Unit 1 Lecture 2

Bacterial Morphology

Characteristics of Life

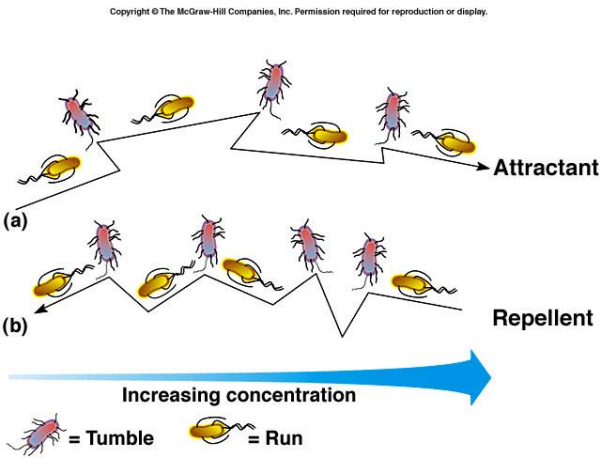
For an organism to be alive it must possess the following properties:

- Heredity: the transmission of an organism's genome
- Reproduction: the ability of an organism to pass on its genetic material to its offspring
- Growth: the ability to increase in size and in number of cells
- Development: includes all aspects of change over the life of the organism
- Metabolism: includes all of the chemical reactions that occur within the cells whether they are breakdown or synthesis reactions
- Responsiveness: is the capacity to interact with its environment

Structure of Typical Bacterial Cells

Bacteria are very tiny. Their cell size usually ranges from 0.5µ - 1.0µ by 1.0µ - 1.5µ. There are basically two distinct areas of the cell, the area outside the cell membrane and the area within the cell membrane. The area outside the cell membrane is discussed first.

Flagella are special structures that are long extensions of the protoplast used for motility toward desirable substrate or away from harmful substrate. This special movement is known as **chemotaxis**. Special stains are needed to coat the flagella to make them visible. Bacteria exhibit different types of flagella. Flagella stains are sometimes used to help in the identification of the microbe. If there are no flagella present, it is referred to as **atrichous**. If a bacterium possesses only single flagella at one end, it is describe as being **monotrichous**. A flagellum at opposite ends of the cell is defined as **amphitrichous** and a tuft of flagella at one end is known as **lophothrichous**. Flagella emitting from all surfaces are referred to as being **peritrichous**. Periplasmic flagella are internal flagella found in spirochetes.



