

# I. Chapter 7 Inside the Cell

- All cells have:
  - Nucleic acids that store and transmit information.
  - Proteins that perform most of the cell's vital functions.
  - Carbohydrates that provide chemical energy, carbon, support, and identity.
  - A plasma membrane, which serves as a selectively permeable membrane barrier.

## A. 7.1 Bacterial and Archaeal Cell Structures and Their Functions

- Cells are divided into two fundamental types called Eukaryotes and Prokaryotes.
- **Morphology:** the branch of biology that deals with the form of living organisms, and with relationships between their structures.
- Eukaryotic cells have a membrane-bound nucleus and prokaryotic cells do not.
- Members of Bacteria and Archaea are prokaryotic; members of the Eukarya- algae, fungi, plants, and animals- are eukaryotic.

### 1. A Revolutionary New View

- Improvements in microscopy have convinced biologists that prokaryotic cells possess an array of distinct structures and functions found among millions of species. This conclusion represents one of the most exciting discoveries in cell biology in the last 10 years.

### 2. Prokaryotic Cell Structures: A Parts List

#### a) *The Chromosome is Organized in a Nucleoid*

- **Chromosome:** A large, circular DNA molecule, associated with a small number of proteins. The most primitive structure inside a bacterial cell.
- **Genes:** segments of DNA that contain information for building functional RNAs.
- Chromosomes contain DNA, which contain genes.
- DNA uses enzymes to help form a compact, "super-coiled" structure to fit inside the cell.
- **Nucleoid:** the location and structural organization of the circular chromosome.
- In addition to one or more chromosomes, bacterial cells may contain from one to about a hundred small, usually circular, supercoiled DNA molecules called **plasmids**.
- Plasmids contain genes but are physically independent of the circular chromosome.
- Most of the time plasmids are inactive unless the cells need to adapt to unusual circumstances.

#### b) *Ribosomes Manufacture Proteins*

- Ribosomes complex structures composed of large and small subunits, each of which contains RNA and protein molecules.
- Biologists refer to ribosomes, along with other multicomponent complexes that perform specialized tasks, as "macromolecular machines."

#### c) *Photosynthetic Species have Internal Membrane Complexes*

- It is common to observe extensive internal membranes in prokaryotes that perform photosynthesis.

- Photosynthetic membranes observed in prokaryotes contain the enzymes and pigment molecules required for reactions to occur that convert the energy in sunlight to chemical energy stored in sugars and develop as infoldings of the plasma membrane.
- The extensive photosynthetic membranes increase the cell's ability to make food.

#### *d) Organelles Perform Specialized Functions*

- Recent research indicates that several bacterial species have internal compartments that qualify as organelles.
- **Organelle:** a membrane bound compartment inside the cell that contains enzymes or structures specialized for a particular function.
- Bacterial organelles perform an array of tasks including:
  - Storing calcium ions
  - Holding crystals of the mineral magnetite, which function like a compass needle to help cells sense a magnetic field and swim in a directed way
  - Organizing enzymes responsible for synthesizing complex carbon compounds from carbon dioxide
  - Sequestering enzymes that generate chemical energy from ammonium ions

#### *e) The Cytoskeleton Structures the Cell Interior*

- Bacteria and Archaea contain long, thin fibers that serve a variety of roles inside the cells.
- All bacterial species contain protein fibers that are essential for cell division to take place.
- **Cytoskeleton:** protein filaments that help maintain cell shape.

#### *f) Plasma Membrane Separates Life from Nonlife*

- All the contents of the cell, excluding the nucleus, are collectively termed the **cytoplasm**.

#### *g) The Cell Wall Forms a Protective "Exoskeleton"*

- When water enters the cell via osmosis and makes the cell's volume expand, pressure is resisted by a stiff **cell wall**.
- Bacterial and Archaeal cell walls are a tough, fibrous layer that surround the plasma membrane.
- The cell wall protects the organism and gives it shape and rigidity.
- In addition, many bacteria have another protective layer outside the cell wall that consists of a lipids with polysaccharides attached.
- Lipids that contain carbohydrate groups are termed **glycolipids**.

#### *h) External Structures Enable Movement and Attachment*

- **Flagella:** a structure assembled from 40 different proteins at the cell surface, embedded in the plasma membrane and rotates a long helical filament that propels cells through water.
- **Fimbriae:** needlelike projections that extend from the plasma membrane of some bacteria and promote attachment to other cells or surfaces.

## **B. 7.2 Eukaryotic Cell Structures**

- Eukaryotic cells are larger than prokaryotic cells.
- Larger size has the downside of a larger surface area to volume ratio.

## 1. Benefits of Organelles

- **Cytosol**: the fluid portion between the plasma membrane and organelles.
- Compartmentalization of cell through organelles provides two key advantages:
  - (1) Incompatible chemical reactions can be separated.
  - (2) Chemical reaction become more efficient.
- When typical prokaryotic and eukaryotic cells are compare, four key differences stand out.
  - o 1. Eukaryotic chromosomes are found inside a membrane-bound compartment called the nucleus.
  - o 2. Eukaryotic cells are often much larger than prokaryotic cells.
  - o 3. Eukaryotic cells contain extensive amount of internal membrane.
  - o 4. Eukaryotic cells feature a particularly diverse and dynamic cytoskeleton.

## 2. Eukaryotic Cell Structures: A Parts List

### a) *The Nucleus*

- The **nucleus** contains the chromosomes and functions as the administrative center for information storage and processing.
- The nucleus is enclosed in a complex double membrane call the **nuclear envelope**.
- **Nuclear lamina**: a lattice like sheet formed by fibrous proteins inside the surface of the nuclear envelope, which stiffen the structure and maintains the shape.
- Chromosomes do not float freely inside the nucleus- each chromosome occupies a distinct area.
- **Nucleolus**: a distinct region where the RNA molecules found in ribosomes are manufactured and the large and small ribosomal subunits are assembled.

### b) *Ribosomes*

- Eukaryotic ribosomes are complex macromolecular machines that manufacture proteins. They are not classified as organelles because they are not surrounded by membranes.

### c) *Endoplasmic Reticulum*

- The portions of the nuclear envelope extend into the cytoplasm to form an extensive membrane enclosed factory called the **endoplasmic reticulum**.
- The ER membrane is continuous with the nuclear envelope.
- The ER has regions that are distinct in structure and function:
  - o 1. **The rough endoplasmic reticulum (RER)**
  - o 2. **The smooth endoplasmic reticulum (SER)**
- The ribosomes associated with the RER synthesize proteins that will be inserted into the plasma membrane, secreted to the cell exterior, or shipped to an organelle.
- **Lumen**: the interior of a sac structure.
- The lumen of the RER, newly manufactures proteins undergo folding and other types of processing.
- The SER contains enzymes that catalyze reactions involving lipids.
- Depending on the type of cell, the enzymes found in SER may synthesize lipids needed by the organism or break down lipids and other molecules that are poisonous.
- The RER has ribosomes and functions primarily as a protein manufacturing center.
- The SER lacks ribosomes and functions primarily as a lipid-processing center.