AP Bio Unit Reviews

The Cell

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Today's Plan

Cellular Organelles

Membrane Transport

Practice Questions

Unit 2 Q&A

Nucleus

Structure:
- Double membrane (nuclear envelope) with pores

Functions:
- Stores genetic information (DNA)
- Synthesis of RNA
- Ribosome subunit assembly

Rough ER

Structure:
- Membrane studded with ribosomes attached to nuclear envelope

Functions:
- Site of membrane-bound protein and secreted protein synthesis
- Cell compartmentalization
- Mechanical support
- Role in intracellular transport

Smooth ER

Structure:
- Folded, tubelike structure (cisternae)

Functions:
- Detoxification
- Calcium Storage
- Lipid synthesis

Cellular Organelles

Golgi Complex

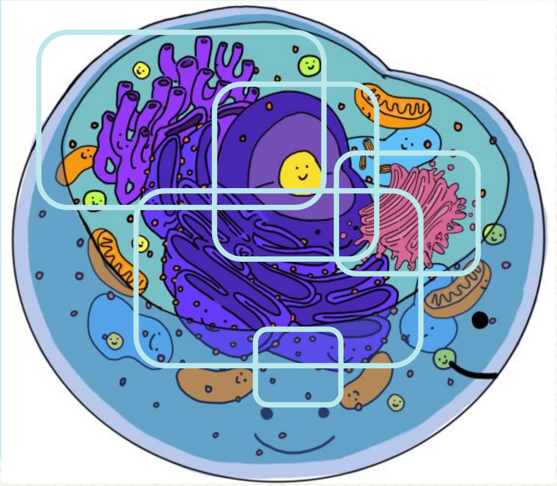
Structure:
- Membrane-bound structure composed on flattened sacs (cisternae)

Functions:
- Folding and chemical modification of synthesized proteins
- Packaging protein traffic

Ribosomes

Structure:
- Composed of rRNA and protein
- Large & small subunits
- Types: bound or free (cytoplasmic)

Functions:
- Protein synthesis



Cellular Organelles

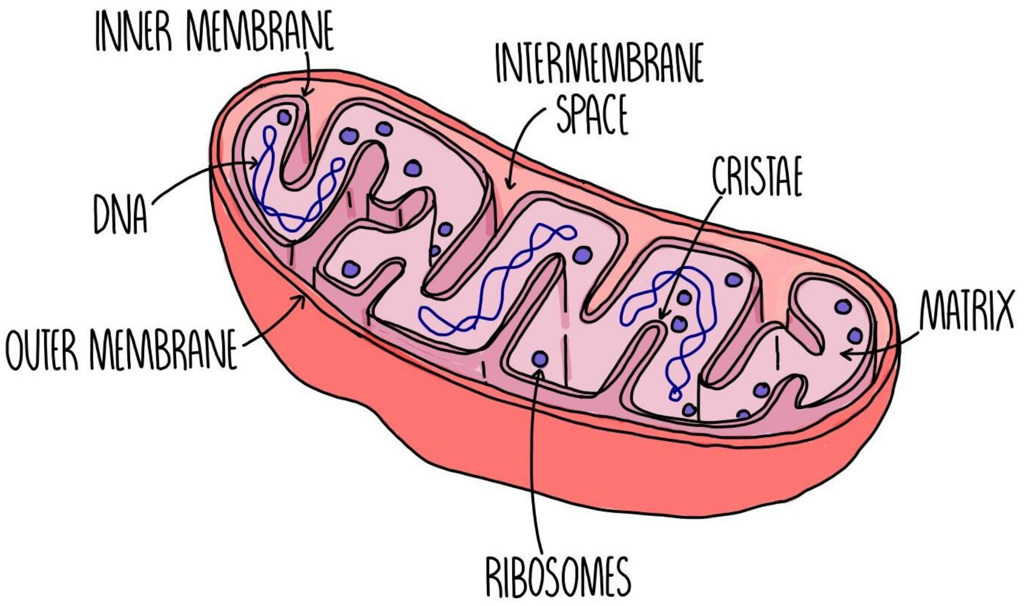
Mitochondria

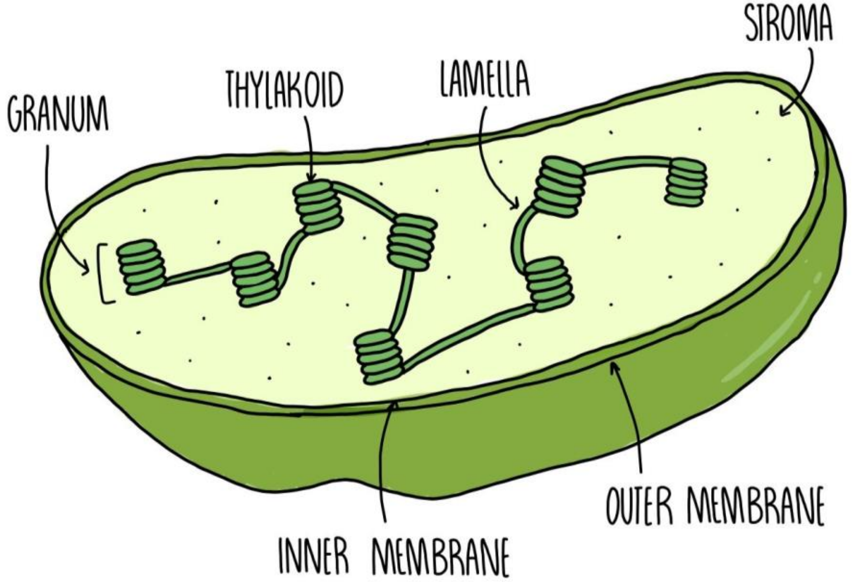
Structure:

