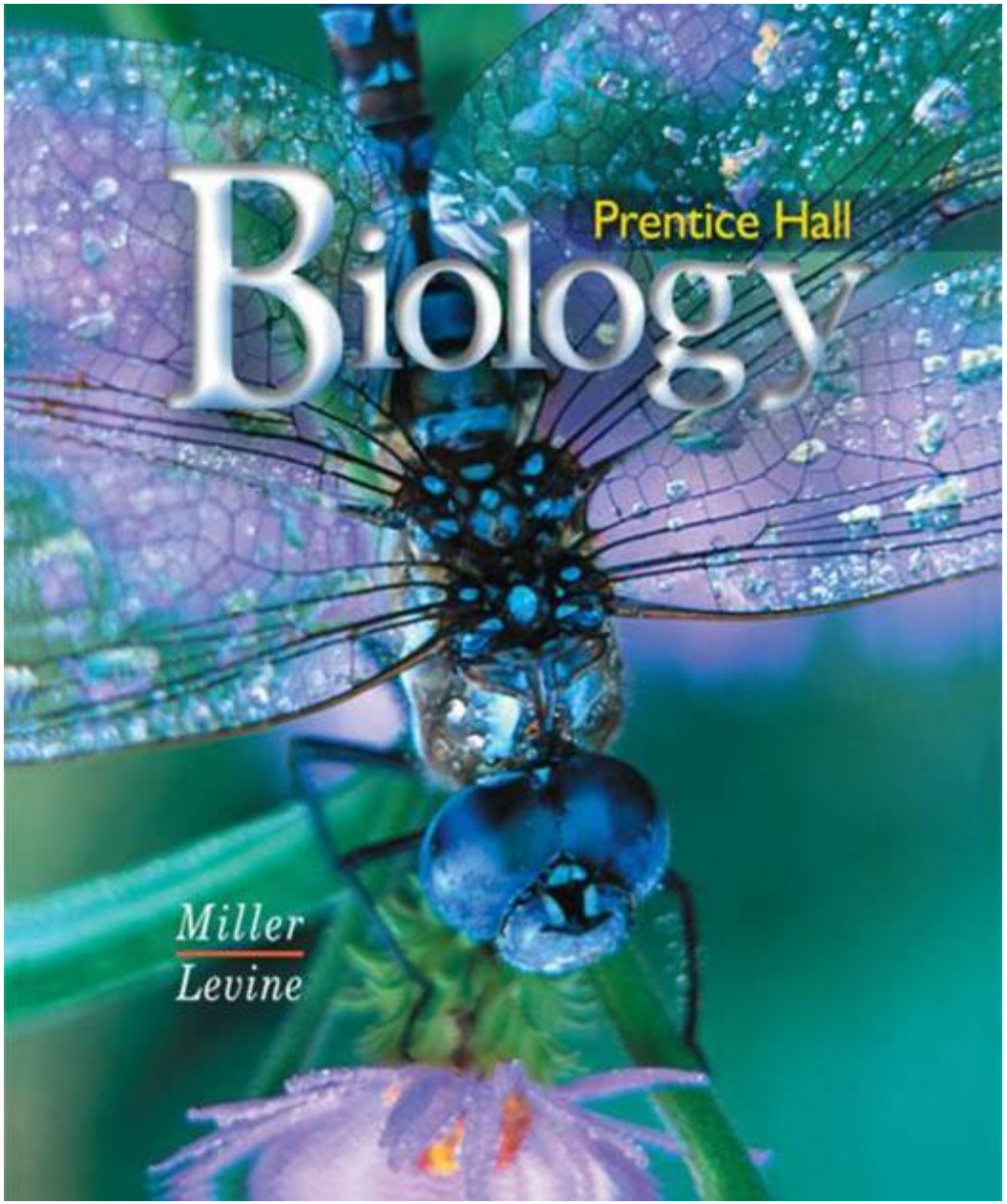
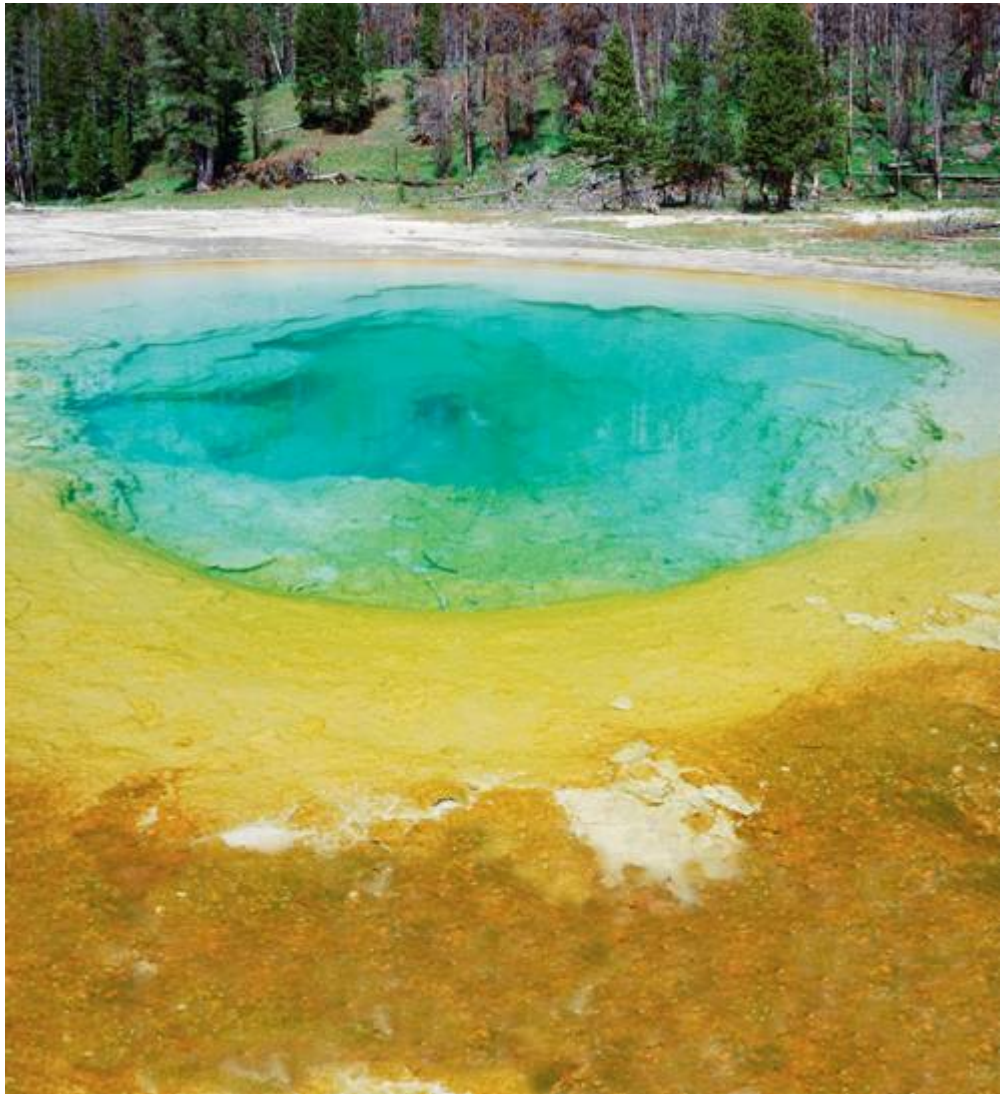


