

Midterm I - 20 October 2008

PART I. Multiple choice questions – (4 points each, 36 points total).

1. When considering the human body (made up of about 10 trillion Eucarya cells), which of the following accurately describes the combined number of bacterial and archaeal cells that call this habitat "home"?
 - A. There are about 10 million of them
 - B. There are about 100 million of them
 - C. There are about 100 trillion of them
 - D. There are no bacteria in MY body!!!
 - E. There are no archaea in MY body!!!

2. Louis Pasteur is recognized as the father of microbiology, which of the following discoveries are attributed to his research efforts?
 - A. Pasteurization process by heat treating (I know, duh)
 - B. Refuted concept of spontaneous generation with swan-necked flasks
 - C. Prevention of diseases like rabies and anthrax by vaccination
 - D. Enhanced fermentation of wine to produce alcohol instead of vinegar
 - E. All of the above

3. A bacterium with a tuft of flagella on one end of its cell would best be considered?
 - A. Monotrichous
 - B. Lophotrichous
 - C. Peritrichous
 - D. Amphitrichous
 - E. None of the above, as this trait has yet to be discovered

4. Considering the multitude of potential metabolic processes available to prokaryotes, which of the following are used to describe specific types of **phototrophic** metabolisms?
 - A. Energy source
 - B. Carbon source
 - C. Electron source
 - D. Hydrogen source
 - E. Electron acceptor

5. Which of the following characteristics is NOT found in association with bacterial endospores?
- A. Dehydration
 - B. Dipicolinic acid
 - C. Low calcium content
 - D. Small acid-soluble proteins
 - E. Spore coat
6. Which of the following is an invariant feature found among all microbial cells?
- A. Cell wall
 - B. Endospores
 - C. Gas Vesicles
 - D. Capsules
 - E. Cell Membrane
7. Which of the following structures is NOT found in a typical Gram-negative cell wall?
- A. Peptidoglycan cell wall
 - B. Teichoic acids
 - C. Direct crosslink between DAP & D-Ala
 - D. Periplasmic space
 - E. Core polysaccharides
8. Based on rRNA comparisons, we now know that:
- A. Eucarya evolved directly from the Domain Bacteria
 - B. Eucarya evolved directly from the Domain Archaea
 - C. Mitochondria evolved from the Domain Archaea
 - D. The oldest Domain to evolve were the Archaea
 - E. Two of the above are correct
9. Which of the following macromolecules accounts for the greatest amount in terms of the number of molecules in a typical bacterial cell?
- A. RNA
 - B. DNA
 - C. Polysaccharide
 - D. Lipid
 - E. Protein

PART II. Matching & Fill-in-the-blank – (Number of points in parentheses, 28 total).

10. (16 points) Match each description with the corresponding name below (use letter).

_____ Microbiologist who used rRNA to describe the 3 domains of life.

_____ Dutch cloth tradesman and amateur microscope builder who reported microscopic wee animalcules in the 1600's.

_____ Made significant discoveries concerning chemolithotrophy and introduced the concept of viruses.

_____ Pioneered human and environmental genome shotgun-sequencing.

_____ Used his developments in pure culture isolation with Germ Theory and an animal model system to reveal the causative agent for tuberculosis.

_____ Performed first experiments that disagreed with spontaneous generation.

_____ Got medical students to wash their hands before delivering babies.

_____ Discovered the first “magic bullet” when using salvarsan to treat syphilis.

Choices: (A) Carl Woese; (B) Paul Ehrlich; (C) Robert Koch; (D) Martinus Beijerinck; (E) Craig Venter; (F) Antonie von Leeuwenhoek; (G) Francisco Redi; (H) Ignaz Semmelweis.

11. (12 points) Put the following events in chronological order (1, 2, 3, 4).

_____ First description of microbes

_____ First description of viruses

_____ Discovery of penicillin

_____ First smallpox vaccination

PART III. Short answer questions – (Number of points in parentheses, 41 total).

- 12.** (12 points) *Renibacterium salmoninarium* is a Gram positive bacterium that causes “bacterial kidney disease” in salmonid fishes, which is caused by a chronic infection characterized by gray-white necrotic abscesses in the kidney. This disease was first described in Atlantic salmon from the Spey river in Scotland. It is now prevalent in hatchery-reared salmon and trout throughout the U.S. and elsewhere. If you were a fish pathologist, how would you **prove** that *R. salmoninarum* is the causative agent of the “BKD” disease?
- 13.** (5 points) In two sentences or less, name and describe two of the “hallmarks” of cellular life that viruses lack.
- 14.** (5 points) Briefly, what are **hopanoids** used for in the bacterial cell AND to what eucaryotic cell structure are they most analogous?

- 15.** (9 points) Consider the structure and function of ribosomes. Briefly, ...
- A.** What are the relative proportions of RNA and protein in a ribosome?

 - B.** Why is it that protein synthesis and transcription are able to be coupled in bacteria?

 - C.** Why are most eucaryotic ribosomes actually bigger than bacterial & archaeal ones?
- 16.** (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)?
- 17.** (5 points) What is specifically meant by the statement that; “All bacteria and archaea are osmotrophs”?

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

- 18.** (15 points) You are conducting undergraduate research for a professor who gives you a viable culture labeled *Gemmata obscuriglobus*. He tells you that it is a member of the order *Planctomycetales*, a rather unusual group of *Bacteria*, and proceeds to leave town for an oceanographic cruise. You determine through standard microbiological methods that this “bacterium” has no peptidoglycan in its’ cell wall (only proteins) and that it has a membrane bound nucleoid. **(A)** You decide your professor is nuts. Why would you think this based on the usual taxonomic characteristics of bacteria? **(B)** You decide to keep studying this organism anyway, and design an experiment to determine if *G. obscuriglobus* is really a member of the domain *Bacteria*. How would you go about conducting this experiment based on a **phylogenetic** approach? **(C)** Why might a phylogenetic approach be a better choice than a taxonomic one in this case?

- 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) A new giant bacterium has recently been discovered in marine sediments, named *Thiomargarita namibiensis*. This bacterium has a coccoid morphology and grows as a “string of pearls” measuring up to **0.5 mm** in diameter. It also shines white (i.e., the pearl-look) due to large refractive sulfur inclusion bodies contained inside of the cell. **(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? **(C)** What is the “normal” size range for most free-living bacteria and why?