

Active Transport

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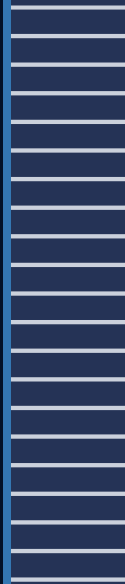
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Assisted Membrane Transport

Assisted Membrane Transport

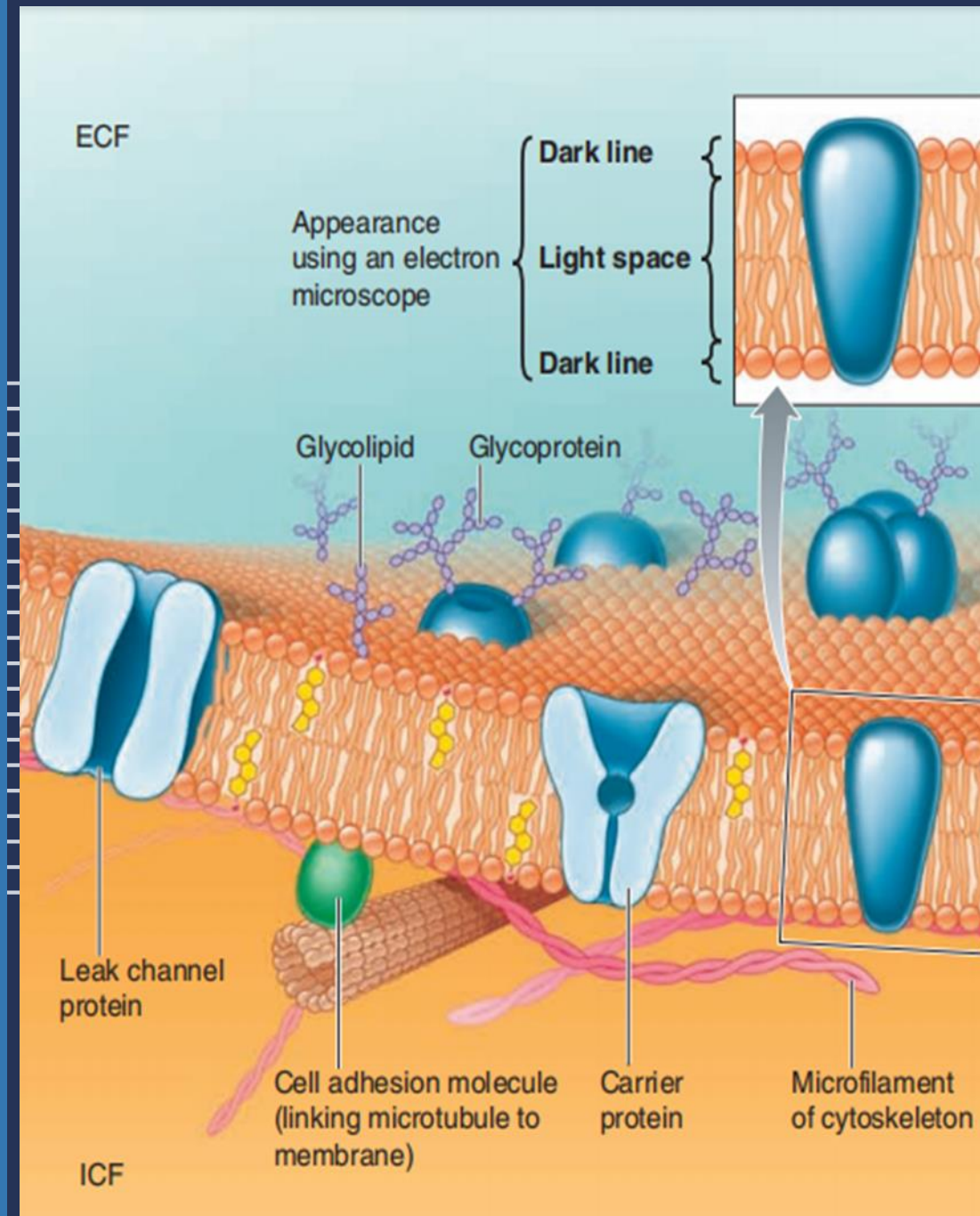
- ❖ **Poorly lipid-soluble** polar molecules that are too big for channels, such as **proteins, glucose, and amino acids**, cannot cross the plasma membrane on their own no matter what forces are acting on them.
- ❖ The cell must provide mechanisms for deliberately transporting these types of molecules into or out of the cell as needed.



