CONCEPT: TRANSPORTERS AND ATP-DRIVEN PUMPS

Transporters

● ***Transporters*** transport _____ molecules across the membrane through conformational changes

□ Can modulate passive (Glucose uniport –GLUT1) or active transport

□ Three classes of active transporters exist

- **ATP-Driven pumps**: Use energy from ATP to drive transport

- **Coupled pumps**: Use energy from concentration gradient of one molecule to drive transport of another

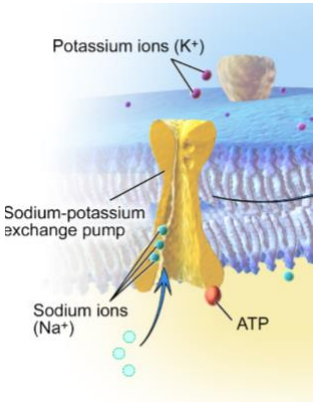
- Sometimes referred to as *indirect active transport*

- *Symports* move the two molecules in the same direction

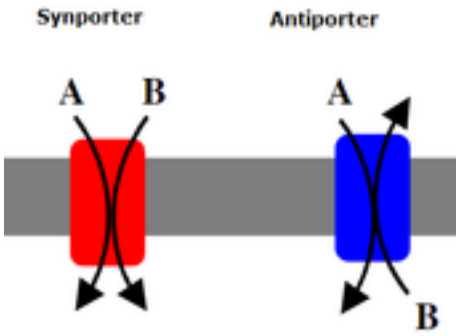
- *Antiports* move the two molecules in opposite directions

- **Light-driven pumps:** Use energy from light to drive transport across a membrane

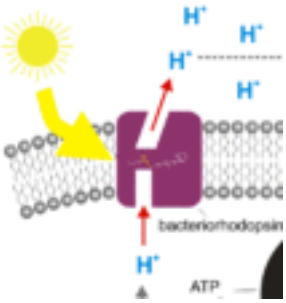
EXAMPLE:



ATP-powered pump



Coupled Pumps



Light Driven Pumps

● **NA^{2+} glucose symporter** allows for glucose _____ into the cytosol even when concentrations are high

□ Uses energy from sodium moving down its gradient to trigger glucose uptake

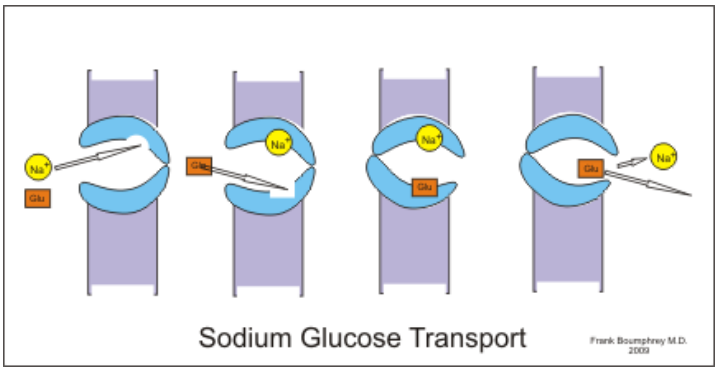
- Binding of sodium enhances the binding of glucose - but both are required for transport

□ Found on apical surface of gut epithelial

□ Different transporters exist on basolateral surface (passive glucose uniporters)

- Releases glucose into blood stream

EXAMPLE: Sodium Glucose Symporter



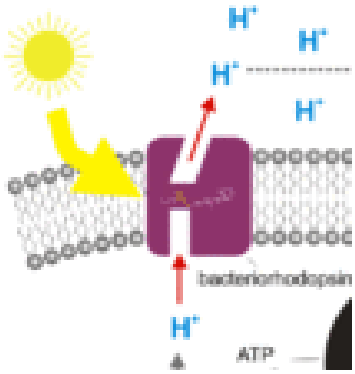
● **Bacteriorhodopsin** uses _____ energy to pump H^+ ions

□ Found in archaea *H. halobium* that lives in the Great Salt Lake in Utah

□ Contains *retinal* a molecule that senses light

- After light hits the retinal, it causes a proton to move to the cell exterior

EXAMPLE: Bacteriorhodopsin pumps H^+ out of the cell



ATP-Driven Pumps

● The four classes of ATP-driven pumps transport molecules _____ a gradient using energy from ATP

□ **P pumps** are phosphorylated in the process of pumping ions across the plasma membrane

□ **V pumps** transport H+ ions across a vacuolar membrane

- Maintaining acidity in lysosomes by pumping H^+ into the lumen

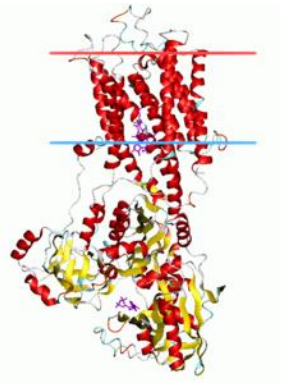
□ **F pumps** work in reverse by using H^+ gradients to drive ATP synthesis

□ **ABC transporters** pump small molecules across the cell membrane (largest group of the four classes)