- Double membrane
  (outer: smooth; inner: highly folded)

Functions:

- Site of oxidative phosphorylation
  (cristae/inner membrane)
- Site of Krebs Cycle (matrix)





Chloroplast

Structure:

- Double outer membrane (thylakoid sac stacked: grana and fluid: stroma)

Functions:

- Site of photosynthesis
- Thylakoid: Light Reactions
- Stroma: Calvin-Benson Cycle

Cellular Organelles

Mitochondria

Structure:

- Double membrane (outer: smooth; inner: highly folded)

Functions:

- Site of oxidative phosphorylation (cristae/inner membrane)
- Site of Krebs Cycle (matrix)

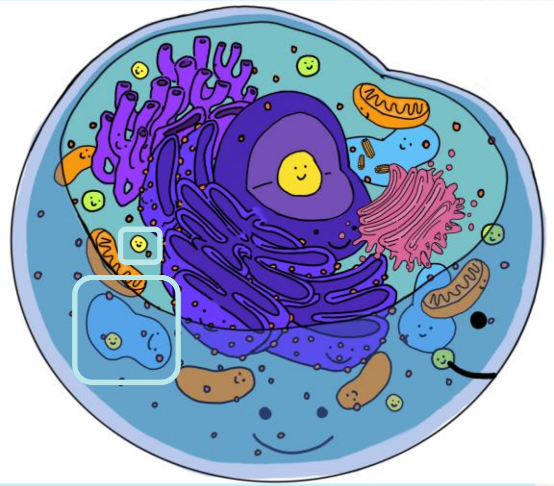
Lysosome

Structure:

- membrane-enclosed sacs that contain hydrolytic enzymes

Functions:

- Intracellular digestion (recycle cell organic materials & programmed cell death: apoptosis)



Structure:

- membrane-bound sac

Functions:

- storage and release of macromolecules and cellular waste products
- Central: water retention – turgor pressure
- Contractile: osmoregulation (protist)
- Food: phagocytosis, fuse with lysosome

Vacuole

Structure:

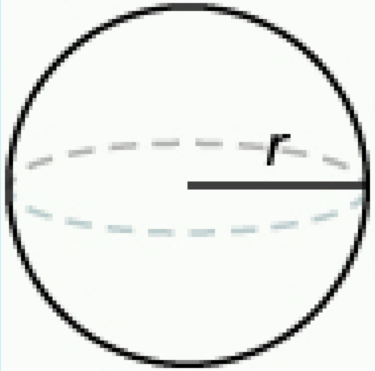
- Double outer membrane (thylakoid sac stacked: grana and fluid: stroma)

Functions:

- Site of photosynthesis
- Thylakoid: Light Reactions
- Stroma: Calvin-Benson Cycle

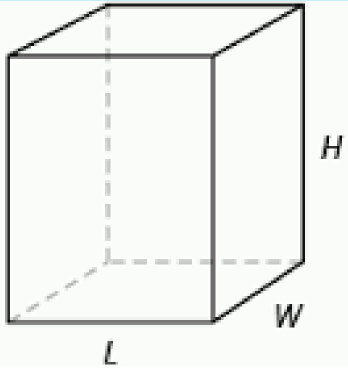
Chloroplast

Surface Area: Volume



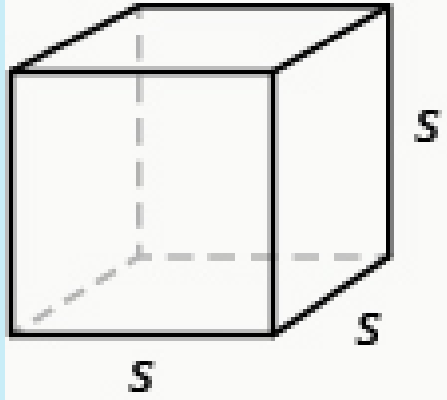
Volume: $V = \frac{4}{3}\pi r^3$

Surface Area: $S = 4\pi r^2$



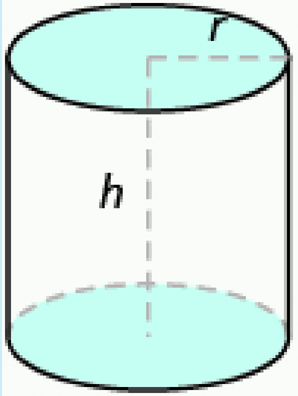
Volume: $V = LWH$

Surface Area: $S = 2LH + 2LW + 2WH$



Volume: $V = s^3$

Surface Area: $S = 6s^2$



Volume: $V = \pi r^2 h$ or $V = Bh$

Surface Area: $S = 2\pi r^2 + 2\pi rh$

Smaller cells typically have a higher surface area-to-volume ratio and more efficient exchange of materials with the environment.