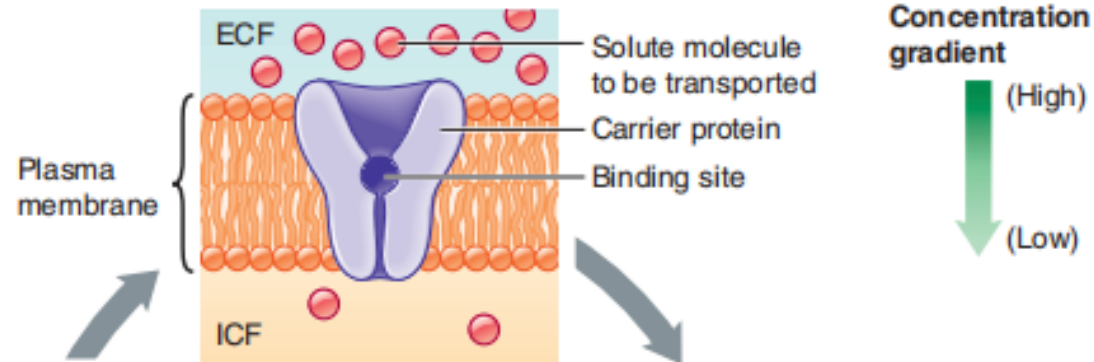
Carrier-mediated transport

Carrier-mediated transport

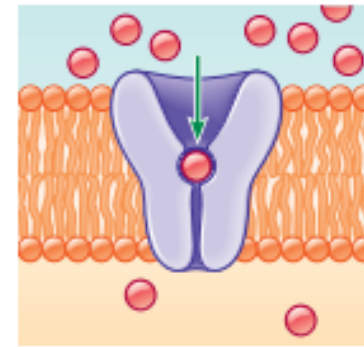
- ❖ A carrier protein spans **the thickness of the plasma membrane** and can change its conformation (**shape**) so that specific binding sites within the carrier are alternately exposed to the ECF and the ICF.



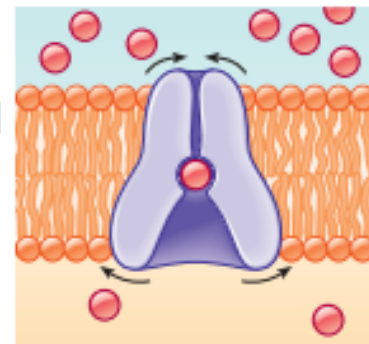
1 Carrier protein takes conformation in which solute binding site is exposed to region of higher concentration.



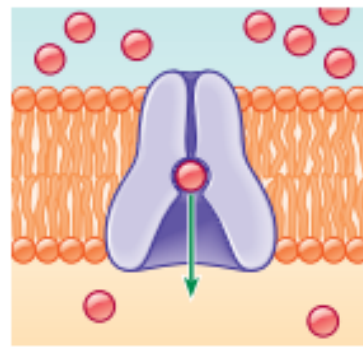
2 Solute molecule binds to carrier protein.



3 Carrier protein changes conformation so that binding site is exposed to region of lower concentration.



4 Transported solute is released and carrier protein returns to conformation in step 1.



Direction of transport



Carrier-mediated transport

- ❖ Both channels and carriers are proteins that span the plasma membrane and serve as selective avenues for movement of water-soluble substances across the membrane, but there are notable **differences** between them:
 1. Only ions fit through the **narrow channels**, whereas small polar molecules such as glucose and amino acids are transported across the membrane by **carriers**.
 2. **Channels** can be open or closed, but **carriers** are always “open.”
 3. Movement through **channels** is considerably **faster** than carrier-mediated transport is.