19–1 Bacteria (p471-477)



Microorganisms = Microbes

Microbiology is the study of living creatures too small to see with the unaided eye including :

- **bacteria**
- **protozoa**
- **fungi**
- **algae**
- **viruses**
- other miniature creatures.

Why study Microbiology?

1. Microbes are an essential component of an ecosystem - especially as saprophytes and their role in nutrient recycling.

2. We use them to produce pharmaceuticals, clean up hazardous waste and to make food products - like cheese, yoghurt, alcohol and breads.

3. Microbes can wreak havoc on all creatures by invading them and causing disturbance and infection.

Understanding microbes is vital to life on earth

Examples of microbe uses

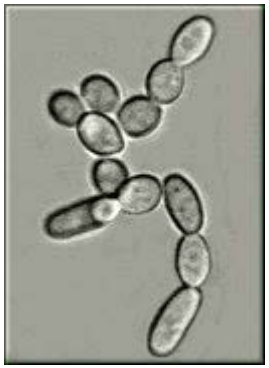
Fungi:

1. *Saccharmyces* cerevisiae - yeast - used in bread, beer and wine-making.

2. *Saccharmyces carisbergensis* - yeast - used to make beer.

3. *Saccharmyces rouxii* - yeast - used to make soy sauce.

4. *Penicillium roqueforti* - fungi - used to make roquefort cheese.



Examples of microbe uses bacterium:

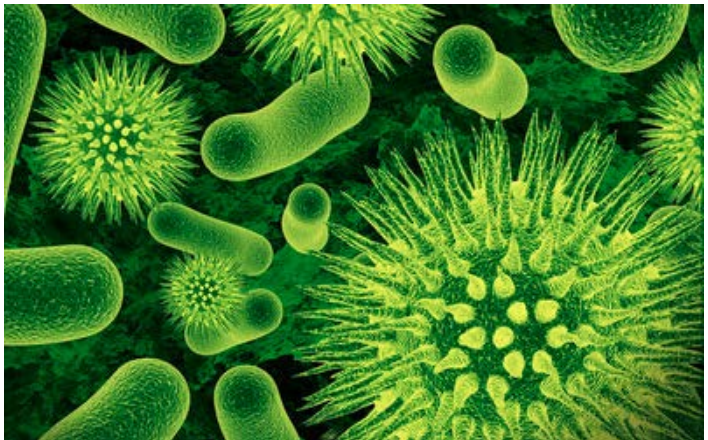
1. *Lactococcus lactis* - bacterium - producer of metabolites which kill other bacteria, especially spores from *Clostridia botulinum* which causes food poisoning. The bacterium is used in saugages when nitrate content is reduced.

2. *Leuconostoc mesenteroides* - bacterium used in the fermentation of sauerkraut.

3. *Acetobacter and Gluconbacter* - bacterium used in production of vinegar.