Membrane Transport

Simple Diffusion

- Passive Transport, No NRG
- Down concentration gradient
- Small, Nonpolar
- No transport protein needed
- Examples: CO_2, O_2, N_2, steroids
- Small amount of H_2O leak through membrane

Facilitated Diffusion

- Passive Transport, No NRG
- Down concentration gradient
- Small Molecules
- Requires transport protein
  Channel vs. Carrier protein
- Example: water, Na^+, K^+, Ca^+

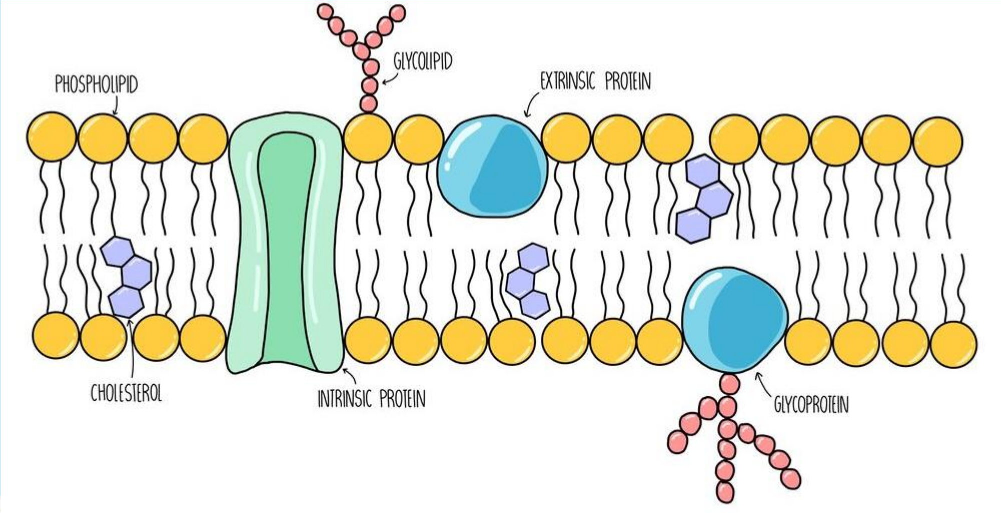
Active Transport

- Requires input of NRG
- Against concentration gradient
- Requires transport protein (carrier protein)
- Example: Na^+, K^+, Ca^+, H^+

Plasma Membrane

Composed of:

- Phospholipids
- Membrane Proteins
- Glycolipids/Glycoproteins
- Cholesterol



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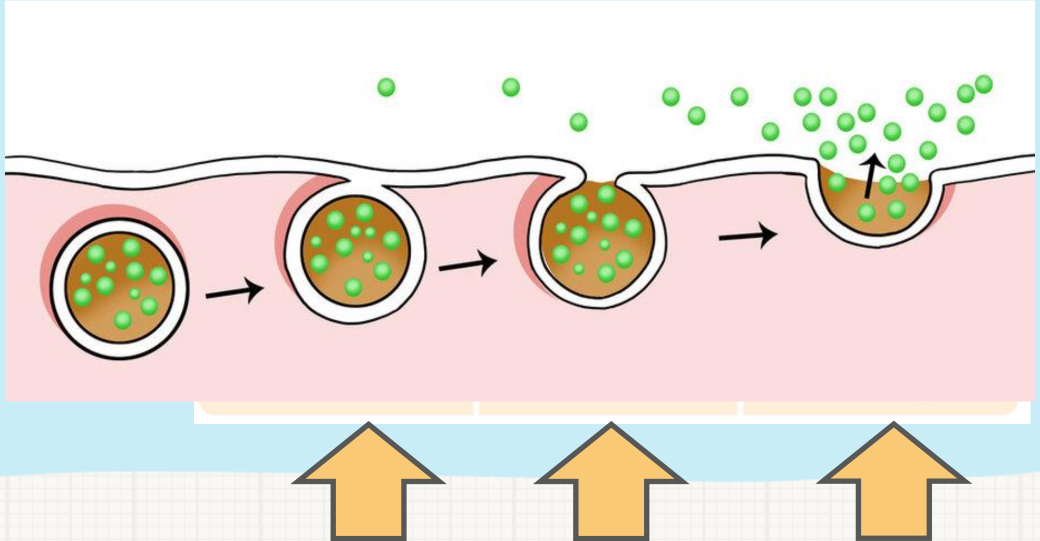
Endocytosis

- Import of materials
- Phagocytosis: Cellular Eating
- Pinocytosis: Cellular Drinking
- Receptor-Mediated: Endocytosis



Exocytosis

Export of materials
Rough ER (synthesize) → Golgi complex (package/modification) → Plasma Membrane

Hypertonic Solution

- **HIGH** solute concentration
- **LOW** free water concentration

- **GAINS** water from hypotonic solution

Isotonic Solution

- **EQUAL** solute concentration (as other solution)
- **EQUAL** free water concentration (as other solution)