Carrier-mediated transport

- ❖ Three important characteristics determine the kind and amount of material that can be transferred across the membrane: **specificity**, **saturation**, and **competition**.



Carrier-mediated transport

❖ 1. Specificity:

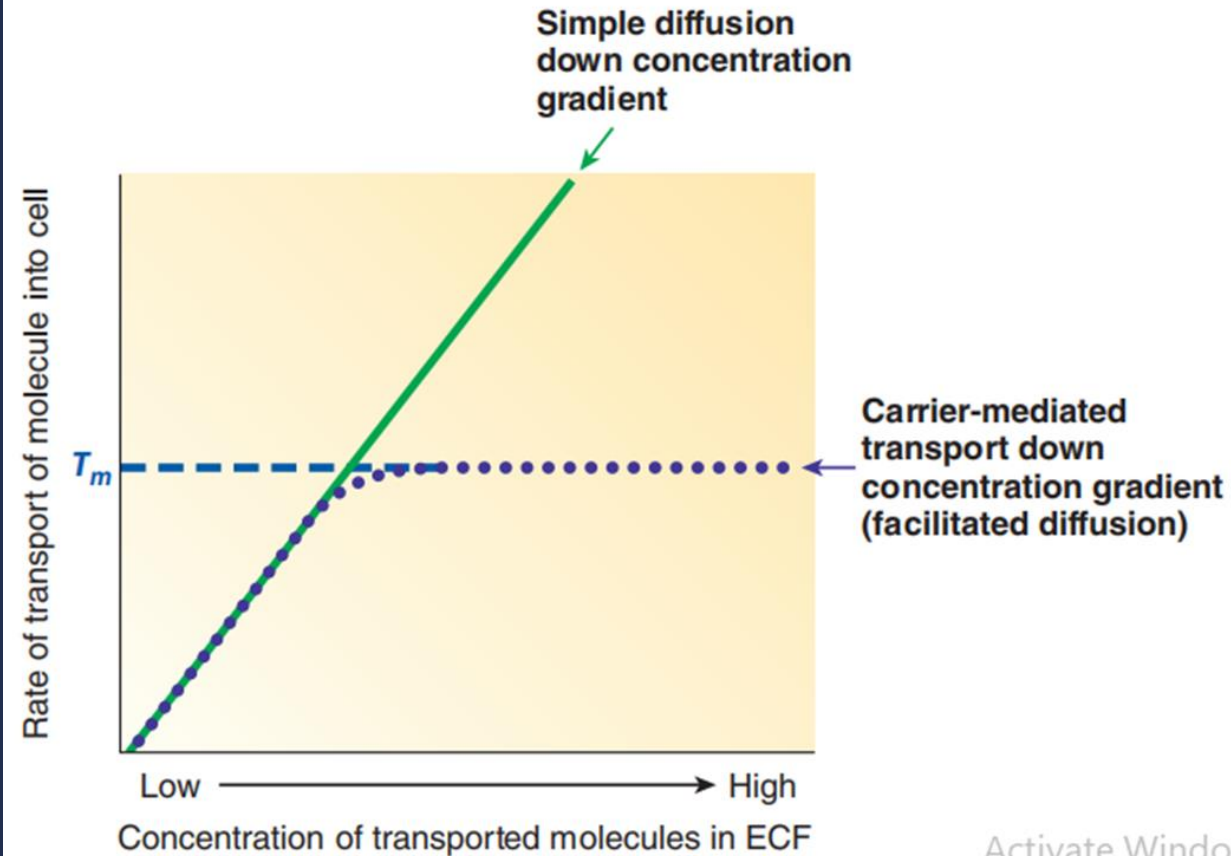
- Each carrier protein is specialized to transport a **specific substance** or, at most, a few **closely related** chemical compounds.
- For example, **amino acids cannot bind to glucose carriers**, although several similar amino acids may be able to use the same carrier.



