4.7: Prokaryotic Diversity (Exercises)

4.1: Prokaryote Habitats, Relationships, and Microbiomes

Prokaryotes are unicellular microorganisms whose cells have no nucleus. Prokaryotes can be found everywhere on our planet, even in the most extreme environments. Prokaryotes are very flexible metabolically, so they are able to adjust their feeding to the available natural resources. Prokaryotes live in communities that interact among themselves and with large organisms that they use as hosts (including humans).

Multiple Choice

The term prokaryotes refers to which of the following?

A. very small organisms  
B. unicellular organisms that have no nucleus  
C. multicellular organisms  
D. cells that resemble animal cells more than plant cells

B

The term microbiota refers to which of the following?

A. all microorganisms of the same species  
B. all of the microorganisms involved in a symbiotic relationship
C. all microorganisms in a certain region of the human body
D. all microorganisms in a certain geographic region

C

Which of the following refers to the type of interaction between two prokaryotic populations in which one population benefits and the other is not affected?

A. mutualism
B. commensalism
C. parasitism
D. neutralism

B

True/False

Among prokaryotes, there are some that can live in every environment on earth.

True

Fill in the Blank

When prokaryotes live as interacting communities in which one population benefits to the harm of the other, the type of symbiosis is called ________.

parasitism

The domain ________ does not include prokaryotes.

Eukarya

Pathogenic bacteria that are part of the transient microbiota can sometimes be eliminated by ________ therapy.
antibiotic

Nitrogen-fixing bacteria provide other organisms with usable nitrogen in the form of ________.

ammonia

Short Answer

Compare commensalism and amensalism.

Give an example of the changes of human microbiota that result from medical intervention.

4.2: Proteobacteria

Proteobacteria is a phylum of gram-negative bacteria and are classified into the classes alpha-, beta-, gamma-, delta- and epsilonproteobacteria, each class having separate orders, families, genera, and species. Alphaproteobacteria are oligotrophs. The taxa chlamydias and rickettsias are obligate intracellular pathogens, feeding on cells of host organisms; they are metabolically inactive outside of the host cell. Some Alphaproteobacteria can convert atmospheric nitrogen to nitrites.

Multiple Choice

Which of the following describes Proteobacteria in domain Bacteria?

A. phylum
B. class
C. species
D. genus

A

All Alphaproteobacteria are which of the following?

A. oligotrophs
B. intracellular
C. pathogenic
D. all of the above
E. none of the above
A

Class Betaproteobacteria includes all but which of the following genera?

A. Neisseria.
B. Bordetella.
C. Leptothrix.
D. Campylobacter.

D

Haemophilus influenzae is a common cause of which of the following?

A. influenza
B. dysentery
C. upper respiratory tract infections
D. hemophilia

C

Fill in the Blank

Rickettsias are _______ intracellular bacteria.

obligate

The species _______, which belongs to Epsilonproteobacteria, causes peptic ulcers of the stomach and duodenum.

Helicobacter pylori

The genus Salmonella belongs to the class _______ and includes pathogens that cause salmonellosis and typhoid fever.

Gammaproteobacteria
Short Answer

What is the metabolic difference between coliforms and noncoliforms? Which category contains several species of intestinal pathogens?

Why are *Mycoplasma* and *Chlamydia* classified as obligate intracellular pathogens?

Critical Thinking

The cell shown is found in the human stomach and is now known to cause peptic ulcers. What is the name of this bacterium?

(credit: American Society for Microbiology)

4.3: Nonproteobacteria Gram-negative Bacteria and Phototrophic Bacteria

Gram-negative nonproteobacteria include the taxa spirochetes; the Cytophaga, Fusobacterium, Bacteroides group; Planctomycetes; and many representatives of phototrophic bacteria. Spirochetes are motile, spiral bacteria with a long, narrow body; they are difficult or impossible to culture. Several genera of spirochetes contain human pathogens that cause such diseases as syphilis and Lyme disease. Cytophaga, Fusobacterium, and Bacteroides are classified together as a phylum called the CFB group.

Multiple Choice

Which of the following is the organelle that spirochetes use to propel themselves?

A. plasma membrane  
B. axial filament  
C. pilum
Which of the following bacteria are the most prevalent in the human gut?

A. cyanobacteria
B. staphylococci
C. Borrelia
D. Bacteroides

Which of the following refers to photosynthesis performed by bacteria with the use of water as the donor of electrons?

A. oxygenic
B. anoxygenic
C. heterotrophic
D. phototrophic

Fill in the Blank

The bacterium that causes syphilis is called ________.