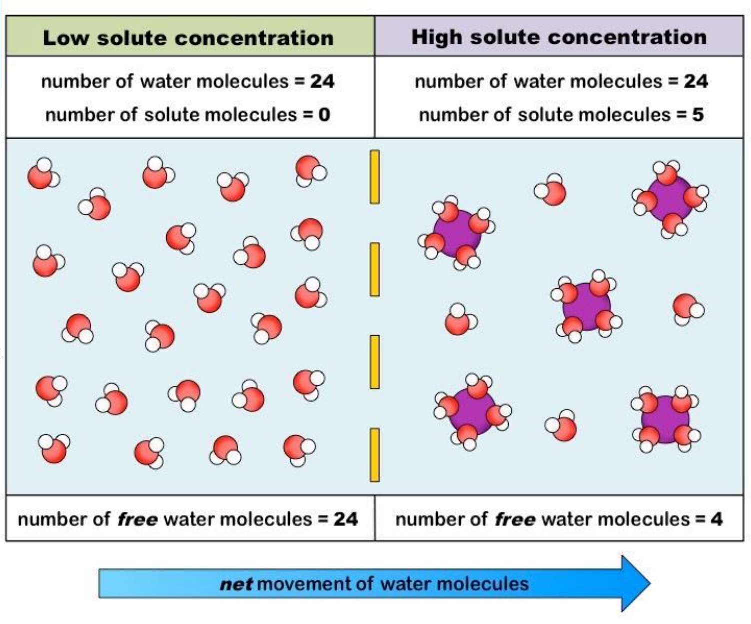
- Equal water movement into and out of solution

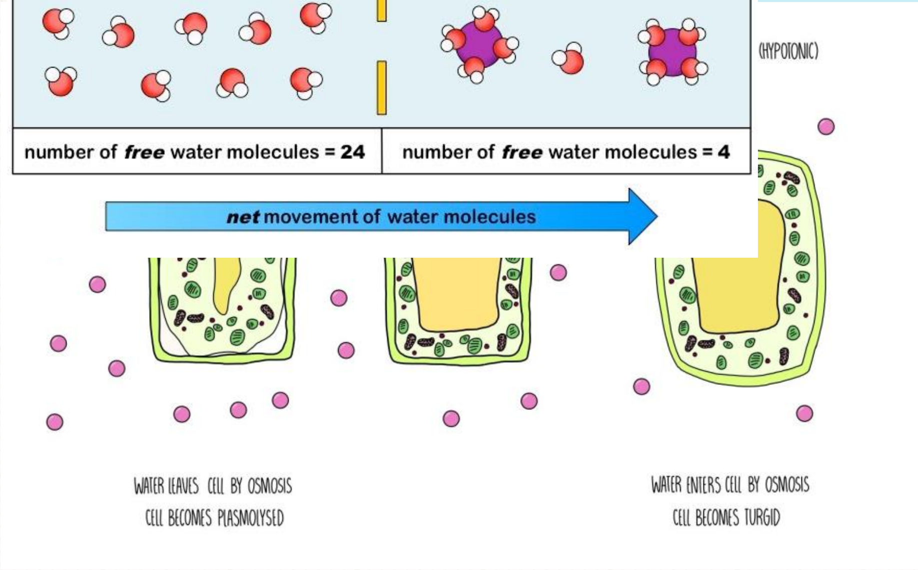
Hypotonic Solution

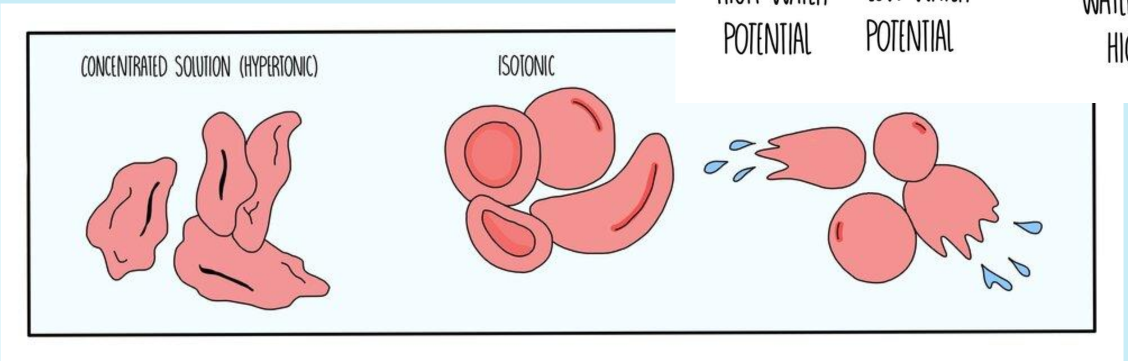
- **LOW** solute concentration
- **HIGH** free water concentration

