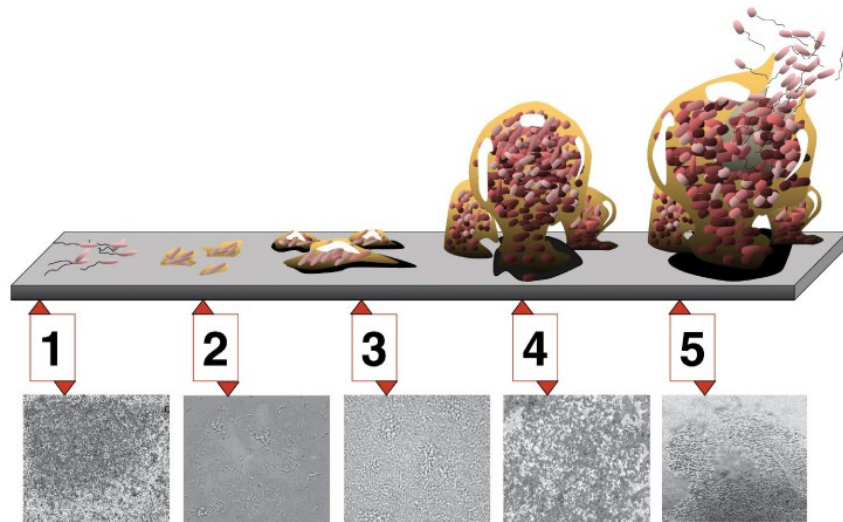


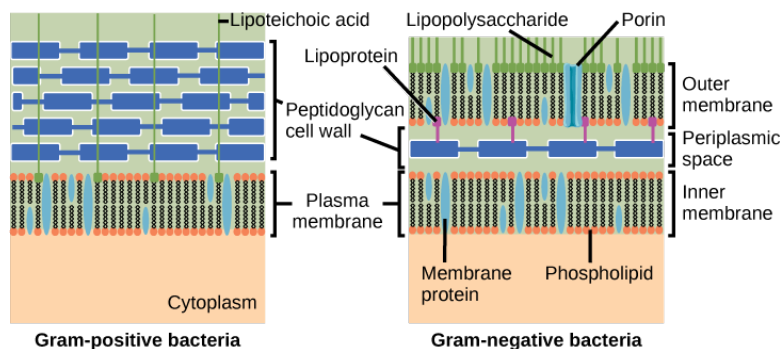
Biology 2eUnit 5: **Biological Diversity**Chapter 22: **Prokaryotes: Bacteria and Archaea****Visual Connection Questions**

1. Compared to free-floating bacteria, bacteria in biofilms often show increased resistance to antibiotics and detergents. Why do you think this might be the case?



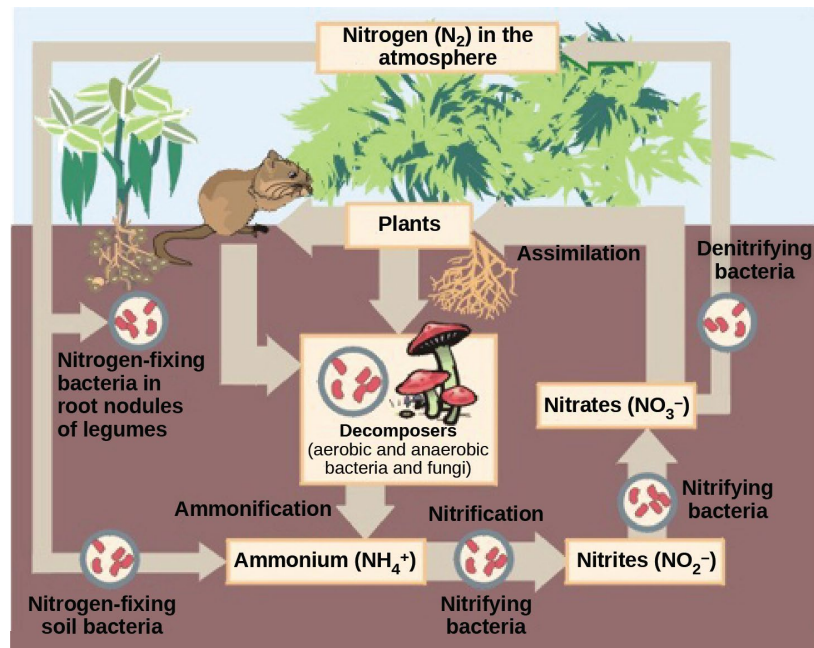
The extracellular matrix and outer layer of cells protects the inner bacteria. The close proximity of cells also facilitates lateral gene transfer, a process by which genes such as antibiotic resistance genes are transferred from one bacterium to another. And even if lateral gene transfer does not occur, one bacterium that produces an exo-enzyme that destroys antibiotic may save neighboring bacteria.