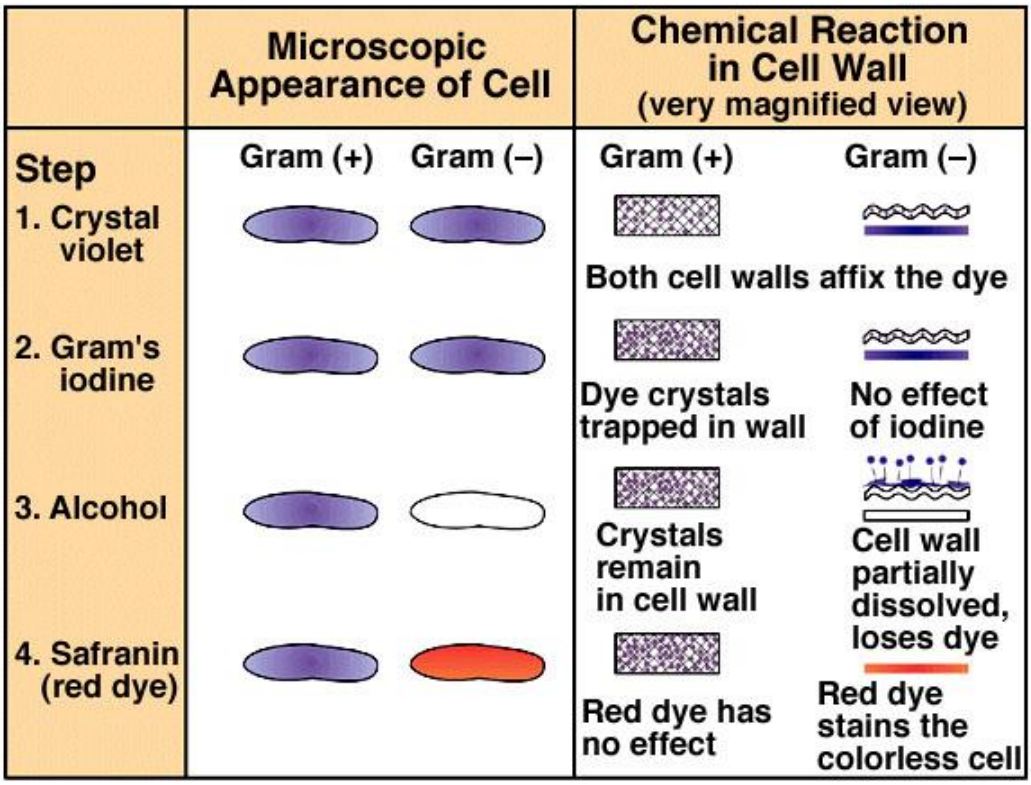
Another projection outside of the cell is **Fimbriae**. These are filamentous, hollow appendages that are used to grip surfaces (adhesion). If a bacterial strain does not have fimbriae it will be much less pathogenic because it

cannot attach to a cell. Fimbriae are visible only with the electron microscope and found only in gram negative cells.

Pili are also filamentous, hollow appendages. However they are used to exchange DNA (sex pili). More will be said about these structures later. They are also only visible only with the electron microscope

The cellular envelope is a non-living structure surrounding the protoplast. Primarily it is the **cell wall**. The main function is protective. It isolates cell membrane from the environment, resists osmotic destruction, and helps regulate the passage of large molecules. Depending on whether the cell is gram positive or gram negative it is composed of different amounts of peptidoglycan, teichoic acid (holds colonies together), polysaccharide complex that takes the place of cellulose and gives strength to the wall, and lipids (restrict water soluble chemicals).

The gram stain is one of the most important tools a microbiologist uses in the identification of a microorganism. Below is the Gram Stain procedure and the reactions that accompany the steps.



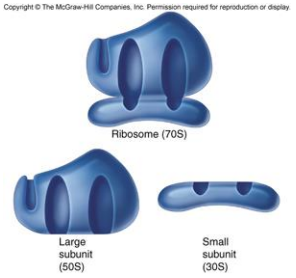
Another structure located outside the cell wall is a non-living layer called the **Glycocalyx**. It requires a special stain to see and includes the capsule or the

slime layer. Their function is to resist phaegocytosis, promote adhesion, and prevent dehydration. It also receives signals from the environment and passes those signals into the cell.

