

Study Guide for EXAM I

Major concepts of microbiology

Below are some things we discussed at length in class because they are important in the study of microbes. Understand these topics:

- What was the general mindset at the time of the discovery of microbes? Understand the hypothesis of spontaneous generation and be able to describe the experiments that disproved it.
- Explain how the science of microbiology benefited from the scientific method.
- What is the relevance of small cell size?
- What are characteristics of Archaea that make them similar to and different from Bacteria and Eukarya? What does this tell us?
- What structures of Bacterial and Archaeal cells are invariant? What does this tell us about our Last Universal Common Ancestor?
- What structures of Bacterial and Archaeal cells are variant? How do they vary?
- What structures of Bacteria (there aren't any known Archaeal pathogens to date) are good targets for antibiotics? Why?
- Discuss diversity of prokaryotes... the many ways/places that prokaryotic cells live and survive.
- Understand the methods that microbiologists use to classify diverse microbes. What level of diversity (e.g. metabolic, ecological, structural) might be useful in identifying fairly run-of-the-mill clinical isolates? What about novel environmental samples? What major progress in our thinking and our methodologies have occurred in the past 30 years?
- Be familiar with the Tree of Life, based on 16S rRNA phylogeny: which organisms are most abundant overall? Where do plants and animals fall? Are people more closely related to Bacteria or Archaea? What methods were used to generate the tree in the first place? Is it precise?

Examples of fun facts to know

- What percentage of microbes we have grown *in vitro*?
- How old *might* the oldest (as far as we know) viable endospores might be?
- What's the hottest temperature we've been able to subject a living cell to, and have it live?
- How does the size of a bacterial chromosome compares to the cell's diameter?

History of microbiology

- Name the four main questions that drove microbiology as a science.
- Be familiar enough to match the names of major figures with their accomplishments.

rRNA sequencing and the Tree of Life

Be able to discuss the following:

- How do new species arise? How do we define a "prokaryotic" "species"? Do you think this definition is a good one?
- What methods do microbiologists use to make inferences about the *evolutionary relationships* among species? What is the difference between phenetic and phyletic methodologies? Understand the methodology and data interpretation for %GC, DNA:DNA hybridization, ribotyping, multi-locus sequence typing, and FAME analysis to describe relationships among organisms.

Cellular microbiology

- Be able to describe a prokaryotic nucleoid in terms of size, organization, and replication.
- Be able to sketch the structural and molecular differences between cell envelopes of gram positive and gram negative bacteria.

- Discuss the various roles of the cytoplasmic membrane.
- Discuss three forms of transport across cell membranes.
- Know the key characteristics of endospores: when in the life cycle do they develop, what structures and molecular characteristics make them unique from vegetative cells, and what environmental extremes can they withstand?
- Be able to sketch and label (with functions) the flagellar machinery.
- Understand the significance of injectisomes and their structural and evolutionary relationship to flagellae.
- Be able to define (or recognize images of) the following: S layers, capsule, fimbriae, pilus, inclusion body, and gas vesicle.

Recognize structures including, but not limited to these. Know key features of each.

- Bacterial and archaeal membrane lipids: ether or ester linkage? What type of lipid tail? Mono or bilayer?
- Lipopolysaccharide from Gram negative bacteria: what part is toxic? What part is antigenic?
- Sterols: what do these do, and where are they found?
- Peptidoglycan: be able to identify the sites affected by lysozyme and penicillin. Be able to differentiate between Gram negative and Gram positive structures.
- Teichoic acid: where is this found?
- Dipicolinic acid: where is this found and what is its function?
- Diaminopimelic acid: where is this found?