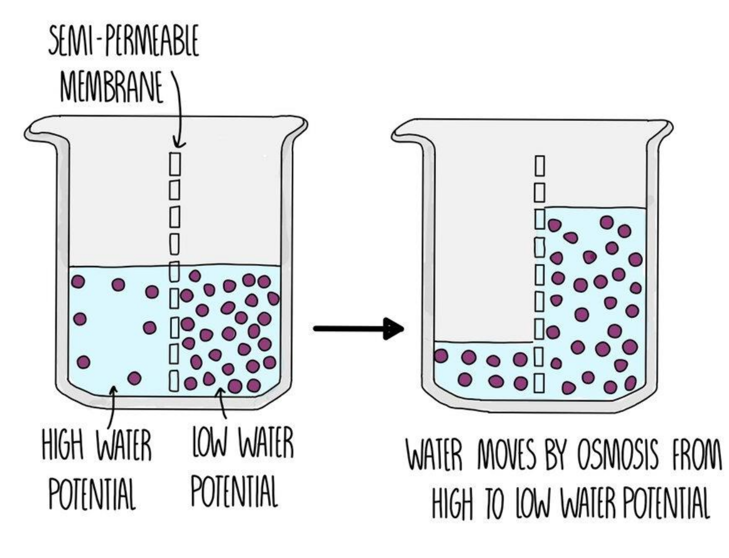
- **LOSES** water to hypertonic solution