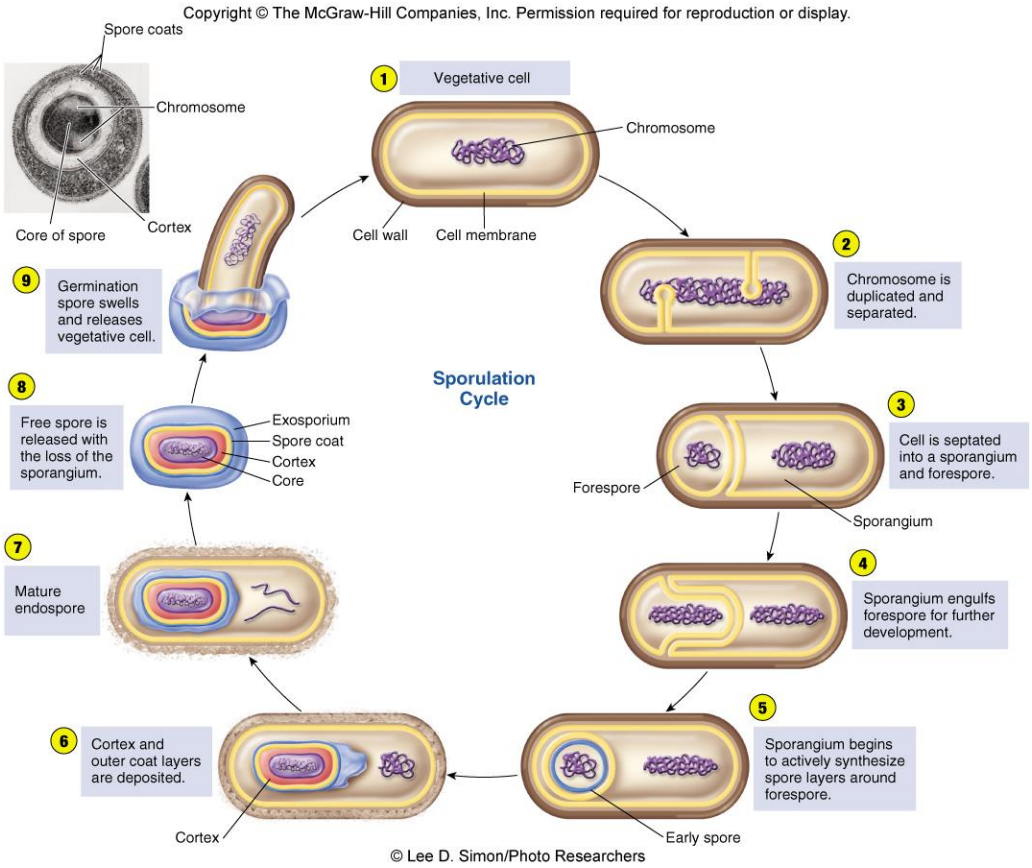
The interior of the cell is called the protoplast. Starting just inside of the cell wall is the **cell membrane** (the outermost living component). The cell membrane is composed of a phospholipid bilayer and fluid mosaic proteins. Its function is to regulate materials entering and leaving cell, synthesize lipids, synthesize the cell wall and capsule, and in some cases photosynthesis. An invagination of excess cell membrane is called a **mesosome**. Mesosomes are responsible for cellular respiration and participation in the reproduction of DNA.

A very important component within the cell is the **DNA** present. DNA permits change in new environments. There are a number of ways DNA is stored within the cell. DNA is found in the **nucleoid**, the **chromosome**, or **chromatoid body**. This DNA is required for cellular reproduction and metabolism. The chromosome is a large, non-descript circular entity. Any living organism requires for genetic continuity and metabolism regulation. A small circular piece of DNA that is not required for reproduction or metabolism is a **plasmid**. Plasmids are very important in the transfer of resistance genes.

Ribosomes are responsible for protein synthesis. They are very tiny structures [70S instead of 80S (Svedberg units)].



Granules are inclusion bodies or storage bodies. In the granules chemicals accumulated by the cell, associated with energy needs. A couple of examples are metachromatic granules and sulfur granules.