Carrier-mediated transport

❖ 2. Saturation:

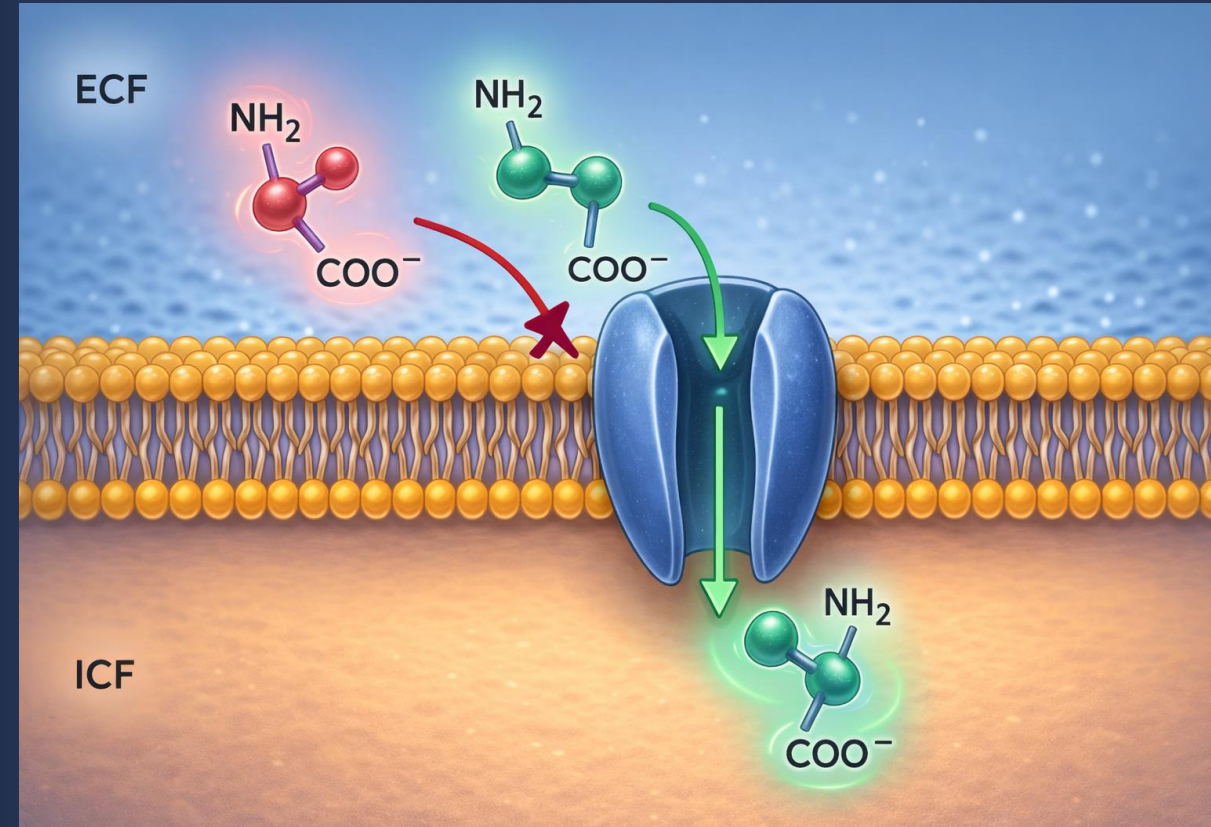
- A limited number of carrier binding sites are available within a particular plasma membrane for a specific substance.



Carrier-mediated transport

3. Competition:

- Several closely related compounds may **compete** for a ride across the membrane on the same carrier.



Facilitated diffusion

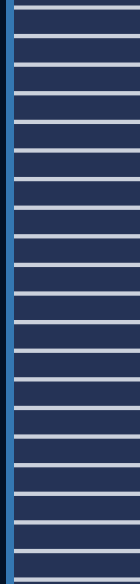
Facilitated diffusion

- ❖ Facilitated diffusion uses a carrier to facilitate (**assist**) the transfer of a particular substance across the membrane “downhill” **from high to low concentration**.
- ❖ This process is **passive** and **does not require energy** because movement occurs naturally down a concentration gradient.