2. Which of the following statements is true?



a. Gram-positive bacteria have a single cell wall anchored to the cell membrane by lipoteichoic acid.

3. Which of the following statements about the nitrogen cycle is false?



d. Nitrification is the process by which nitrites (NO_2^-) are converted to ammonium ion (NH_4^+).

Review Questions

4. The first forms of life on Earth were thought to be _____.

b. prokaryotes

5. Microbial mats _____.

d. all of the above (are the earliest forms of life on Earth, obtained their energy and food from hydrothermal vents, are multi-layered sheet of prokaryotes including mostly bacteria but also archaea)

6. The first organisms that oxygenated the atmosphere were

a. cyanobacteria

7. Halophiles are organisms that require _____.

a. a salt concentration of at least 0.2 M

8. Many of the first prokaryotes to be cultured in a scientific lab were human or animal pathogens. Why would these species be more readily cultured than non-pathogenic prokaryotes?

c. Most of the necessary culture conditions could be inferred for pathogenic prokaryotes.

9. The presence of a membrane-enclosed nucleus is a characteristic of _____.

b. eukaryotic cells

10. Which of the following consist of prokaryotic cells?

d. bacteria and archaea

11. The cell wall is _____.

b. exterior to the cell membrane

12. Organisms most likely to be found in extreme environments are _____.

d. archaea

13. Prokaryotes stain as Gram-positive or Gram-negative because of differences in the cell _____.

a. wall

14. Pseudopeptidoglycan is a characteristic of the walls of _____.

c. archaean prokaryotic cells

15. The lipopolysaccharide layer (LPS) is a characteristic of the wall of _____.

b. Gram-negative bacteria

16. Which of the following elements is not a micronutrient?

b. calcium

17. Prokaryotes that obtain their energy from chemical compounds are called _____.

c. chemotrophs

18. Ammonification is the process by which _____.

a. ammonia is released during the decomposition of nitrogen-containing organic compounds

19. Plants use carbon dioxide from the air and are therefore called _____.

b. producers

20. Cyanobacteria harness energy from the sun through photosynthesis, and oxidize water to provide electrons for energy generation. Thus, we classify cyanobacteria as _____.

a. Photolithotrophs

21. A disease that is constantly present in a population is called _____.

c. endemic

22. Which of the statements about biofilms is correct?

d. All statements are correct.

23. Which of these statements is true?

a. An antibiotic is any substance produced by an organism that is antagonistic to the growth of prokaryotes.

24. A person in England arrives at a medical clinic with a fever and swollen lymph nodes shortly after returning from a visit to New Mexico. For which bacteria should the doctor test the patient?

d. *Yersinia pestis*

25. MRSA has emerged as a serious infectious disease, with the first case of methicillin-resistant *S. aureus* being detected in 1961. Why are medical professionals so concerned when antibiotics exist that can kill MRSA?

d. All of the above. (MRSA can transfer methicillin-resistance to other bacteria, Patients are not treated with correct antibiotics rapidly enough to prevent serious illness, MRSA could acquire additional antibiotic resistance genes from other bacteria to become a “super bug”)

26. Which of these occurs through symbiotic nitrogen fixation?

d. All of the above occur (The plant benefits from using an endless source of nitrogen, The soil benefits from being naturally fertilized, Bacteria benefit from using photosynthates from the plant)

27. Synthetic compounds found in an organism but not normally produced or expected to be present in that organism are called ____.

d. xenobiotics

28. Bioremediation includes ____.

b. the use of prokaryotes to clean up pollutants

29. In addition to providing yogurt with its unique flavor and texture, lactic acid-producing bacteria also provide which additional benefit during food production?

b. Lowering the pH to kill pathogenic bacteria

Critical Thinking Questions

30. Describe briefly how you would detect the presence of a non-culturable prokaryote in an environmental sample.

As the organisms are non-culturable, the presence could be detected through molecular techniques, such as PCR.

31. Why do scientists believe that the first organisms on Earth were extremophiles?

Because the environmental conditions on Earth were extreme: high temperatures, lack of oxygen, high radiation, and the like.

32. A new bacterial species is discovered and classified as an endolith, an extremophile that lives inside rock. If the bacteria were discovered in the permafrost of Antarctica, describe two extremophile features the bacteria must possess.