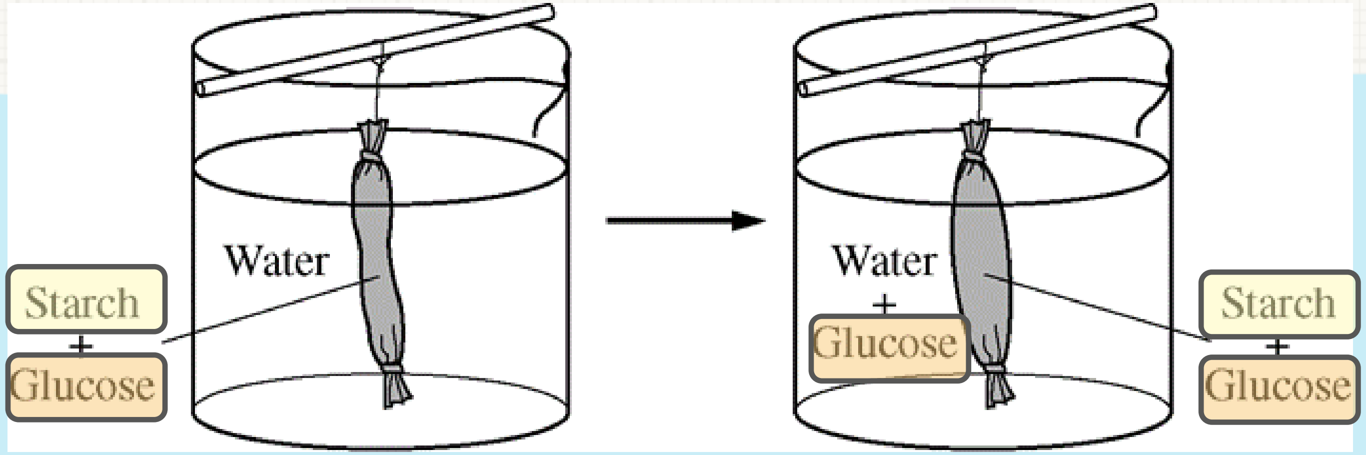
Osmosis



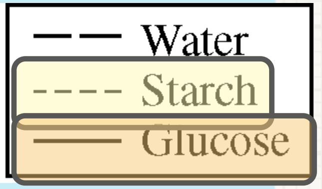


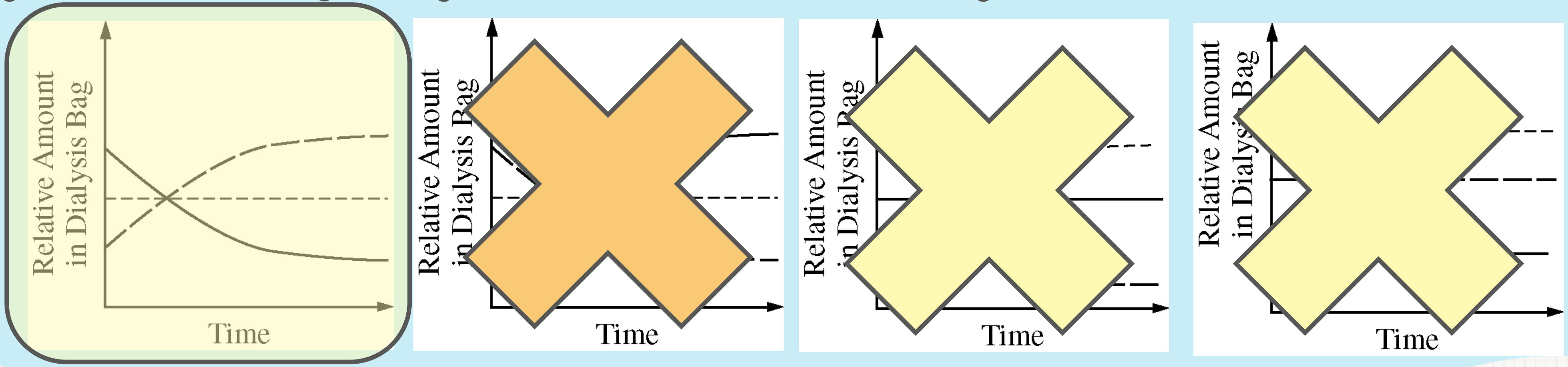






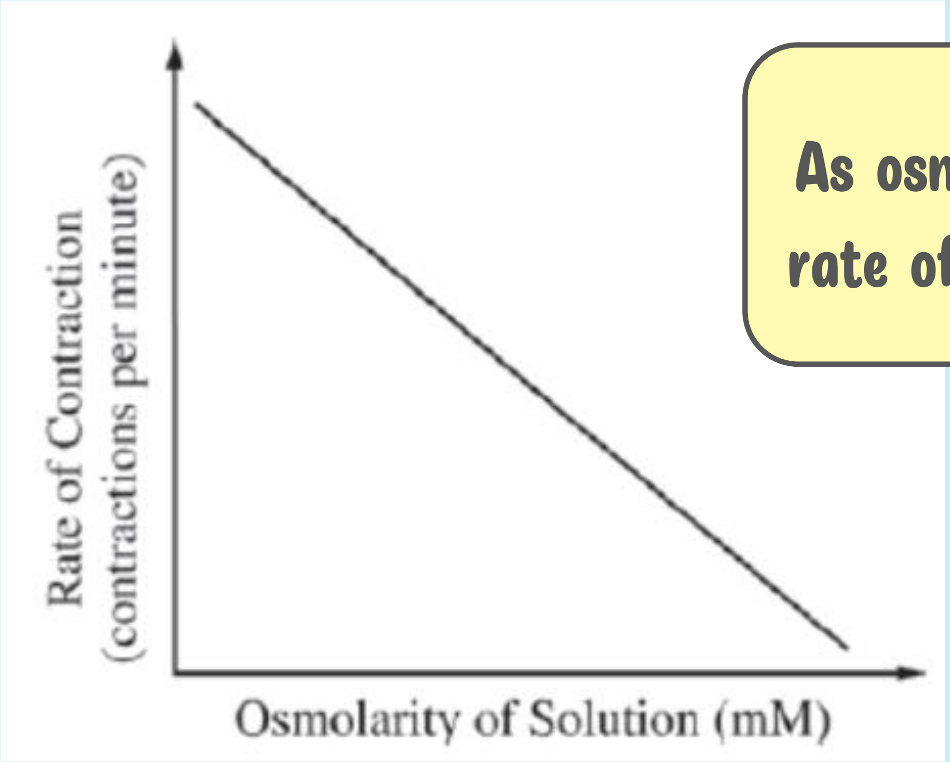
A common laboratory investigation involves putting a solution of starch and glucose into a dialysis bag and suspending the bag in a beaker of water, as shown in the figure below. The investigation is aimed at understanding how molecular size affects movement through a membrane. Which of the following best represents the amount of starch, water, and glucose in the dialysis bag over the course of the investigation?





Multiple Choice Practice:

Paramecia are unicellular protists that have contractile vacuoles to remove excess intracellular water. In an experimental investigation, paramecia were placed in salt solutions of increasing osmolarity. The rate at which the contractile vacuole contracted to pump out excess water was determined and plotted against osmolarity of the solutions, as shown in the graph. Which of the following is the correct explanation for the data?



As osmolarity increases, the rate of contraction decreases

Multiple Choice Practice:

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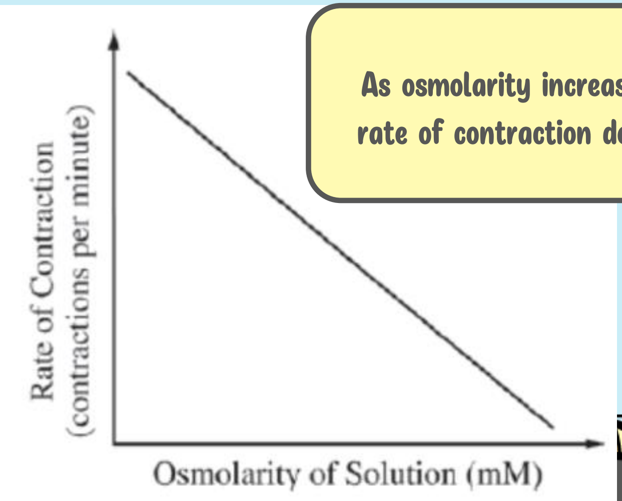


As osmolarity increases, the rate of contraction decreases

a. At higher osmolarity, lower rates of contraction are required because more salt diffuses into the paramecia.