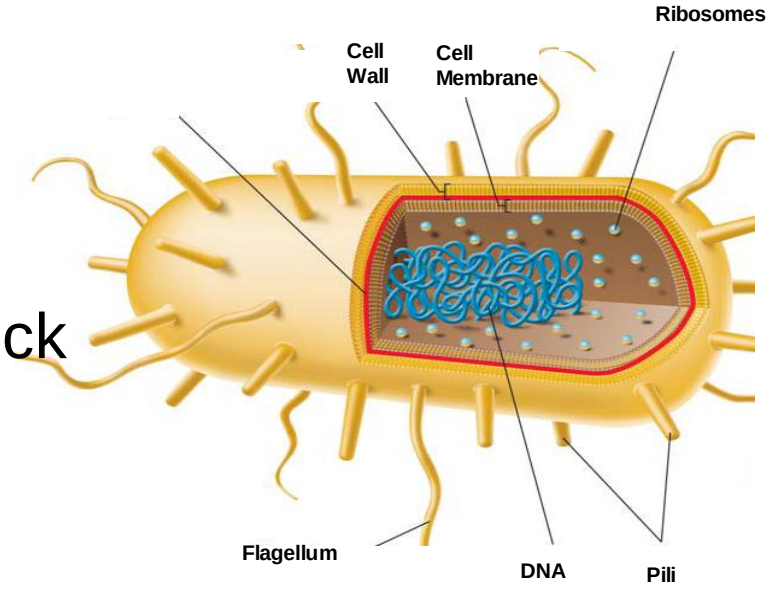
Bacteria - common word for **prokaryote**

- Unicellular organisms that **lack a nucleus**, they have a **nucloid**
- Typically range in size from 1 µm – 5 µm. However, there are bacteria cells as large as 100 µm or 0.1 mm (Note: The typical eukaryotic cell ranges in size from 10 to 100 µm and viral particles are usually smaller than 1 µm).
- Prokaryotic cell- do not have cytoplasmic organelles found in eukaryotic cells except for ribosomes.



Cell Structure (p472)

- nucleoid region (no nucleus) -genetic material - ribonucleic acid (RNA) or deoxyribonucleic acid (DNA)
- ribosomes
- cytoplasm
- cell membrane
- cell wall – one or two layers thick
- pili
- if motile – flagella
- if photosynthetic – photosynthetic pigments are found in the cell membrane

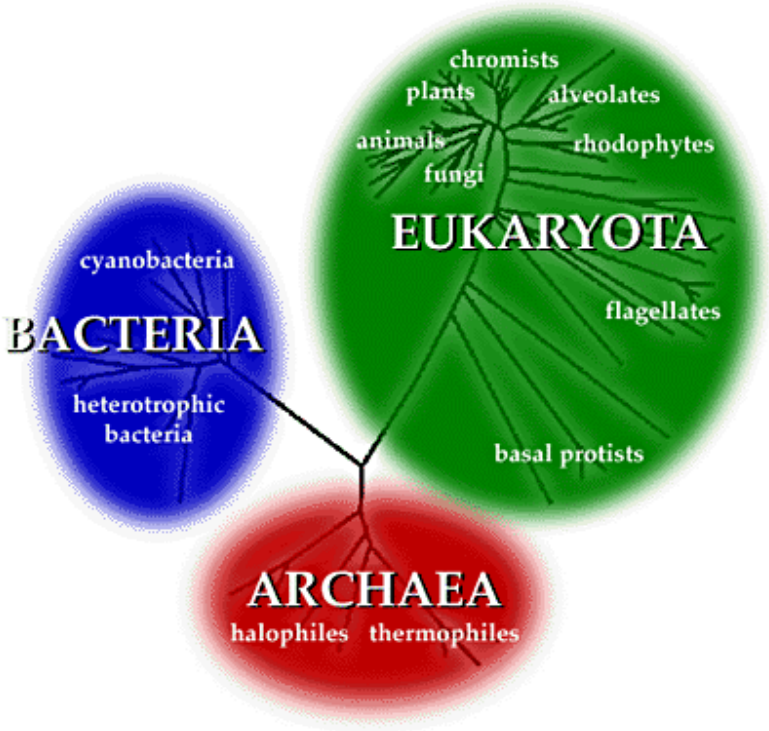


Classifying Prokaryotes

All prokaryotes were once placed in the **Kingdom Monera.**

Recently, biologists divided them into two different kingdoms:

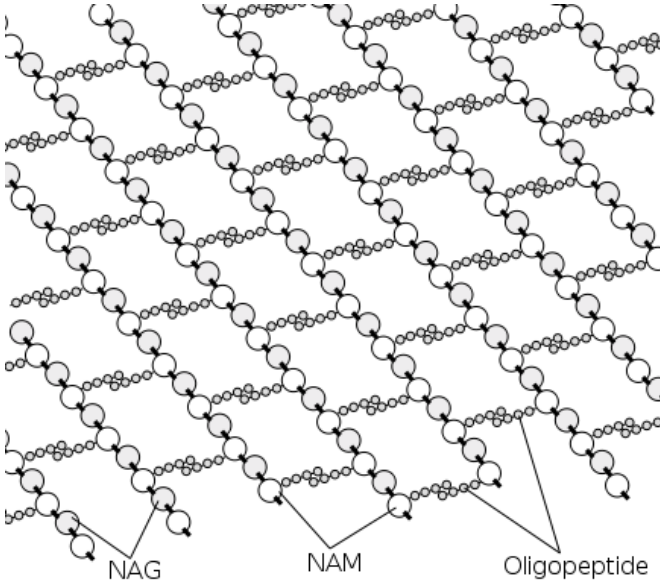
- **Eubacteria**
- **Archaebacteria**



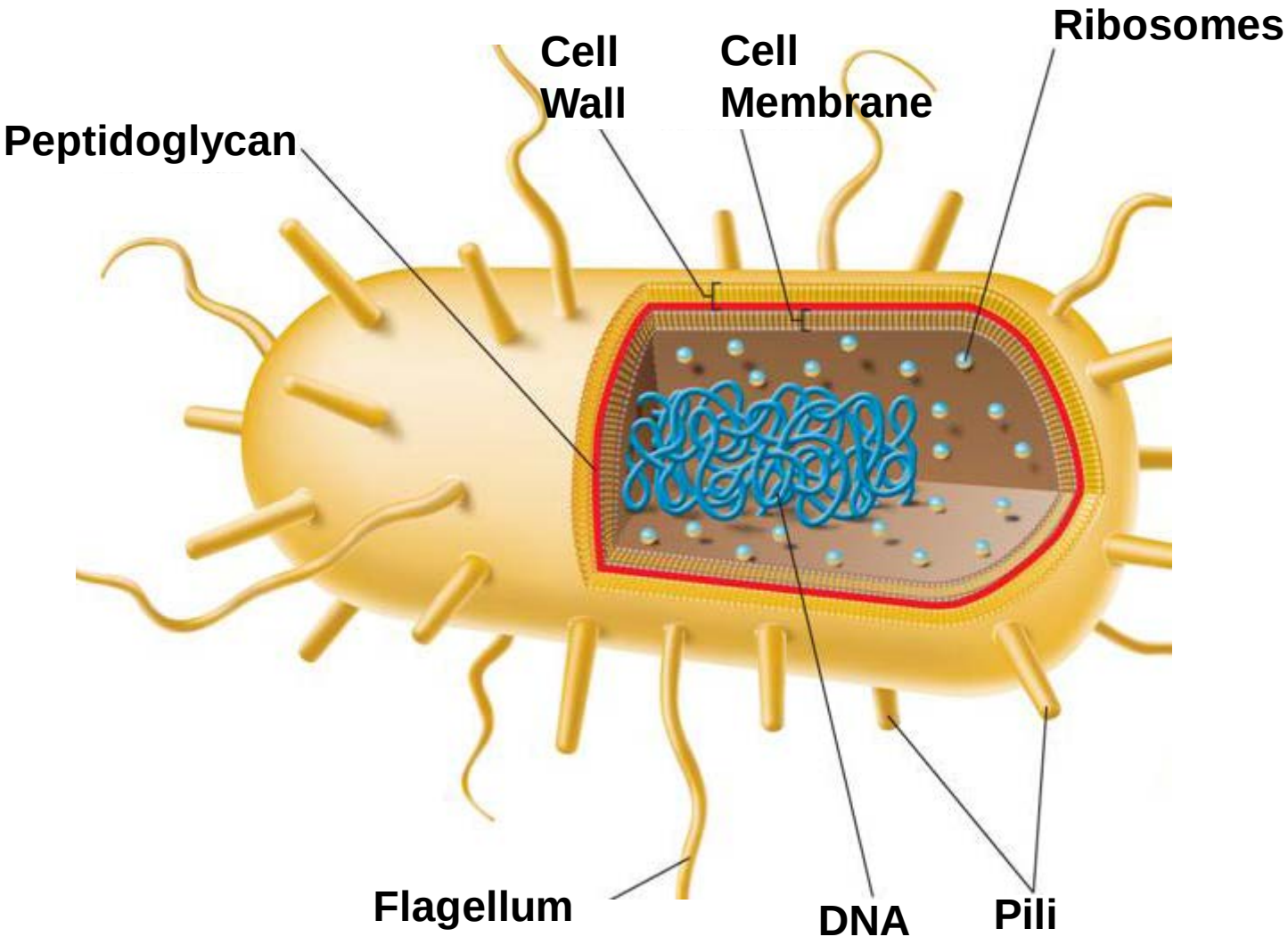
Eubacteria ("true bacteria")

Eubacteria have a cell wall that protects the cell and determines its shape.

The cell wall of eubacteria contain **peptidoglycan**.

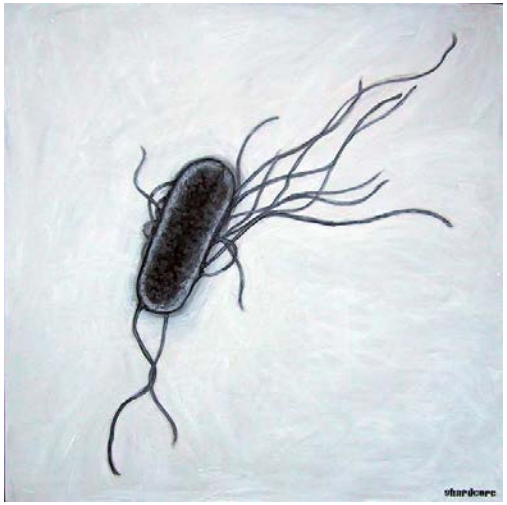


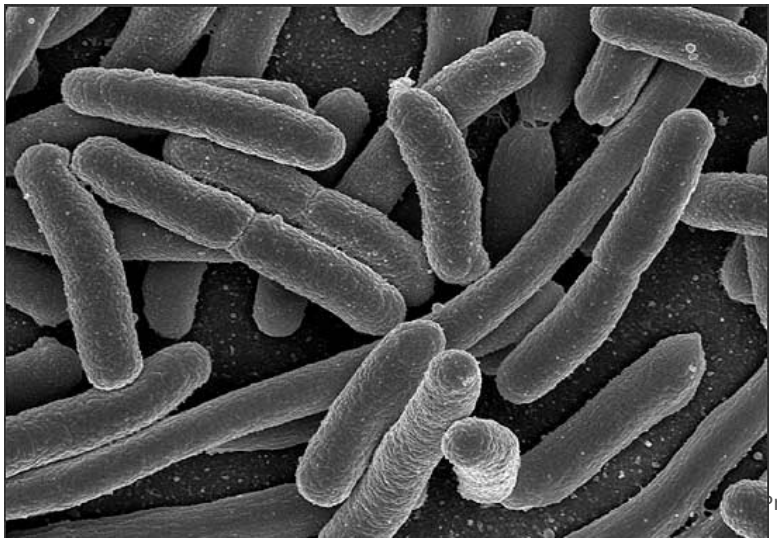
E. coli, a Typical Eubacterium



Eubacteria include organisms that live in a variety of environments, including:

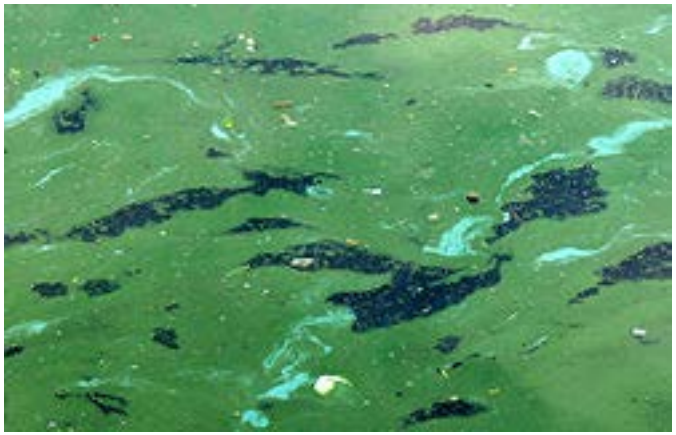
- in fresh and salt water
- on land
- in the human body





Ex. of Eubacteria

Cyanobacteria



- Blue green algae
- Photosynthetic
- Found throughout the world in different environments
- Fresh water, salt water, on land, hotsprings, in the Artic.

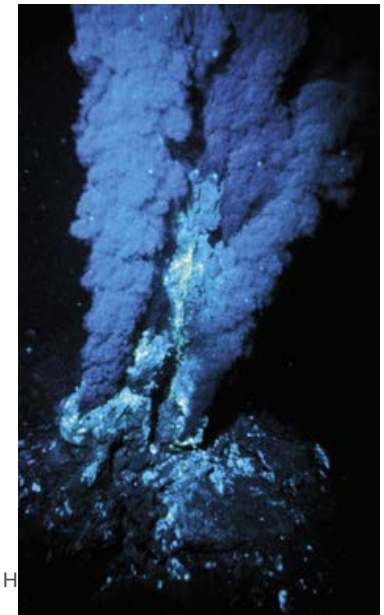
Archaebacteria

The cells walls of archaebacteria **do not contain** peptidoglycan.

In addition, the DNA sequences of key archaebacterial **genes** are **more like** those of **eukaryotes** than those of eubacteria.

Many archaebacteria live in extreme environments.

- **Methanogens** live in oxygen-free environments, such as thick mud and animal digestive tracts.
- Other archaebacteria live in salty environments or in hot springs where water temperatures approach the boiling point.



Identifying Prokaryotes

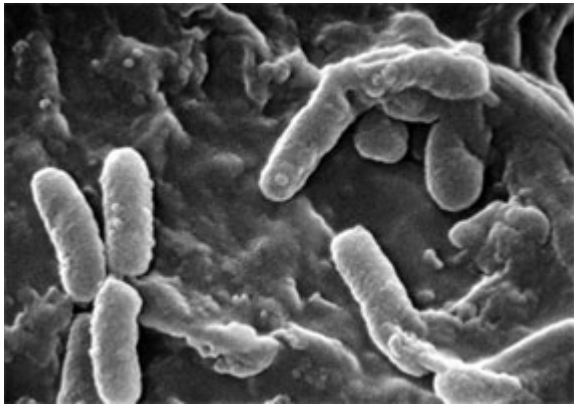
Prokaryotes are identified by characteristics such as:

- **shape**
- **the chemical nature of their cell walls**
- **the way they move**
- **the way they obtain energy**

Shapes

Rod-shaped prokaryotes are called **bacilli**.