Facilitated diffusion

- ❖ The most notable example of facilitated diffusion is the transport of **glucose** into cells.
- ❖ Glucose **can not** cross plasma membranes on its own because it is **not lipid soluble and is too large to fit through a channel**.
- ❖ Glucose transporters, or **GLUTs**.

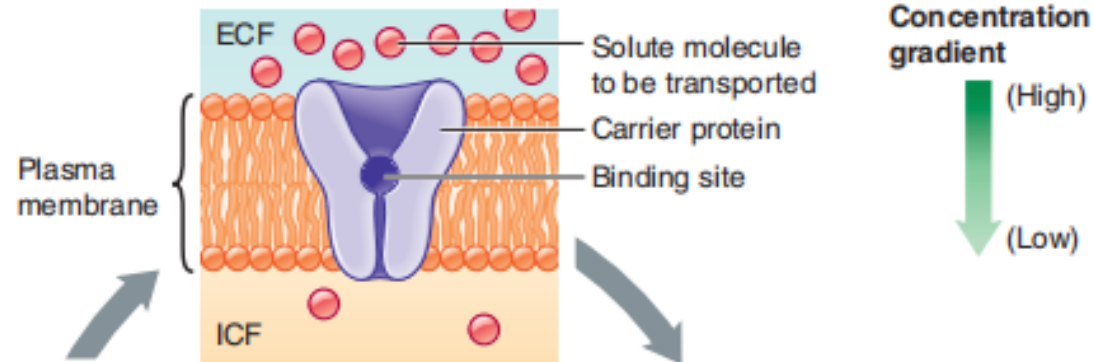


Facilitated diffusion

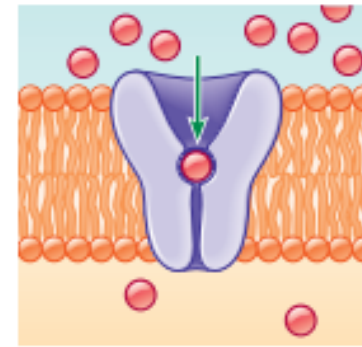
- ❖ Because passengers are **more likely to bind with the carrier on the high-concentration side** than on the low-concentration side, the **net movement always proceeds down the concentration gradient** from higher to lower concentration



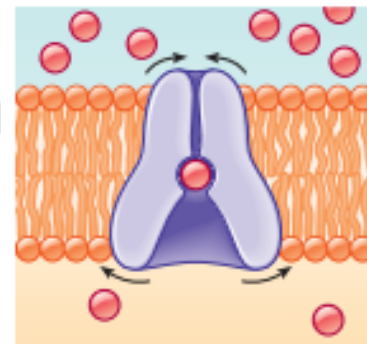
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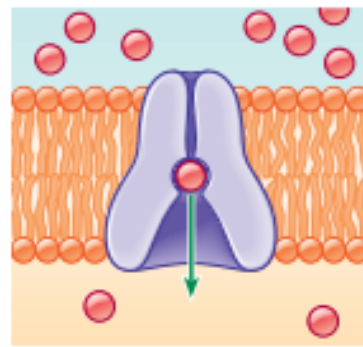
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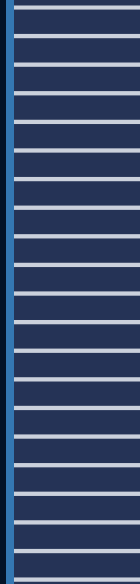
Active transport

Active transport

❖ Active transport also **uses a carrier protein** to transfer a specific substance across the membrane, but in this case the carrier transports the substance **uphill against its concentration gradient**.

❖ Types of active transport:

1. **Primary active transport**
2. **Secondary active transport**



Primary active transport

- ❖ In primary active transport, **energy** is directly required to move a substance against its concentration gradient; the carrier splits **ATP** to power the transport process.



