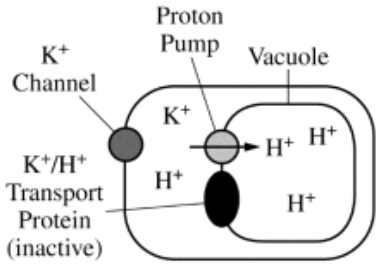
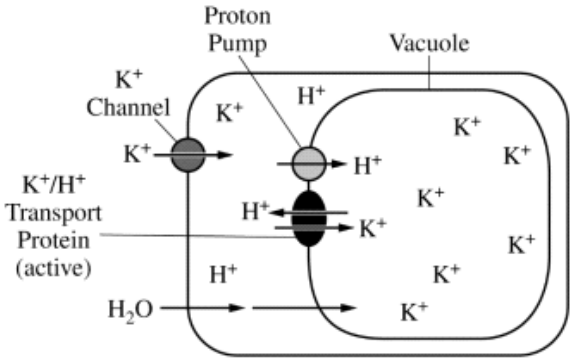
Unit 2: Cell Structure and Function

Topic	Learning Objective(s)
2.1 Cell Structure: Subcellular Components	**SYI-1.D** Describe the structure and/ or function of subcellular components and organelles.
2.2 Cell Structure and Function	**SYI-1.E** Explain how subcellular components and organelles contribute to the function of the cell.
	SYI-1.F Describe the structural features of a cell that allow organisms to capture, store, and use energy
2.3 Cell Size	**ENE-1.B** Explain the effect of surface area-to-volume ratios on the exchange of materials between cells or organisms and the environment.
	ENE-1.C Explain how specialized structures and strategies are used for the efficient exchange of molecules to the environment.
2.4 Plasma Membranes	**ENE-2.A** Describe the roles of each of the components of the cell membrane in maintaining the internal environment of the cell.
	ENE-2.B Describe the Fluid Mosaic Model of cell membranes.
2.5 Membrane Permeability	**ENE-2.C** Explain how the structure of biological membranes influences selective permeability
	ENE-2.D Describe the role of the cell wall in maintaining cell structure and function.
2.6 Membrane Transport	**ENE-2.E** Describe the mechanisms that organisms use to maintain solute and water balance.
	ENE-2.F Describe the mechanisms that organisms use to transport large molecules across the plasma membrane.
2.7 Facilitated Diffusion	**ENE-2.G** Explain how the structure of a molecule affects its ability to pass through the plasma membrane.
2.8 Tonicity and Osmoregulation	**ENE-2.H** Explain how concentration gradients affect the movement of molecules across membranes.
	ENE-2.I Explain how osmoregulatory mechanisms contribute to the health and survival of organisms.
2.9 Mechanisms of Transport	**ENE-2.J** Describe the processes that allow ions and other molecules to move across membranes.
2.10 Cell Compartmentalization	**ENE-2.K** Describe the membrane-bound structures of the eukaryotic cell.
	ENE-2.L Explain how internal membranes and membrane-bound organelles contribute to compartmentalization of eukaryotic cell functions.
2.11 Origins of Cell Compartmentalization	**EVO-1.A** Describe similarities and/or differences in compartmentalization between prokaryotic and eukaryotic cells.
	EVO-1.B Describe the relationship between the functions of endosymbiotic organelles and their free-living ancestral counterparts.

Free Response Practice

2019 #8

TABLE 1. CHANGES IN MORNING GLORY PETAL CELLS DURING FLOWER OPENING

	BUD	OPEN FLOWER
		
Vacuole pH	6.6	7.7
Flower Color	Red	Blue
Cell Volume	Small	Large

The petal color of the Mexican morning glory (*Ipomoea tricolor*) changes from red to blue, and the petal cells swell during flower opening. The pigment heavenly blue anthocyanin is found in the vacuole of petal cells. Petal color is determined by the pH of the vacuole. A model of a morning glory petal cell before and after flower opening is shown in Table 1.

(a) **Identify** the cellular component in the model that is responsible for the increase in the pH of the vacuole during flower opening AND **describe** the component's role in changing the pH of the vacuole.

(b) A researcher claims that the activation of the K^+/H^+ transport protein causes the vacuole to swell with water. **Provide reasoning** to support the researcher's claim.

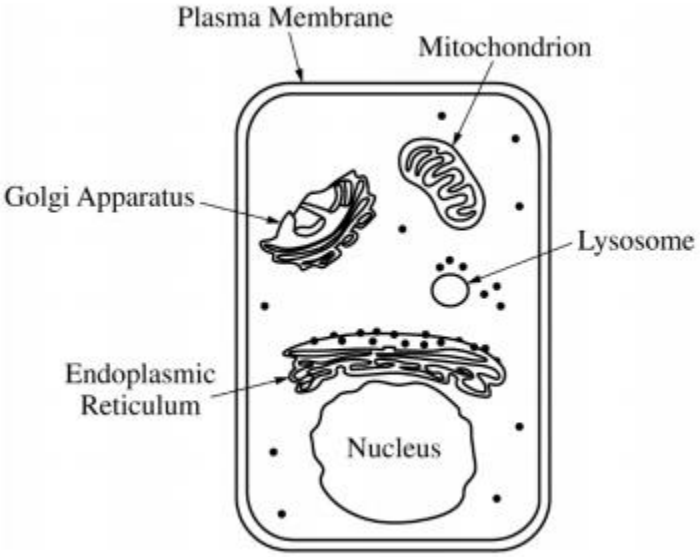
2018 #6

Cystic fibrosis is a genetic condition that is associated with defects in the CFTR protein. The CFTR protein is a gated ion channel that requires ATP binding in order to allow chloride ions (Cl^-) to diffuse across the membrane.