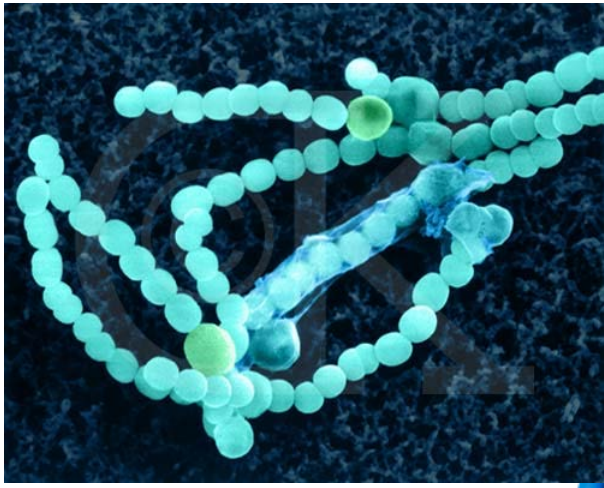
Bacilli



ex. *E. Coli*

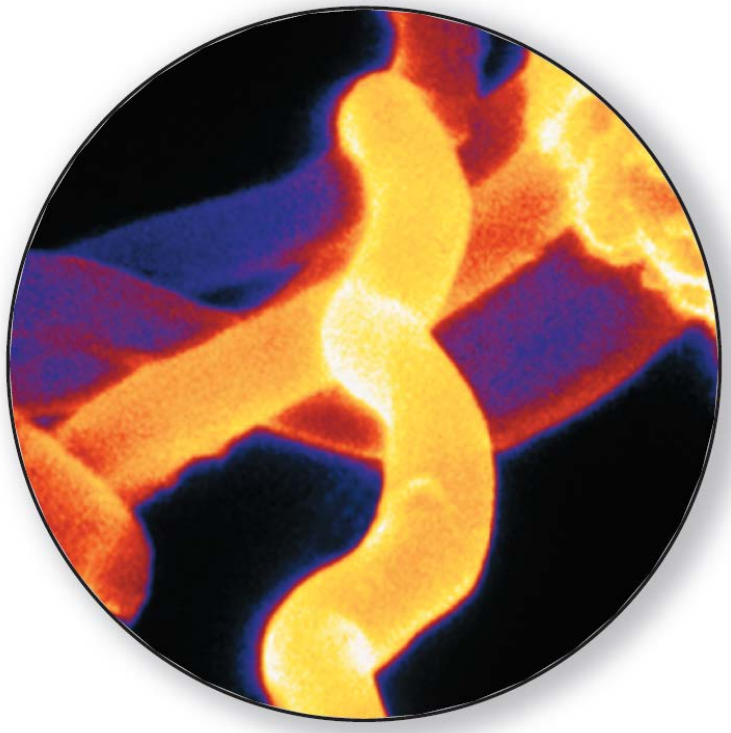
Spherical prokaryotes are called **cocci**.

Cocci



ex. *Streptococcus*
Pneumococcus

Spiral and corkscrew-shaped prokaryotes are called **spirilla**.



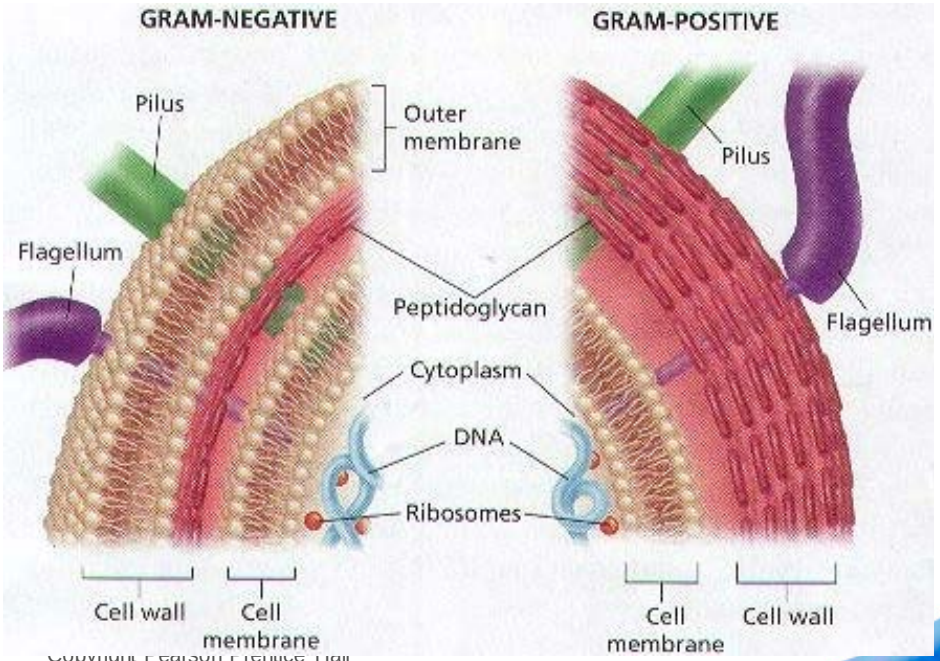
Spirilla

Cell Walls

Two different types of cell walls are found in eubacteria.

Gram-positive bacteria have thick cell walls with large amounts of peptidoglycan.

Gram-negative bacteria have thinner cell walls inside an outer lipid layer.



Cell Walls

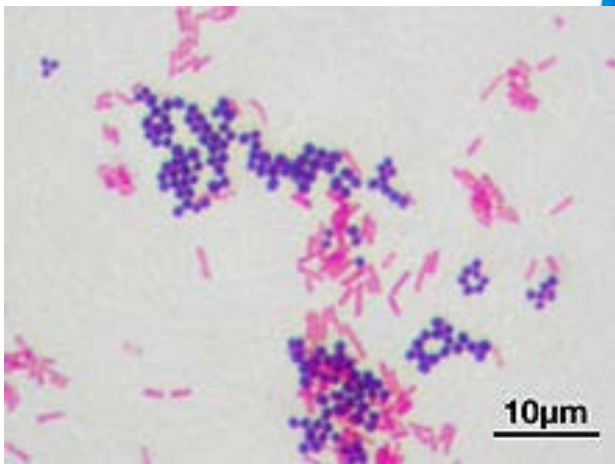
A method called **gram staining** tells them apart.

Does the bacterium take up the gram stain?

Gram stain = crystal violet and saphrine. Either the violet or the red dye is taken up but not both.

a. **Gram +ve bacteria**: look purple under the microscope. B have only one layer of cell wall.

b. **Gram –ve bacteria**: look red under the microscope. B has two layers of cell wall.



Bacteria Movement

Does the bacterium move?

a. **No movement**

b. Propelled by one or more **flagella.**

c. **Spiral** or **lash forward**.