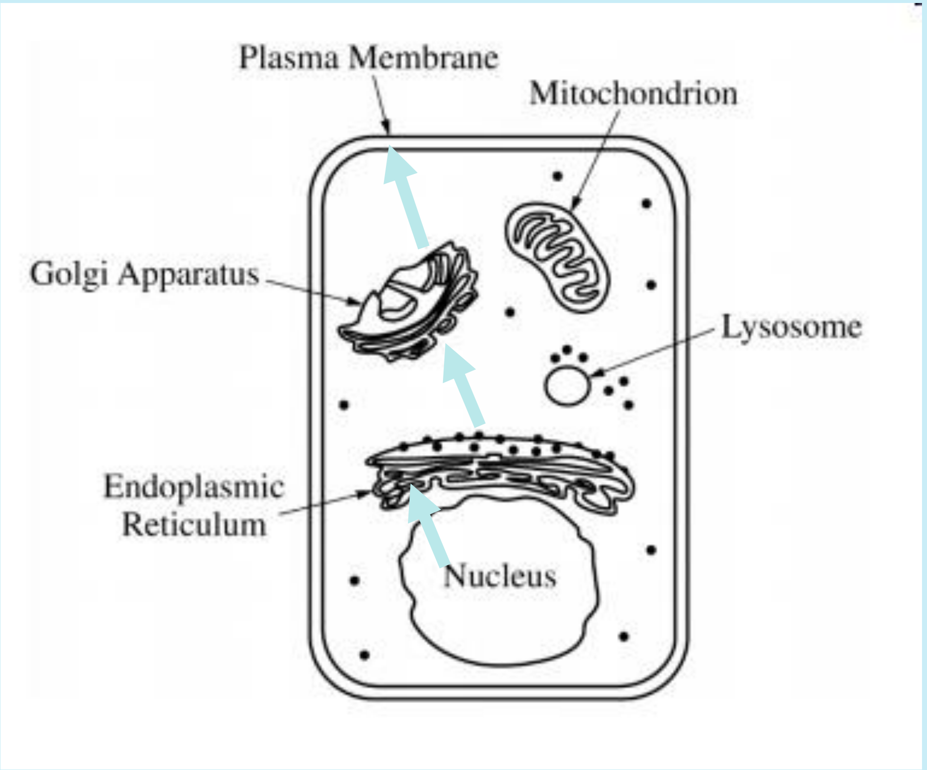
b. The contraction rate increases as the osmolarity decreases because the amount of water entering the paramecia by osmosis increases.

c. The contractile vacuole is less efficient in solutions of high osmolarity because of the reduced amount of ATP produced from cellular respiration.

d. In an isosmotic salt solution, there is no diffusion of water into or out of the paramecia, so the contraction rate is zero.

Free Response Practice (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.

Free Response Practice (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.

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

Identification (1 point)

- (Rough) Endoplasmic Reticulum/ER

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

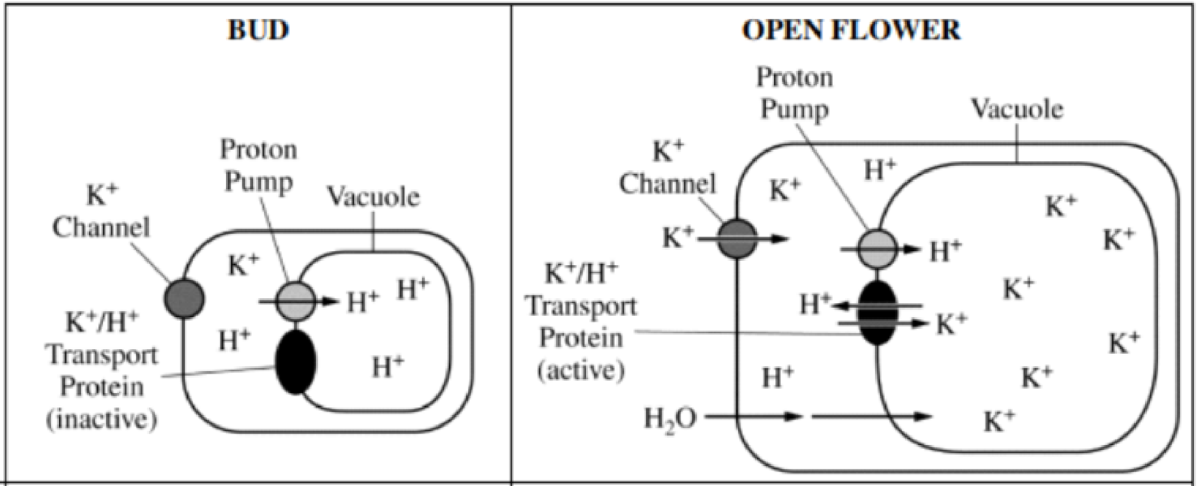
Identification (1 point)

- In the (cellular/plasma) membrane

Free Response Practice (2019 #8):

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.

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

Free Response Practice (2019 #8):

(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.