Possible answers include:

- Psychrophile

- Hypolith – survival in low humidity/water environment

33. Mention three differences between bacteria and archaea.

Responses will vary. A possible answer is: Bacteria contain peptidoglycan in the cell wall; archaea do not. The cell membrane in bacteria is a lipid bilayer; in archaea, it can be a lipid bilayer or a monolayer. Bacteria contain fatty acids on the cell membrane, whereas archaea contain phytanyl.

34. Explain the statement that both types, bacteria and archaea, have the same basic structures, but built from different chemical components.

Both bacteria and archaea have cell membranes and they both contain a hydrophobic portion. In the case of bacteria, it is a fatty acid; in the case of archaea, it is a hydrocarbon (phytanyl). Both bacteria and archaea have a cell wall that protects them. In the case of bacteria, it is composed of peptidoglycan, whereas in the case of archaea, it is pseudopeptidoglycan, polysaccharides, glycoproteins, or pure protein. Bacterial and archaeal flagella also differ in their chemical structure.

35. A scientist isolates a new species of prokaryote. He notes that the specimen is a bacillus with a lipid bilayer and cell wall that stains positive for peptidoglycan. Its circular chromosome replicates from a single origin of replication. Is the specimen most likely an Archaea, a gram-positive bacterium, or a gram-negative bacterium? How do you know?

The specimen is most likely a gram-positive bacterium. Since the cell wall contains peptidoglycan and the chromosome has one origin of replication, we can conclude that the specimen is in the Domain Bacteria. Since the gram stain detects peptidoglycan, the prokaryote is a gram-positive bacterium.

36. Think about the conditions (temperature, light, pressure, and organic and inorganic materials) that you may find in a deep-sea hydrothermal vent. What type of prokaryotes, in terms of their metabolic needs (autotrophs, phototrophs, chemotrophs, etc.), would you expect to find there?

Responses will vary. In a deep-sea hydrothermal vent, there is no light, so prokaryotes would be chemotrophs instead of phototrophs. The source of carbon would be carbon dioxide dissolved in the ocean, so they would be autotrophs. There is not a lot of organic material in the ocean, so prokaryotes would probably use inorganic sources, thus they would be chemolithotrophs. The temperatures are very high in the hydrothermal vent, so the prokaryotes would be thermophilic.

37. Farmers continually rotate the crops grown in different fields to maintain nutrients in the soil. How would planting soybeans in a field the year after the field was used to grow carrots help maintain nitrogen in the soil?

Soybeans are members of the legume family, so their roots have nodules that are colonized by nitrogen-fixing bacteria (ex. *Rhizobium*). Planting a crop that promotes nitrogen fixation after growing a crop that depletes nitrogen from the soil ensures that the soil continues to contain sufficient nutrients to grow more crops in the future.

38. Imagine a region of soil became contaminated, killing bacteria that decompose dead plants and animals. How would this effect the carbon cycle in the area? Be specific in stating where carbon would accumulate in the cycle.

Losing the bacteria that serve as decomposers in the ecosystem would disrupt the carbon cycle, but not stop it completely since fungi can also serve as decomposers. Without bacterial decomposers functioning, organic waste would accumulate in the area, and less carbon dioxide would be released back into the atmosphere.

39. Explain the reason why the imprudent and excessive use of antibiotics has resulted in a major global problem.

Antibiotics kill bacteria that are sensitive to them; thus, only the resistant ones will survive. These resistant bacteria will reproduce, and therefore, after a while, there will be only resistant bacteria.

40. Researchers have discovered that washing spinach with water several times does not prevent foodborne diseases due to *E. coli*. How can you explain this fact?

E. coli colonizes the surface of the leaf, forming a biofilm that is more difficult to remove than free (planktonic) cells. Additionally, bacteria can be taken up in the water that plants are grown in, thereby entering the plant tissues rather than simply residing on the leaf surface.

41. Your friend believes that prokaryotes are always detrimental and pathogenic. How would you explain to them that they are wrong?

Remind them of the important roles prokaryotes play in decomposition and freeing up nutrients in biogeochemical cycles; remind them of the many prokaryotes that are not human pathogens and that fill very specialized niches. Furthermore, our normal bacterial symbionts are crucial for our digestion and in protecting us from pathogens.

42. Many people use antimicrobial soap to kill bacteria on their hands. However, overuse may actually increase the risk of infection. How could this occur?

Soap indiscriminately kills bacteria on skin. This kills harmful bacteria, but can also eliminate “good” bacteria from the skin. When the non-pathogenic bacteria are eliminated, pathogenic bacteria can colonize the empty surface.