Video Bacteria Shape and Move (3min)

https://www.youtube.com/watch?v=R7WTxaGvnhU

Metabolic Diversity (p473-474)

How Do Bacteria Obtain Energy?

Prokaryotes are divided into two main groups:

1. **Heterotrophs** get their energy by consuming organic molecules made by other organisms.

   1.a) **Photoheterotrophs**

   These organisms are photosynthetic, using sunlight for energy, but they also need to take in organic compounds as a carbon source.

   1.b) **Chemoheterotrophs**

   - Most heterotrophic prokaryotes must take in organic molecules for both energy and a supply of carbon.

Metabolic Diversity (p473-474)

How Do Bacteria Obtain Energy?

Prokaryotes are divided into two main groups:

2. Autotrophs make their own food from inorganic molecules.

2.a) **Phototrophic autotrophs** (ex. Cyanobacteria)

Use light energy to convert carbon dioxide and water to carbon compounds and oxygen in a process similar to that used by green plants. These organisms are found where light is plentiful, such as near the surfaces of lakes, streams, and oceans.

Metabolic Diversity (p473-474)

How Do Bacteria Obtain Energy?

Prokaryotes are divided into two main groups:

2. Autotrophs make their own food from inorganic molecules.

2.b) **Chemitrophic autotrophs**

Like photoautotrophs, chemoautotrophs make organic carbon molecules from carbon dioxide. Unlike photoautotrophs, however, they do not require light as a source of energy. Instead, they use energy directly from chemical reactions involving ammonia, hydrogen sulfide, nitrites, sulfur, or iron. Some chemoautotrophs live deep in the darkness of the ocean.

Releasing Energy

Respiration in general: All organisms need a constant supply of energy to perform alltheir life activities. The energy (adenosine triphosphate) is supplied by the process of cellular respiration or fermentation.

1. Cellular Respiration (Aerobic Respiration)
   -requires oxygen and sugar.
   -end product: carbon dioxide and water.

$C H O + O \rightarrow C O + H O + ATP$

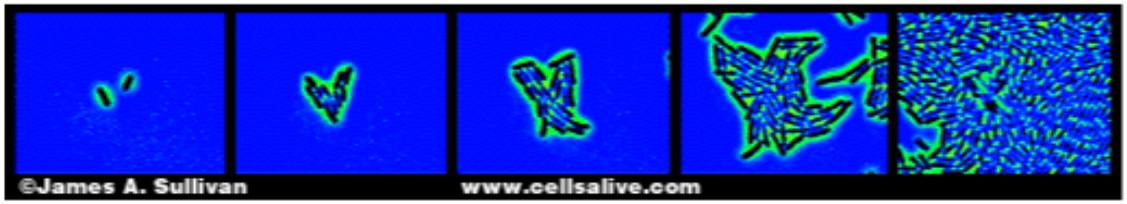
2. Fermentation (Anaerobic Respiration)
   -involves the formation of ATP in the absence of oxygen

$C H O \rightarrow C O + H O + ATP$

Bacterial Respiration

- **Obligate aerobes** require a constant supply of oxygen.
- Bacteria that live without oxygen because they may be killed by it are called **obligate anaerobes.**
- Bacteria that can survive with or without oxygen are known as **facultative anaerobes.**

Reproduction



Binary Fission (asexual reproduction)

Binary fission is a type of asexual reproduction in which an organism replicates its DNA and divides in half, producing **two identical daughter cells (clones)**.

- Bacterial cells divide every 20 minutes.
- Bacterial cells live in colonies. These colonies may be spherical in shape or rod-like in shape.
- Each cell in a colony is a clone of the original bacterium that started the colony.
- Genetic variation only arises through genetic mutation.

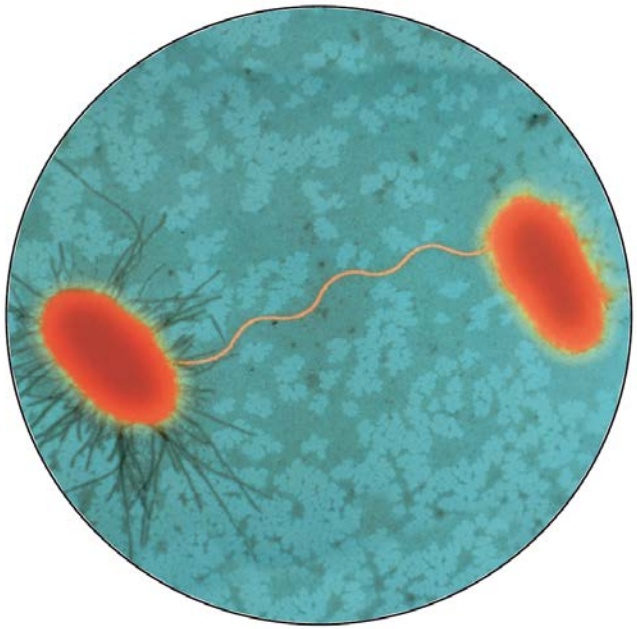
Video Bacteria division (binary fission) (8sec)

- https://www.youtube.com/watch?v=4grQSLmWXQk

Conjugation (sexual reproduction) (p368)

During **conjugation**, a **hollow bridge** forms between two bacterial cells, and genes move from one cell to the other.

Each cell ends of with a **different set of genetic material** than before conjugation.