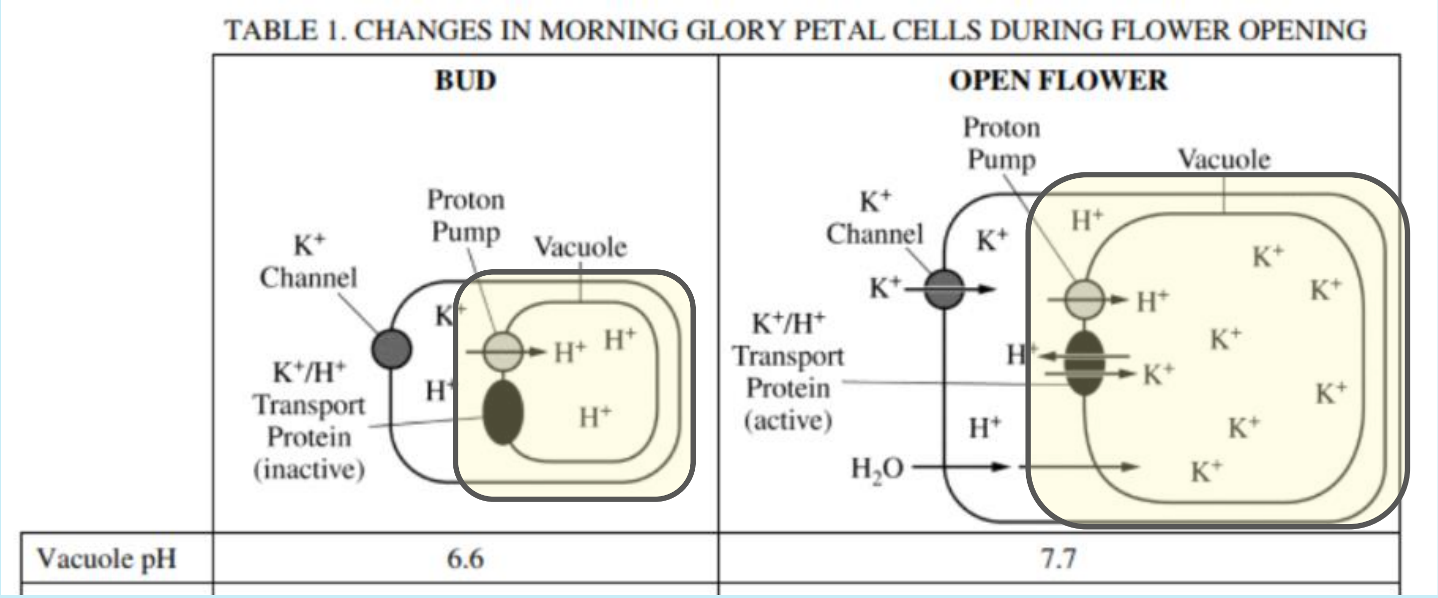


TABLE 1. CHANGES IN MORNING GLORY PETAL CELLS DURING FLOWER OPENING

	BUD	OPEN FLOWER
Vacuole pH	6.6	7.7

Identification (1 point)

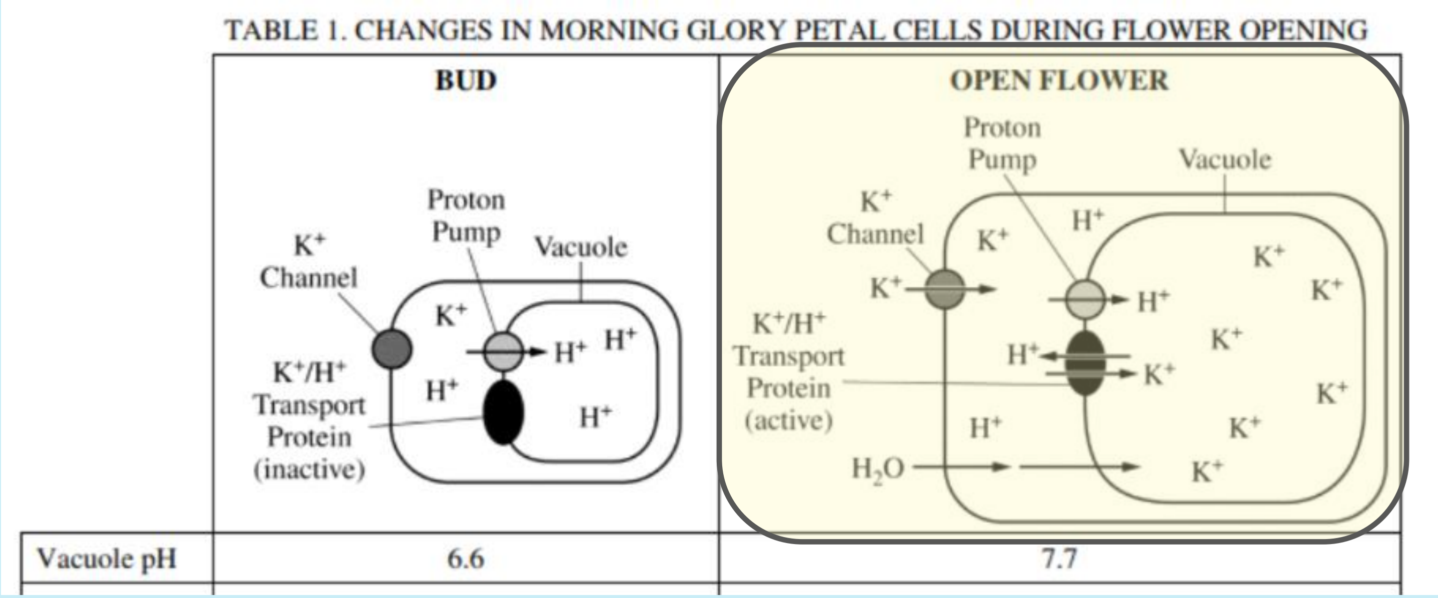
- (K^+ / H^+) transport protein

Description (1 point)

- It moves H^+ out of the vacuole.

Free Response Practice (2019 #8):

(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.



	BUD	OPEN FLOWER
Vacuole pH	6.6	7.7

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.

Q & A

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