

Diversity of Prokaryotes and Viruses - Chapter 19

The good, the bad, and the ugly

Outline

Which organisms are members of the Bacteria and Archaea Domains?

How do Prokaryotes survive and reproduce?

How do Prokaryotes affect us and other organisms?

Viruses, Viroids, and Prions, what are they?

Interesting facts:

Did you know that you are home to **trillions** of prokaryotes??

In terms of **abundance**, prokaryotes rule as Earth's predominant form of life.

Life on Earth was solely prokaryotic for the first **1.5 billion years**.

The prokaryotic domains (Bacteria and Archaea) were the first organisms and arose on earth (about 3.5 billion years ago).

While only about 5000 prokaryotic species have been described, there may be as many 500,000 - 5,000,000

Prokaryotes range in size from 0.2-1.0 micrometers in diameter (see fig 19-10).

How big (or small) is a micrometer? 1/1,000,000 of a meter. But just how small is that? The thickness of a dime is about 1 millimeter (1000 micrometers).

The two domains appear similar in many respects however they are different in some very basic ways.

One main distinction between the Bacteria and the Archaea is that the cell walls of Bacteria contain peptidoglycan (Archaea do not)

This bacterial cell wall is composed of peptidoglycan

Peptidoglycan is a complex of structural polysaccharides cross-linked by peptides

How to identify clades of prokaryotes?

Shape

Locomotion

Pigments

Nutrients required

Staining properties

The cell wall of a bacteria gives it the different types of characteristic shapes (See fig. 19-1)

Round = coccus

Bacillus = rod shaped

Spirillum = spirals

The peptidoglycan cell wall of bacteria can be stained by a specific stain known as a **Gram stain** (named for Hans Christian Gram, a Danish physician)

The Domain Bacteria can be divided into two groups based on the ability to be stained with Gram stain.

Gram positive bacteria have the cell wall exposed to the environment.

Some bacteria are not stained by Gram stain (Gram negative bacteria). These bacteria still have a peptidoglycan cell wall, but they also have an extra outer membrane.

Compared with gram-positive bacteria, **gram-negative bacteria are more resistant against antibiotics**, despite their thinner peptidoglycan layer, because of their additional, relatively impermeable cell wall.

About half the bacterial species are capable of motion using rotating flagella (See 19-2a).

-flagella (singular flagellum) are filaments that extend from the membrane of a cell and are used for **cellular locomotion**

The anchor of the bacterial flagellum is an "axle-and-wheel" arrangement which allows the flagellum to rotate like a propeller.

Prokaryotes with flagella exhibit either very little movement or random movement when in a **uniform environment**.

However, in a heterogeneous environment mobile bacteria demonstrate a behavior known as **taxis**.

-taxis is the orientation or movement of an organism either toward or away from a stimulus.

If its toward the stimulus = **positive taxis**

If its away from the stimulus = **negative taxis**

3 main types of taxis in prokaryotes:

Chemotaxis - movement toward (food) or away from (toxic substance) a **chemical stimulus**.

Phototaxis - movement toward or away from **light**.

Magnetotaxis - movement toward or away from the **Earth's magnetic field**.

All require that the organism have the ability to sense the stimulus. The sensors are usually in the cell membrane.

A slime layer surrounds the cell walls of some prokaryotes and functions **to attach the prokaryote to a surface** and may also act as **protective covering** (see fig 19-3).

Slime layer is made up of polysaccharide or protein. Sometimes these bacteria aggregate to form biofilms. This biofilm is dental plaque, the cause of tooth decay.

Another way that bacteria attach themselves to a surface (e.g., a host-cell or another bacterium) via **pili** (singular pilus).

-pili are hair-like structures on the surface of certain bacteria that aid in attachment.

Some prokaryotes, especially the bacilli, can form a protective **endospore** in response to harsh environmental conditions.

-endospores are protective "resting" structures in which the bacterial chromosome is surrounded by a durable wall. (See fig 19-4)

Prokaryotes have evolved to live in **almost every possible environment condition** found on Earth including some very **extreme** conditions.

While the range of conditions that the domains bacteria and archaea can live in is large, the conditions a **single species requires may be very specific**.

Prokaryotes occupy many diverse habitats however some of the most extreme environments are the realms of the **Archaea**. Some examples include:

Halophiles (**salt loving**) that inhabit the extremely salty Dead Sea and Great Salt Lake.

Thermophiles (**heat loving**), including thermoacidophiles, which live in acidic hot springs or in the hot (105° C) water surrounding deep-sea volcanic vents.

Yellowstone National Park's hot springs

Other autotrophic prokaryotics, like cyanobacteria, obtain their energy from sunlight via photosynthesis (see fig 19-6).

There are also heterotrophic prokaryotes that must have an organic food source for either their energy or their carbon source.

Chemosynthesis – some prokaryotes grow using their autotrophic methods and derive their energy from inorganic chemicals