Conjugation
(magnification: 7000×)

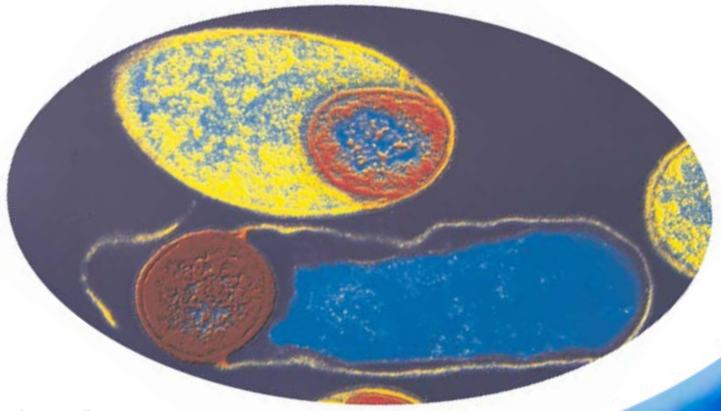
Spore Formation

(not a real form of reproduction!)

In unfavorable growth conditions, many bacteria form **spores**.

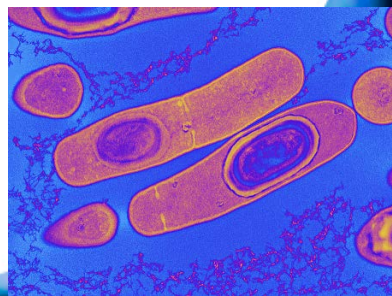
An **endospore** forms when a bacterium produces a thick internal wall that encloses its DNA and some of its cytoplasm.

Spores can remain for months or even years while waiting for more favorable growth conditions.



Unusual Lifestyles

- Cold tolerant bacteria - *Psychrophiles*
- Salt tolerant - *Halophiles* - can live in water with up to 20% salinity (our body fluids: 0.9% salinity)
- Hot temperature tolerant - *thermoacidophiles* - tolerate temperatures of up to 80 C and also tolerate low pH 1 - 4 (acidic). Found in geysers and hot springs.
- Spore formers - bacterium like *Clostridium* under extreme conditions will change form into an endospore - as an endospore - the bacterium can tolerate excessive heat/cold. They are resistant to extreme conditions b/c of the endospores thick cell wall.



Importance of Bacteria (p476-477)

Bacteria are vital to the living world.

- Some are **producers** that capture energy by photosynthesis.
- **Nitrogen fixers** change chemically nitrogen gas into ammonia or other nitrogen compounds, usable by plants. Many plants have symbiotic relationships with nitrogen-fixing bacteria in their roots.
- Others are **decomposers** that break down the nutrients in dead matter (**saprophytes**).
- Still other bacteria have human uses.

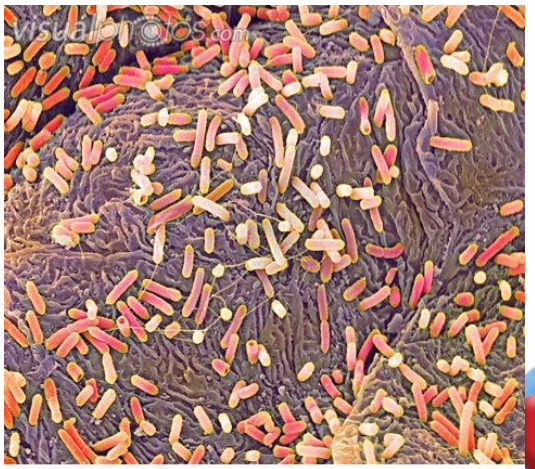
Importance of Bacteria (p476-477)

Bacteria are vital to the living world.

- Cattle can only digest grass b/c of the bacteria in their digestive tracts. Without these bacteria no vertebrate can digest grass or hay
- Many bacteria recycle and decompose dead material.
- Bacteria can be found in any habitats.
- All organisms on earth are dependent on nitrogen fixing bacteria.
- Sewage decomposition - bacteria are added to sewage to break it down.

Human Uses of Bacteria

- Used in the production of foods/beverages.
- Used in industry-digest petroleum, waste management, mining, synthesizing drugs/chem
- Used in our bodies - required for digestion, absorption of nutrients.
- synthesis of drugs and chemicals via genetic engineering
- production of vitamins in human intestines



E. coli bacteria in digestive system, coloured SEM

Only few Bacteria cause Harm

Will be covered in Chapter 19-3

19–1 Section QUIZ

Continue to:

Section QUIZ

- or -

Click to Launch:

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End Show

1 Which characteristic distinguishes eubacteria from archaebacteria?

a. Eubacteria lack peptidoglycan in their cell walls.

b. Eubacteria contain peptidoglycan in their cell walls.

c. Eubacteria lack a nucleus.

d. Eubacteria do not possess mitochondria.

2 Rod-shaped prokaryotes are called

a. bacilli.

b. cocci.

c. spirilla.

d. streptococci.

3 Bacteria that must live without oxygen are called

a. obligate aerobes.

b. facultative anaerobes.

c. obligate anaerobes.

d. facultative aerobes.

4 Prokaryotes that make their own food molecules from carbon dioxide and water but live where there is no light are called

a. photoautotrophs.

b. photoheterotrophs.

c. chemoautotrophs.

d. chemoheterotrophs.

5 Bacteria that attack and digest the tissue of dead organisms are called

a. decomposers.

b. nitrogen fixers.

c. chemoautotrophs.

d. archaebacteria.

END OF SECTION