5. The majority of the bacterial cell's dry weight (96.1% in *E. coli*) is due to just a few macromolecules and polymers. Which of the following is NOT a major component of a bacterial cell?

    A. RNA
    B. Peptidoglycan (aka murein)
    C. Proteins
    D. Vitamins
    E. Lipids

6. Which of the following is an invariant feature found among all microbial cells?

    A. Ribosomes
    B. Endospores
    C. Cell wall
    D. Capsules
    E. Flagella

7. Which of the following structures is NOT found in a typical Gram positive cell wall?

    A. Peptidoglycan cell wall
    B. Techoic acids
    C. Pentaglycine interbridge
    D. Lipotechoic acids
    E. Core polysaccharides

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

9. Which of the following macromolecules accounts for the greatest amount of weight in a typical bacterial cell?

    A. RNA   D. Lipid
    B. DNA   E. Protein
    C. Polysaccharide

PART II. Short answer questions – (Number of points in parentheses, 69 points total).

10.   (9 points) Arrange the following features 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   ____ ➔ ____ ➔ ____ ➔ ____ ➔ ____ ➔ ____

11.   (12 points) *Aeromonas salmonicida* (aka salmon killer) is a bacterium that causes "furunculosis" disease in salmonid fishes. This disease has now spread worldwide, and is most commonly encountered during the freshwater aquiculture of salmonids. Furunclulosis 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**?

12. (9 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 bacterial flagella and ATPase share in common?

13. (5 points) You have a culture of your favorite cyanobacteria and are wondering if they have gas vesicles. How might you go about testing for this variant feature even if you don't have a microscope handy?

14. (5 points) Briefly, what are **hopanoids** used for in the bacterial cell AND to what eukaryotic cell structure are they most analogous?

15. (6 points) Consider the lessons that can be learned from the Big Tree of Life. **(A)** What does the general overall topology tell us regarding the number of primary lines of evolutionary descent? **(B)** Even though the overall branch lengths are shorter for the archaea, why do we NOT consider them to be primitive, but instead just less complex?

16. (18 points) Briefly discuss the importance and the function for each of the following variant compounds as they relate to microbial cells. Please indicate where the structure is found in the cell AND if the structure is exclusively (mostly) in Gram-positive bacteria, Gram-negative bacteria, or archaea.

A. Diaminopimelic acid (DAP) –

B. Lipid A region –

C. Porins –

D. Small acid-soluble proteins –

E. Paracrystalline S-layer –

F. Biphytanyl tetraether lipids –

17. (5 points) Consider the microbial concept of a species as opposed to the macrobial concept (i.e., plants and animals). Which is more specific in terms of differentiation among closely related taxa (less divergent)?

PART III. Short Essay – (Number of points in parentheses, 45 points total).

18.   (15 points) A giant bacterium has recently been discovered in the digestive tract of a marine surgeonfish, this symbiont bacterium is named *Epulopiscium fishelsoni*. This bacterium has a gigantic rod morphology and grows nearly 5 times bigger that a *Paramecium* measuring up to **0.75 mm** in length. (A) Based on this information and what you already know about surface area to volume ratios, what are the major problems that this bacterium must overcome? (B)What advantage might this bacterium have achieved by being so large, especially when considering its native habitat? (C) What is the "normal" size range for most free-living bacteria and why?

19. (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 has the highest potential to contain phylogenetic information: nucleic acids, lipids, proteins, polysaccharides? **(B)** Explain the choice you made, i.e., why does this macromolecule function better as a document of evolutionary history with respect to the other macromolecules listed above (are there any alternative macromolecules on the list that might also work in this regard?). **(C)** What are **three** features that would help to make a good semantide?

20. (15 points) Now that you know a bit about the variant and invariant structures and some key characteristics of bacterial and archaeal 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 would you look for first, etc. Design your classification system so that it might be used by other microbiologists to differentiate among real world microbes. Describe the reasoning behind your choices.