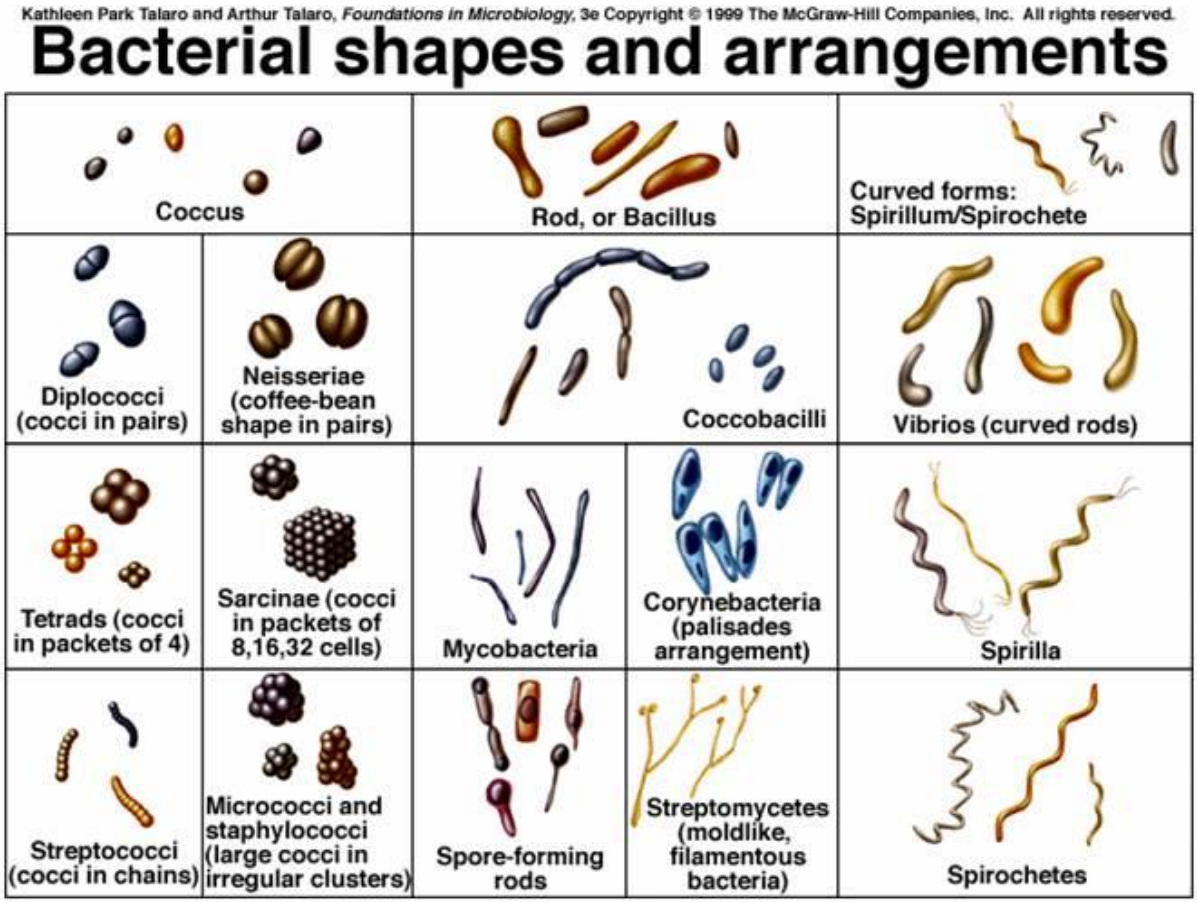
The final structure found in the cell is the **endospore**. It is a cellular resting stage that protects the cell in unfavorable conditions. Endospores are resistant to heat, desiccation, freezing, radiation, and chemicals. They are long-lasting (recently, spores thousands of years old were revitalized). There are not reproductive in nature. They are dehydrated to suspend animation. Their location (terminal, central, and subterminal) in the cell can help in the identification of the organism. Their shape is round to oval and their size: varies from same size as bacteria to larger than bacteria. There are only two genera of bacteria that we will discuss that possess spores (*Bacillus* and *Clostridium*).

Bacterial Shapes and Arrangements

Cocci (sing. coccus) are tiny spheres. If they are paired, they are called diplococci; if in chains, they are called streptococci; if in a packet of four cells, it is a Tetrad while packets of 8, 16, and 32 are called Sarcinae. Micrococci and staphylococci form irregular clusters.

