BIO.3 The student will investigate and understand relationships between cell structure and function. Key concepts include

a) evidence supporting the cell theory;
b) characteristics of prokaryotic and eukaryotic cells;
c) similarities between the activities of the organelles in a single cell and a whole organism;
d) the cell membrane model; and
e) the impact of surface area to volume ratio on cell division, material transport, and other life processes.

Essential Understandings

The concepts developed in this standard include the following:

- Cell theory is the unifying theme in biology because it emphasizes the similarity of all living things. Cell theory states that 1) living things are composed of one or more cells; 2) cells are the basic units of structure and function of all living things; and 3) new cells arise from pre-existing cells. †
- The development of cell theory was accelerated by the ability to make observations on a microscopic level. The development and refinement of magnifying lenses and light microscopes made the observation and description of living cells possible. †
- Continued advances in microscopy allow observation of cell organelles and ultrastructure. Current technology allows the observation of cellular processes underlying both cell structure and function. †
- Cell structure and chemistry are ways in which organisms differ from each other. The diversity that exists ranges from simple prokaryotic cells to complex multicellular organisms. †
- The simplest life forms exhibiting cellular structure are the prokaryotes. Earth's first cells were prokaryotes. Prokaryotic cells exist in two major forms: eubacteria and archaebacteria. Prokaryotes are Earth's most abundant inhabitants. They can survive in a wide range of environments and obtain energy in a variety of ways.
- Eukaryotes differ from prokaryotes based on size, genetic material surrounded by a nuclear membrane, and the addition of membrane bound organelles (i.e., mitochondria and chloroplasts).
- Eukaryotes arose from prokaryotes and developed into larger, more complex organisms, from single-celled protists to multicellular protists, fungi, plants, and animals.

Essential Knowledge and Skills

In order to meet this standard, it is expected that students will

- describe the key events leading to the development of the cell theory.
- compare and contrast characteristics of prokaryotic and eukaryotic cells.
- compare and contrast the activities of an organelle in a single cell and a whole organism.
- identify the following essential cell structures and their functions
  - the nucleus (contains DNA; site where RNA is made)
  - ribosome (site of protein synthesis)
  - mitochondrion (site of cell respiration)
  - chloroplast (site of photosynthesis)
  - endoplasmic reticulum (transports materials through the cell)
  - Golgi (site where cell products are packaged for export)
  - lysosome (contains digestive enzymes)
  - cell membrane (controls what enters and leaves the cell)
  - cell wall (provides support)
  - vacuole (storage of material)
  - cytoplasm (contains organelles and site of many chemical reactions)
  - centriole (organizes spindle fibers in animal cells)
  - cytoskeleton
- describe how the selective permeability of the cell membrane affects the life of a cell.
- describe processes associated with movement across the membrane for diffusion, facilitated diffusion, osmosis, and active transport.
- describe the relationship between a cell's external solute concentration and its effect on the cell's internal solute concentration.

Essential Understandings	Essential Knowledge and Skills
• Some organisms exist as a single cell, while others are composed of many cells, each specialized to perform distinct metabolic functions. The basic processes necessary for living things to survive are the same for a single cell as they are for a more complex organism. A single-celled organism has to conduct all life processes by itself. A multicellular organism has groups of cells that specialize to perform specific functions. • Cellular activities necessary for life include chemical reactions that facilitate acquiring energy, reproduction, and maintaining homeostasis. Relationships between structure and function can be examined at each of the hierarchical levels of organization: molecular, cellular, organism, population, community, and ecosystem. • Cellular differences between plant and animal cells include the presence of a cell wall that gives the plant cell a defined shape, the presence of chloroplast, and the number of vacuoles. • The fluid mosaic model of a membrane emphasizes the arrangement and function of a bilayer of phospholipids, transport proteins, and cholesterol. • Homeostasis of a cell is maintained by the plasma membrane comprised of a variety of organic molecules. The membrane controls the movement of material in and out of the cell, communication between cells, and the recognition of cells to facilitate multiple metabolic functions. • Diffusion occurs in cells when substances (oxygen, carbon dioxide, salts, sugars, amino acids) that are dissolved in water move from an area of higher concentration to an area of lower concentration. • Facilitated diffusion occurs in cells when larger substances are moved from an area of higher concentration to an area of lower concentration with the assistance of a carrier protein without the use of energy. • Osmosis refers to the movement of water molecules through a semi-permeable membrane from an area of greater water concentration or pressure (lower solute concentration) to an area of lesser water concentration or pressure (higher solute concentration). • Active transport refers to the movement of solid or liquid particles into and out of a cell with an input of energy. • As cells increase in size, surface area to volume ratios decrease, making cells unable to obtain nutrients or remove wastes. To reduce the effects of this, cells divide to stay small or change shape to increase surface area or reduce volume. †Revised June 2013	• compare the efficiency of the ability of a cell to transport material based on surface area to volume ratios. **Directions:** **1. Read the "Essential Understandings" and "Essential Knowledge and Skills."** **2. On a separate sheet of paper, write 15 questions a teacher could put on a quiz or a test.** **3. Write a key (the answer for each question).** **Example:** ***Q – What form of technology was essential for the development of the cell theory?*** ***A – The microscope***