

Unit 8: Biodiversity

Content Outline: Bacteria Kingdoms (8.3) – Part 1

- I. Prokaryotes (Bacteria) are the *oldest organisms* and most adaptive organisms on the planet.
 - A. Some famous bacteria include Plague, TB, Cholera, Botulinum, and Anthrax.
 - B. Most bacteria are harmless though.
 - C. Bacteria are essential for life to exist. They are involved in nutrient recycling – they are decomposers.
Good place to quickly review the Biogeochemical cycles, especially the nitrogen cycle as it is mainly bacteria.

- II. Two **Domains** of Bacteria exist:
 - A. Bacteria (common) and Archaea (extremophiles)
 - B. The genetic difference is located in the *small subunit of the ribosome's RNA sequence*.
Please show a picture of a ribosome and remind students that the bottom is for support and the top is the actual “factory” that makes the protein by translation.

- III. Bacterial Structure
 - A. All prokaryotes are *unicellular*.
 - B. Three basic shapes of prokaryotes exist:
 1. **Cocci** (Means “round”.)
 2. **Bacilli** (Means “rod”.)
 3. **Helical** (Means “spiral”.)
 - C. Most prokaryotes will have a **cell wall**. (This is not the same as a plant’s cell wall.)
 1. This structure is primarily *for protection* of the underlying cell membrane.
 2. It also helps prevent the prokaryotes from bursting in an aquatic environment. (The cell is hypertonic to water.) Please remind students that water always moves from hypotonic to hypertonic until isotonic.
 3. The cell wall is mainly composed of proteins and sugars. (These are called **peptidoglycans**.)
 (“peptide” refers to the proteins; “glycan” refers to the sugars.)
 4. Scientists perform a Gram staining for easy, fast identification of most bacteria.
 - a. Gram + (stain blue) (They possess a *thick* peptidoglycan layer.)
 - b. Gram - (stain Red) (These possess a *thin* peptidoglycan layer *between* phospholipid layers.)
 - c. Gram- are more dangerous to humans and are usually resistant to antibiotics.
 - D. Some bacteria produce a **Capsule** that covers the cell wall. The capsule is a *sticky substance for adherence* to surfaces. This capsule material is what actually makes people sick; not the bacteria.
 - E. Some prokaryotes have flagella, or cilia/fimbriae, or a helix body shape for movement.
 - F. Some prokaryotes can move by “sliming”. (“Spitting” out a layer of mucous in front of them to slide on.)

- IV. **Taxis** - refers to movement in *response to a stimulus*. (These terms could be used with *any* organism.)
 - A. (+) indicates movement “toward”; (-) indicates movement “away”.
 - B. The prefix tells the type of stimulus. (photo-light; geo-gravity; rheo-current; chemo-chemical)

- V. Bacterial Genome
 - A. A prokaryote genome is about 1/1000th the amount of a Eukaryotic cell genome.
 - B. It consists of a single *circular* strand located in the nucleoid region. (It is not *linear*, like in Eukaryotes.)
 - C. The Domain Archaea have histones to help DNA coil up; the Domain Bacteria do not have histones.
 1. More evidence for *common ancestry with Eukaryotes*, which also have histones.
 - D. Prokaryotes also have plasmids for exchanging. (Most plasmids contain resistance information.)
Please briefly remind students of the process of DNA recombination in the process of cloning.

- VI. Bacterial reproduction is accomplished by the process of **Binary Fission** to create clones. (It is asexual reproduction.)
 - A. It is like Mitosis, except there is no G2 phase or Mitosis phases... just G1, S, and cytokinesis.

- VII. Means of Nutrition (feeding)
 - A. **Saprobies** - The eating of dead material. (These are decomposers.)
 - B. **Parasites** - These harm other organisms.
 - C. **Nitrogen Fixation** - Feeding on Ammonia– NH₃ make Ammonium – NH₄.
 - D. **Nitrification** - Feeding on Ammonium and producing Nitrite – NO₂ as waste **OR** feeding on NO₂ and producing Nitrate – NO₃ as waste.
 - E. **Photosynthesis** - Using sunlight energy, CO₂, and H₂O to make sugar.
 - F. **Chemosynthesis** - Using Hydrogen Sulfide – H₂S for energy instead of sunlight energy in making sugars.
 - G. **Heterotroph** - Feeding on another organism.
Please help students “see” the terms.

Part 2

- I. Oxygen Demands (These terms can be used with other organism too.)
 - a. **Obligate Aerobes** - These must intake oxygen to utilize their primary source of energy. (“Obligate” means “must”; “Aerobe” means “with oxygen”.)
 - b. **Facultative Anaerobes** - These organisms can be both. They can “function” with or without oxygen.
 - c. **Obligate Anaerobes** - These must be *without oxygen*. (They die in the presence of oxygen.)
Please help students “see” the terms.

- II. Terms used with Archaea (extremophiles) with regards to their living environments:
 - A. **Methanogens** - Produce Methane gas – CH₄. These are mainly associated with ruminants. (Animals with a rumen as part of the “stomach”.), Swamps, waste disposal, and trash dumps also produce methane. You have them too... living in your large intestine. These are the organisms that cause us to release gas or “fart”.
 - B. **Halophiles** - These are salt lovers. (“halo” means “salt”; “phile” means “lover of”.) These bacteria are associated with places like the Dead Sea in Israel or Great Salt Lakes of Utah.
 - C. **Thermophiles** - These are heat lovers. (These bacteria are found in hot springs or volcanoes.)
Please help students to “see” the terms.

- III. Ecological Impact of Bacteria
 - A. They are *important recyclers of nutrients*. (They are **decomposers/saprobies**.)
 - B. Some can perform *Nitrogen Fixation* that makes Nitrogen available for plants → animals eat the plants.

- IV. Symbiotic Relationships with Bacteria
 - A. Three types of relationships can exist:
 1. **Mutualism** (+;+) *Both* organisms benefit.) (For example, E. Coli in the intestines of most animals. They help with reabsorbing water from the process of digestion.)
 2. **Commensalism** (+; 0) *Only one* organism benefits) (These are rare.)
 3. **Parasitism** (- ; +) One organism is *harmed* and the other organism benefits.) (For example, Strep Throat in humans.)

- V. Pathogenic Bacteria (Disease causing)
 - A. These prokaryotes account for more than half of all non- genetic diseases in humans.
 - B. **Opportunists** (such as streptococcus) become a problem when the body is busy fighting something else, such as a cold virus. (They see an *opportunity* to reproduce and take over.)
 - C. **Exotoxins** – These are secreted proteins that cause disease. (These are mostly Gram + bacteria.)
 - D. **Endotoxins** – Proteins of the capsule/membrane/cell wall. (These are mostly Gram – bacteria.)
 - E. **Antibiotics** – These are substances that kill bacteria. (They usually end with “mycin”.) (The name means “*substance against life*”.)

- VI. **Bioremediation** – This term refers to cleaning up the environment using living organisms.