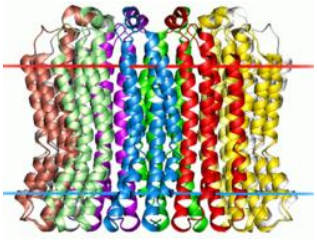
- **Multi-drug resistance protein** (MDR) provide drug resistance by pumping drugs out of cells

- ABC4 can act as a phospholipid flippase

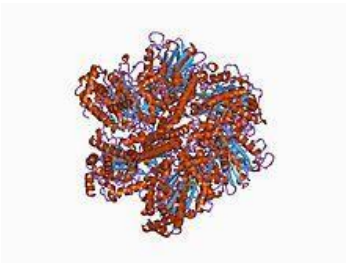
EXAMPLE:



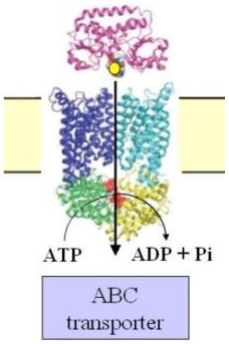
P pump



V pump



F pump



Examples of ATP-Driven Pumps

● ATP drive pumps generate ionic gradients that drive important cellular processes

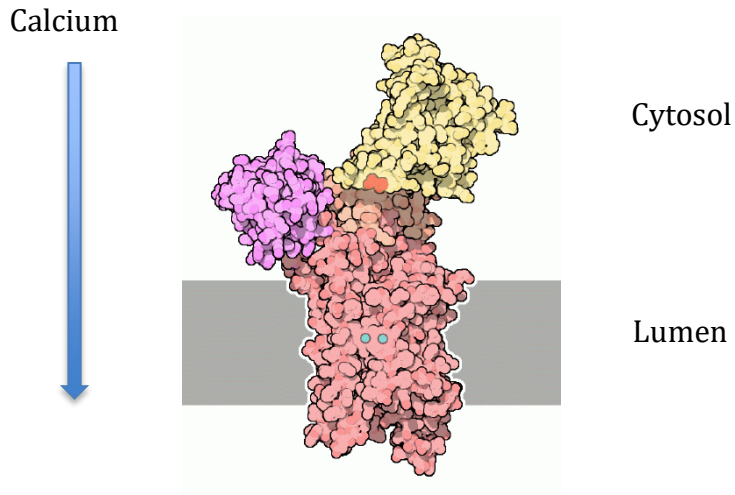
□ The **Ca^{2+} pump** drives muscle relaxation

- This P class pump is found in the *sarcoplasmic reticulum* (specialized form of endoplasmic reticulum)

- Responsible for causing muscle relaxation by pumping calcium from cytosol into SR lumen

- Calcium and ATP binding cause conformational change that opens and releases calcium into SR lumen

EXAMPLE:



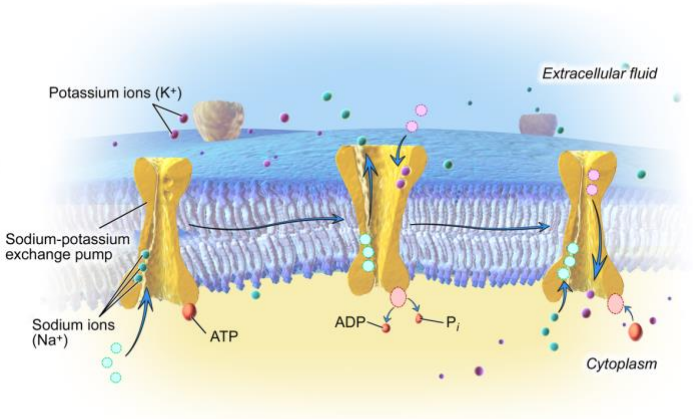
□ The **Na^{2+} K^{+} pump** moves sodium and potassium _____ concentration gradients

- Cytosol: High K^{+} and low Na^{+} - Extracellular space: Low K^{+} and high Na^{2+}

- Pumps three Na^{2+} ions out and two K^{+} ions into the cell per ATP molecule hydrolyzed

- Creates steep concentration gradients of sodium across the plasma membrane

EXAMPLE: Sodium Potassium Pump



The Sodium-Potassium Exchange Pump

PRACTICE

1. Which of the following is not considered a transporter?
   a. V ATP pump
   b. Light driven pumps
   c. Coupled pumps
   d. Ion channels

2. True or False: Transporters always require energy to move solutes across a membrane?
    a. True
    b. False

3. Which of the following classes of ATP-drive pumps can synthesize ATP when reversed?
    a. P pumps
    b. V pumps
    c. F pumps
    d. ABC Transporters

4. The sodium-potassium pump works by doing what?
    a. Pumping one sodium ion into the cell, while pumping one potassium ion out of the cell
    b. Pumping one sodium ion out the cell, while pumping one potassium ion into the cell
    c. Pumping three sodium ion into the cell, while pumping two potassium ion out of the cell
    d. Pumping three sodium ion out the cell, while pumping two potassium ion into the cell