Bacillus (pl. bacilli) is a rod shaped bacteria, usually single, but can also produce regular arrangements. Special formations include pairs of bacilli (diplobacilli), chains of bacilli (streptobacilli), and chains of rods attached side-by-side (palisade) like a picket fence. Other definitions of bacilli concern their size: coccobacilli are very short bacilli; fusiform bacilli are long and

slender with pointed ends; vibrios are slightly curved rods; and pleomorphic bacilli have various rod shapes and lengths.



Spiral forms are always singles unless reproducing and include two forms, the Spirillum, which has a rigid axis when moving and the spirochetes which have a flexible axis when moving.

The planes of division determine the colonial arrangements. One plane of division yields diplo- strepto- or palisade arrangement. Two planes of division yields tetrads. Three planes of division yield staphylococci or Sarcina.

Unusual prokaryotes are the *Rickettsia*, a gram negative, pleomorphic coccobacilli or diplobacillus. *Rickettsia*s are stained with an intracellular stain. They can be grown on living media (obligate intracellular parasite) such as embryonated eggs, small laboratory animals, and in tissue culture. Another obligate intracellular parasite is the *Chlamydia*. They are also gram negative, need to be stained with intracellular stain, and require living media to grow.

History

Procaryotes first appeared about three and one half billion years ago. The **Archaea** are the most primitive of the prokaryotes. While it is thought that the true bacteria evolved from them, some strains still exist today in the

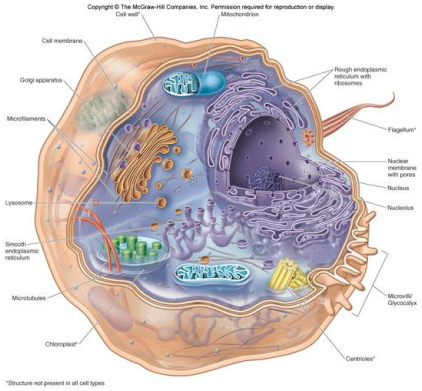
harshest environments on this planet in such places as volcanic vents, swamps and hot springs. Because they live in these extreme environments they are also called **Extremophiles**. Modern humans, on the other hand, have only been around less than 50,000 years, give or take a few years. This poses two very important questions for all living organisms:

1. What is the meaning of Life?
2. What are bacteria going to do to ensure that their answer to question one is in the affirmative for themselves?

Lastly, it is through the metabolism of microbes in an anaerobic environment, that a toxic byproduct of that metabolism was produced. That byproduct, oxygen, allowed eukaryotic microorganisms to evolve and develop.

Eukaryote Morphology

Eukaryotic Cells and Microorganisms



The internal structures of eukaryotic cells differ from prokaryotes. First, there is the **Nucleus** that contains genetic information. It is separated from cytoplasm by a porous nuclear membrane. The nucleus contains both DNA and RNA. Chromosomes can either be haploid or diploid, which means that mitosis is method of cellular reproduction. If chromosomes are diploid, meiosis is method of organism reproduction. This is the most important difference between eukaryotes and prokaryotes. The other main difference is that eukaryotes possess organelles.

The **Endoplasmic reticulum** (ER) can be either smooth or rough. ER functions in the transport of materials from nucleus to cytoplasm

A **Golgi apparatus** functions in nutrient processing, similar to that of ER.

Mitochondria are the energy generators of the cell.

Chloroplasts are photosynthesis machines but since they are found in plants and algae, we will not be discussing them in this course.

Ribosomes also function in protein synthesis.

Eukaryotes first appeared about 1.5 billion years ago. They are thought to have evolved from combinations of prokaryotes. Cellular mechanisms developed by prokaryotes have allowed the eukaryotes to flourish and prosper.

External structures include cilia or flagella for locomotion and a glycocalyx that protects the cell from drying out. It also can allow adherence of cells to surfaces and serves as a receptor of signals from environment. Some eukaryotes have a cell wall for protection, shape, and support.

Although you should read the sections on mycology, protists and helminthes, I will not hold you responsible until we cover the material at a later date.