**1.2 Ultrastructure of Cells**

**Essential idea:** Eukaryotes have a much more complex cell structure than prokaryotes.

**Nature of science:** Developments in scientific research follow improvements in apparatus—the invention of electron microscopes led to greater understanding of cell structure.

**Understandings:**

• Prokaryotes have a simple cell structure without compartmentalization.

• Eukaryotes have a compartmentalized cell structure.

• Electron microscopes have a much higher resolution than light microscopes.

**Applications and skills:**

• Application: Structure and function of organelles within exocrine gland cells of the pancreas and within palisade mesophyll cells of the leaf.

• Application: Prokaryotes divide by binary fission.

• Skill: Drawing of the ultrastructure of prokaryotic cells based on electron micrographs.

• Skill: Drawing of the ultrastructure of eukaryotic cells based on electron micrographs.

• Skill: Interpretation of electron micrographs to identify organelles and deduce the function of specialized cells.

**Prokaryotes**

Draw and label a diagram of a typical prokaryote (e.g. *Escherichia coli*) in the space below:

Prokaryotic cells are capable of a wide variety of metabolic activities.

*Define each of the following:*

**Photosynthesis:**

**Nitrogen fixation:**

**Fermentation:**

*Complete the table:*

|  |  |
| --- | --- |
| **Structure** | **Function** |
| Ribosomes |  |
| Cytoplasm |  |
| Nucleoid |  |
| DNA |  |
| Plasmids (in some prokaryotes, not all) |  |
| Capsule (in some prokaryotes, not all) |  |
| Cell wall (in some prokaryotes, not all) |  |
| Flagellum (in some prokaryotes, not all) |  |
| Pili (in some prokaryotes, not all) |  |

Living organisms were originally divided into five kingdoms based on the presence of certain structural features

In 1978 this system was refined to account for clear biochemical differences between living organisms (specifically, differences in rRNA sequence)

According to the three domain classification scheme, there are three distinct types of cellular organisms to which all living things may belong:

* **Eukarya:** Contain a membrane-bound nucleus (includes plants, animals, protists and fungi)
* **Eubacteria:** Lack a nucleus and consist of the traditional or 'true' bacteria (e.g. most pathogenic forms, E.coli, S. aureus, etc.)
* **Archaea:** Lack a nucleus and consist of the extremophiles or 'ancient' bacteria (e.g. methanogens, thermophiles, halophiles)

*Go to the website* <http://www.ucmp.berkeley.edu/archaea/archaea.html> *and answer the following questions about Archaea.*

When were archaea first discovered?

List five of the extreme environments that archaea inhabit?

*Click on the link of the bottom of the page for “More on Morphology” and answer the following questions.*

How big (or small, depending on how you look at it ) are archaea?

Describe the structural diversity of the archaea.

In what ways are the cellular structures of archaea and eubacteria similar?

What general cellular structures do archaea have in common with ALL cells?

The largest prokaryotes are cyanobacteria, also called blue green algae. They contain chlorophyll pigments for photosynthesis, but these pigments are not contained in membrane bound chloroplasts. Instead, the pigments are held in photosynthetic membranes called thylakoids. Cyanobacteria are often surrounded by a mucilaginous sheath.

*Go to the website* <http://www.ucmp.berkeley.edu/bacteria/cyanointro.html> *and answer the following questions about cyanobacteria.*

List two examples of how cyanobacteria have played an important role in the evolution of life on Earth.

What is endosymbiosis?

Cyanobacteria are also known as blue-green algae. Is the term ‘algae’ appropriate for cyanobacteria? Why or why not?

*Click on the link of the bottom of the page for Life History and Ecology and answer the following questions.*

Describe the relationship between cyanobacteria and fungi.

**Eukaryotes**

*Draw and label a liver cell (typical eukaryote) in the space below:*

*Complete the table:*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Structure** | **Function** | **Diagram** | **Present in?**  **(animal. plant, fungi, protozoa)** | **Visible with?**  **(light or electron microscope)** |
| Cell membrane |  |  |  |  |
| Mitochondria |  |  |  |  |
| Ribosome |  |  |  |  |
| Rough Endoplasmic Reticulum (RER) |  |  |  |  |
| Smooth Endoplasmic Reticulum (SER) |  |  |  |  |
| Golgi apparatus |  |  |  |  |
| Vesicle |  |  |  |  |
| Nucleus |  |  |  |  |
| Nucleolus |  |  |  |  |
| Vacuole |  |  |  |  |
| Chloroplast |  |  |  |  |
| Cytoskeleton |  |  |  |  |
| Cilia and flagella |  |  |  |  |
| Cell wall |  |  |  |  |
| Extracellular matrix |  |  |  |  |

Comparison of Cell Features Between Prokaryotes and Eukaryotes

|  |  |  |
| --- | --- | --- |
| **TRAIT** | **PROKARYOTE** | **EUKARYOTE** |
| **Domains** |  |  |
| **Size** |  |  |
| **Evolved** |  |  |
| **DNA** |  |  |
| **Chromosome(s)** |  |  |
| **DNA location** |  |  |
| **Mode of cell division** |  |  |
| **Cell membrane** |  |  |
| **Ribosomes**  **S = svedberg units; related to the size of organelles** |  |  |
| **Organelles** |  |  |
| **Internal membranes** |  |  |
| **Cytoskeleton** |  |  |
| **Internal materials**  **transport by?** |  |  |
| **Cell wall made of?** |  |  |
| **Flagella** |  |  |

*What features can you identify in the images below?*

