Cellular Objectives

Enduring understanding 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter.

Essential knowledge 2.A.3: Organisms must exchange matter with the environment to grow, reproduce and maintain organization.

2.A.3.b. Explain why surface area-to-volume ratios are important in affecting a biological system's ability to obtain necessary resources or eliminate waste products.

2.A.3.b.1. Using an example from below, explain how as cells increase in volume, the relative surface area decreases and demand for material resources increases; more cellular structures are necessary to adequately exchange materials and energy with the environment.

- **Root hairs**
- **Cells of the alveoli**
- **Cells of the villi**
- **Microvilli**

2.A.3.b.2. Explain why smaller cells have a more favorable surface area-to-volume ratio for exchange of materials with the environment.

Enduring understanding 2.B: Growth, reproduction and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments.

Essential knowledge 2.B.1: Cell membranes are selectively permeable due to their structure.

2.B.1.a. What is the role of the cell membrane?

2.B.1.b. How is selective permeability related to the fluid mosaic model.

2.B.1.b.1. Describe the components of the Cell membranes

2.B.1.b.2. What properties do Phospholipids give the membrane?

2.B.1.b.3. Describe the orientation of the phospholipids

2.B.1.b.4. Describe the chemical characteristics of embedded proteins and how this affects their position in the membrane.

2.B.1.b.5. Describe the movement of the following through the membrane: Small, uncharged polar molecules, small nonpolar molecules, such as N2, Hydrophilic substances such as large polar molecules and ions, and water.

2.B.1.c. Describe the function of the cell walls.

2.B.1.c.1. Describe the composition and location of plant cell walls.

2.B.1.c.2. Describe the composition and location of cells walls of prokaryotes and fungi.

Essential knowledge 2.B.2: Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.

2.B.2.a. Describe passive transport

2.B.2.a.1. Explain the primary role of passive transport.

2.B.2.a.2. Using an example from below, explain how membrane proteins play a role in facilitated diffusion of charged and polar molecules through a membrane.

- **Glucose transport**
- **Na+/K+ transport**

2.B.2.a.3. Explain the terms: hypotonic, hypertonic or isotonic in relationship to the internal environments of cells.

2.B.2.b. Describe active transport.

2.B.2.b.1. Explain the relationship between active transport, free energy and proteins embedded in the membrane.

2.B.2.c. Describe the processes of endocytosis and exocytosis.

<u>Essential knowledge 2.B.3: Eukaryotic cells maintain internal membranes that partition the cell into specialized regions.</u>

2.B.2.3.a. Explain the following: internal membranes facilitate cellular processes by minimizing competing interactions and by increasing surface area where reactions can occur.

2.B.2.3.b. Using an example from below, explain how membranes and membrane-bound organelles in eukaryotic cells localize (compartmentalize) intracellular metabolic processes and specific enzymatic reactions.

- **Endoplasmic reticulum**
- **Mitochondria**
- **Chloroplasts**
- **Golgi**
- **Nuclear envelope**

2.B.2.3.c. Why is this limited to Eukaryotic cells?

Enduring understanding 3.D: Cells communicate by generating, transmitting and receiving chemical signals.

<u>Essential knowledge 3.D.1: Cell communication processes share common features that reflect a shared evolutionary history.</u>

3.D.1.a. List the types of signals involved in communication and where they come from.

3.D.1.b. Describe the types of signal transduction pathways that are under strong selective pressure.

3.D.1.c. Using an example from below, explain how in single-celled organisms, signal transduction pathways influence how the cell responds to its environment.

- **Use of chemical messengers by microbes to communicate with other nearby cells and to regulate specific pathways in response to population density (quorum sensing)**
- **Use of pheromones to trigger reproduction and developmental pathways**
- **Response to external signals by bacteria that influences cell movement**

3.D.1.d. Using an example from below, explain how in multicellular organisms, signal transduction pathways coordinate the activities within individual cells that support the function of the organism as a whole.

- **Epinephrine stimulation of glycogen breakdown in mammals**
- **Temperature determination of sex in some vertebrate organisms**
- **DNA repair mechanisms**

<u>Essential knowledge 3.D.2: Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling.</u>

3.D.2.a. Using an example from below, explain how cells communicate by cell-to-cell contact.

- **Immune cells interact by cell-cell contact, antigen-presenting cells (APCs), helper T-cells and killer T-cells.**
- **Plasmodesmata between plant cells that allow material to be transported from cell to cell.**

3.D.2.b. Using an example from below, explain how cells communicate over short distances by using local regulators that target cells in the vicinity of the emitting cell.

- **Neurotransmitters**
- **Plant immune response**
- **Quorum sensing in bacteria**
- **Morphogens in embryonic development**

3.D.2.c. Explain how signals released by one cell type can travel long distances to target cells of another cell type.

<u>Essential knowledge 3.D.3: Signal transduction pathways link signal reception with cellular response.</u>

3.D.3.a. Describe how signaling begins.

3.D.3.a.1. List the types of different chemical messengers and explain the specific one-to-one

relationship with their receptors.

3.D.3.a.2. Using an example from below, explain how a receptor protein recognizes signal molecules, causing the receptor protein's shape to change, which initiates transduction of the signal.

- **G-protein linked receptors**
- **Ligand-gated ion channels**
- **Receptor tyrosine kinases**

3.D.3.b. Describe signal transduction.

3.D.3.b. 1. Explain signaling cascades.

3.D.3.b. 2. Using an example from below, explain how second messengers are often essential to the function of the cascade.

- **Ligand-gated ion channels**
- **Second messengers, such as cyclic GMP, cyclic AMP calcium ions (Ca2+), and inositol triphosphate (IP3)**

3.D.3.b.3. Many signal transduction pathways include:

3.D.3.b.3.i. Explain the effects of protein modifications using methylation

3.D.3.b.3.ii. Explain the a phosphorylation cascades.

Enduring understanding 4.A: Interactions within biological systems lead to complex properties.

<u>Essential knowledge 4.A.2: The structure and function of subcellular components, and their interactions, provide essential cellular processes.</u>

4.A.2.a. Describe ribosomes structure and function.

4.A.2.b. Describe the two types endoplasmic reticulum (ER) in both structure and function.

4.A.2.c. Describe the Golgi complex structure and their function

4.A.2.d. Describe mitochondria structure and function.

4.A.2.e. Describe lysosomes structure and function

4.A.2.f. Describe a vacuole structure and function

4.A.2.g. Where are chloroplasts found and what is their function.

4.A.2.g.1. Explain the structure and function relationship in the chloroplast.

4.A.2.g.2. Explain what chlorophylls are and why they are important.

4.A.2.g.3. Describe the structure of a chloroplasts.

Untested:

✘ ***There is no particular membrane protein that is required for teaching facilitated diffusion and active transport.***

✘ ***No particular system is required for teaching the concepts in 3.D.3.b. Teachers are free to choose a system that best fosters student understanding.***

✘ ***Specific functions of smooth ER in specialized cells are beyond the scope of the course and the AP Exam***

✘ ***The role of this organelle in specific phospholipid synthesis and the packaging of enzymatic contents of lysosomes, peroxisomes and secretory vesicles are beyond the scope of the course and the AP Exam.***

✘ ***Specific examples of how lysosomes carry out intracellular digestion are beyond the scope of the course and the AP Exam.***

✘ ***The molecular structure of chlorophyll a is beyond the scope of the course and the AP Exam.***