(a) In the provided model of a cell, **draw** arrows to describe the pathway for production of a normal CFTR protein from gene expression to final cellular location.

(b) **Identify** the most likely cellular location of the ribosomes that synthesize CFTR protein.

(c) **Identify** the most likely cellular location of a mutant CFTR protein that has an amino acid substitution in the ATP-binding site.



2017 #8

Estrogens are small hydrophobic lipid hormones that promote cell division and the development of reproductive structures in mammals. Estrogens passively diffuse across the plasma membrane and bind to their receptor proteins in the cytoplasm of target cells.

(a) **Describe** ONE characteristic of the plasma membrane that allows estrogens to passively cross the membrane.

(b) In a laboratory experiment, a researcher generates antibodies that bind to purified estrogen receptors extracted from cells. The researcher uses the antibodies in an attempt to treat estrogen-dependent cancers but finds that the treatment is ineffective. **Explain** the ineffectiveness of the antibodies for treating estrogen-dependent cancers.

2013 #6

The following data were collected by observing subcellular structures of three different types of eukaryotic cells.

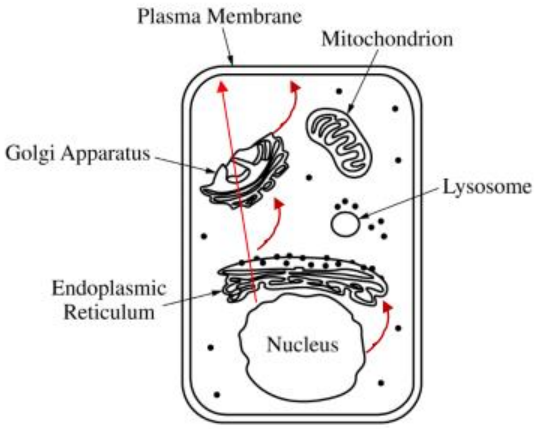
RELATIVE AMOUNTS OF ORGANELLES IN THREE CELL TYPES

Cell Type	Smooth ER	Rough ER	Mitochondria	Cilia	Golgi Bodies
X	Small amount	Small amount	Large number	Present	Small amount
Y	Large amount	Large amount	Moderate number	Absent	Large amount
Z	Absent	Absent	Absent	Absent	Absent

Based on an analysis of the data, **identify** a likely primary function of each cell type and **explain** how the data support the identification.

Free Response Scoring Guidelines

2019 #8		
Part	**Scoring Guidelines**	**Topic**
(a)	**Identification (1 point)** • (K^+ / H^+) transport protein **Description (1 point)** • It moves H^+ out of the vacuole.	2.7 2.8
(b)	**Reasoning (1 point)** • The concentration of solute (K^+) is increasing inside the vacuole. • The solute (K^+) is moving into the vacuole, making it hypertonic/hyperosmotic/lowering water potential.	2.7 2.8

2018 #6		
Part	**Scoring Guidelines**	**Topic**
(a)	**Drawing (1 point)**  The response must follow this pathway: nucleus/nuclear envelope → endoplasmic reticulum → Golgi apparatus → plasma membrane. The response may be in the form of a continuous arrow or multiple discontinuous arrows.	2.1
(b)	**Identification (1 point)** • (Rough) Endoplasmic Reticulum/ER	2.1
(c)	**Identification (1 point)** • In the (cellular/plasma) membrane	2.7

2017 #8		
Part	**Scoring Guidelines**	**Topic**
(a)	**Description (1 point)** • Hydrophobic/nonpolar • Space between phospholipids	
(b)	**Explanation (2 points)** • Antibodies are unable to enter the cell. • (Extracellular) antibodies will not bind to (intracellular) estrogen receptors.	

2013 #6

Part	Scoring Guidelines	Topic
		2.1

Cell Type	**Identify function**		**Explain how data support identification (1 point each correct pair). NOTE: No points for identification without explanation.**		
X	• Locomotion • Movement / surface transport	**AND**	Has cilia for movement and large amounts of mitochondria to provide energy for locomotion of cell itself (ciliated protist) or movement of particles (mucus /oocyte) along cell surface		
Y	• Secretion / exocytosis • Protein synthesis	**AND**	Has large amounts of rough ER and Golgi to produce and package proteins		
	• Lipid/hormone synthesis • Detoxification	**AND**	Has large amounts of smooth ER to produce lipids / hormones		
Z	• Transport	**OR**	• Oxygen transport in animal cells • Water transport in plant cells	**AND**	Does not require these organelles
	• Protection	**OR**	• Epidermal cells (stratum corneum, cork, nails)	**AND**	
	• Support	**OR**	• Ground tissue (schlerenchyma) • Vascular tissue (xylem)	**AND**	
	• Storage	**OR**	• Maximizes volume / space available (hemoglobin, oxygen)	**AND**	
	• No function	**OR**	• Is a dead cell/is undergoing apoptosis	**AND**	