Treponema pallidum pallidum

Bacteria in the genus *Rhodospirillum* that use hydrogen for oxidation and fix nitrogen are ________ bacteria.

purple nonsulfur

Short Answer

Explain the term CFB group and name the genera that this group includes.
Name and briefly describe the bacterium that causes Lyme disease.

Characterize the phylum Cyanobacteria.

4.4: Gram-positive Bacteria

Gram-positive bacteria are a very large and diverse group of microorganisms. Understanding their taxonomy and knowing their unique features is important for diagnostics and treatment of infectious diseases. Gram-positive bacteria are classified into high G+C gram-positive and low G+C gram-positive bacteria, based on the prevalence of guanine and cytosine nucleotides in their genome.

Multiple Choice

Which of the following bacterial species is classified as high G+C gram-positive?

- A. Corynebacterium diphtheriae
- B. Staphylococcus aureus
- C. Bacillus anthracis
- D. Streptococcus pneumonia

A

Fill in the Blank

*Streptococcus* is the ________ of bacteria that is responsible for many human diseases.

genus

One species of *Streptococcus*, *S. pyogenes*, is classified as a ________ pathogen due to the characteristic production of pus in infections it causes.

pyogenic

*Propionibacterium* belongs to ________ G+C gram-positive bacteria. One of its species is used in the food industry and another causes acne.
Short Answer

Name and describe two types of \( S. \text{aureus} \) that show multiple antibiotic resistance.

Critical Thinking

The microscopic growth pattern shown is characteristic of which genus of bacteria?

(credit: modification of work by Janice Haney Carr/Centers for Disease Control and Prevention)

4.5: Deeply Branching Bacteria

Deeply branching bacteria are phylogenetically the most ancient forms of life, being the closest to the last universal common ancestor. Deeply branching bacteria include many species that thrive in extreme environments that are thought to resemble conditions on earth billions of years ago. Deeply branching bacteria are important for our understanding of evolution; some of them are used in industry.

Multiple Choice

The term "deeply branching" refers to which of the following?

A. the cellular shape of deeply branching bacteria
B. the position in the evolutionary tree of deeply branching bacteria
C. the ability of deeply branching bacteria to live in deep ocean waters
D. the pattern of growth in culture of deeply branching bacteria
B

Which of these deeply branching bacteria is considered a polyextremophile?

A. *Aquifex pyrophilus*
B. *Deinococcus radiodurans*
C. *Staphylococcus aureus*
D. *Mycobacterium tuberculosis*

B

Fill in the Blank

The length of the branches of the evolutionary tree characterizes the evolutionary ________ between organisms.

distance

The deeply branching bacteria are thought to be the form of life closest to the last universal ________ ________.

common ancestor

Many of the deeply branching bacteria are aquatic and hyperthermophilic, found near underwater volcanoes and thermal ocean ________.

vents

The deeply branching bacterium *Deinococcus radiodurans* is able to survive exposure to high doses of ________.

ionizing radiation

Short Answer

Briefly describe the significance of deeply branching bacteria for basic science and for industry.

What is thought to account for the unique radiation resistance of *D. radiodurans*?
4.6: Archaea

Archaea are unicellular, prokaryotic microorganisms that differ from bacteria in their genetics, biochemistry, and ecology. Some archaea are extremophiles, living in environments with extremely high or low temperatures, or extreme salinity. Only archaea are known to produce methane. Methane-producing archaea are called methanogens. Halophilic archaea prefer a concentration of salt close to saturation and perform photosynthesis using bacteriorhodopsin.

Multiple Choice

Archaea and Bacteria are most similar in terms of their ________.

A. genetics
B. cell wall structure
C. ecology
D. unicellular structure

D

Which of the following is true of archaea that produce methane?

A. They reduce carbon dioxide in the presence of nitrogen.
B. They live in the most extreme environments.
C. They are always anaerobes.
D. They have been discovered on Mars.

B

Fill in the Blank

_________ is a genus of Archaea. Its optimal environmental temperature ranges from 70 °C to 80 °C, and its optimal pH is 2–3. It oxidizes sulfur and produces sulfuric acid.

Sulfolobus

_________ was once thought to be the cause of periodontal disease, but, more recently, the causal relationship between this archaean and the disease was not confirmed.
Methanobrevibacter oralis

**Short Answer**

What accounts for the purple color in salt ponds inhabited by halophilic archaea?

What evidence supports the hypothesis that some archaea live on Mars?

**Critical Thinking**

What is the connection between this methane bog and archaea?

(credit: Chad Skeers)