Secondary active transport

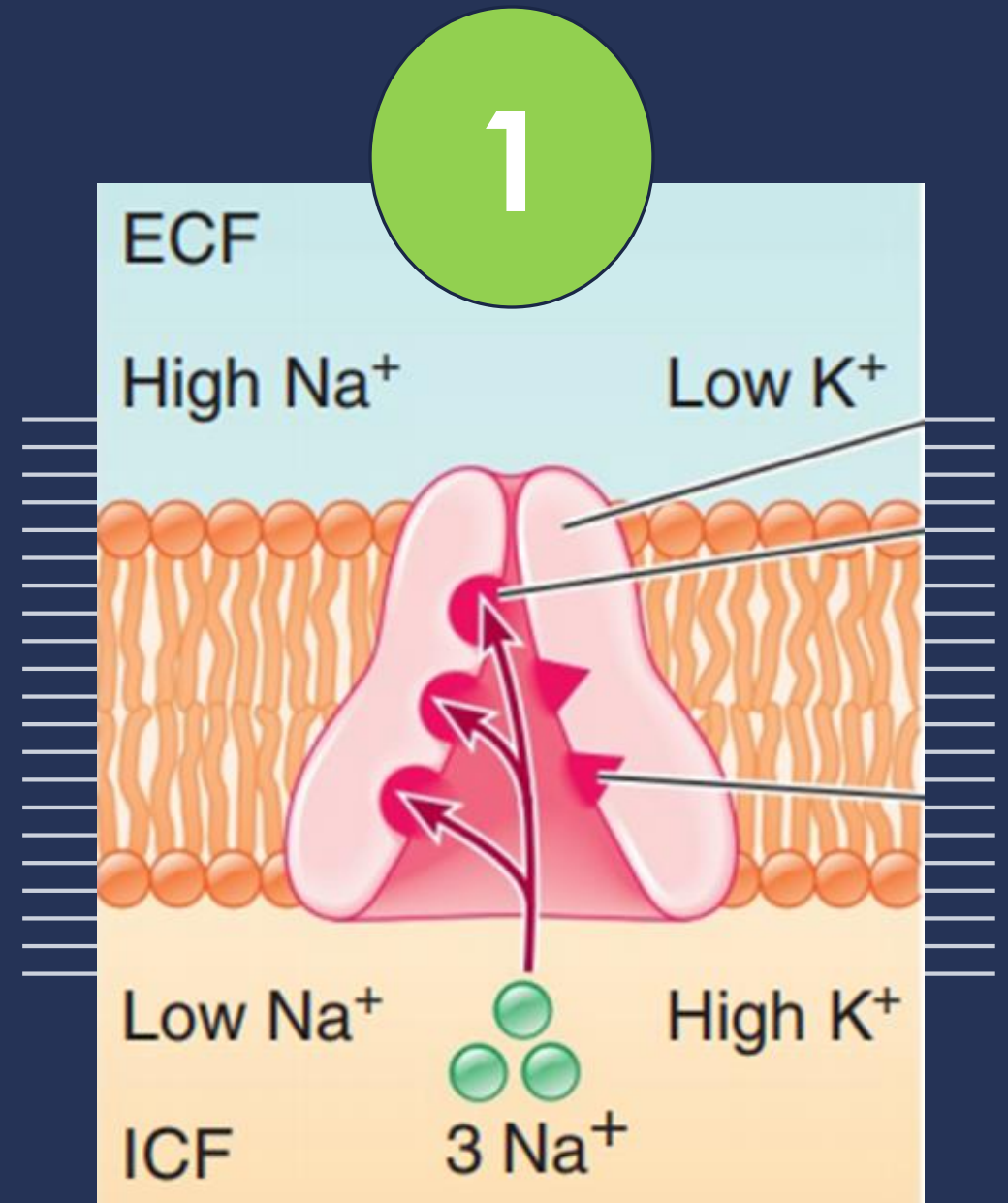
- ❖ In secondary active transport, **energy is required in the entire process**, but it is **not directly** used to produce uphill movement.
- ❖ That is, the carrier does not split ATP; instead, it moves a molecule uphill by using “second hand” energy **stored in the form of an ion concentration gradient**(most commonly a **Na⁺ gradient**). This ion gradient is built up by primary active transport of the ion by a different carrier.



Primary Active Transport

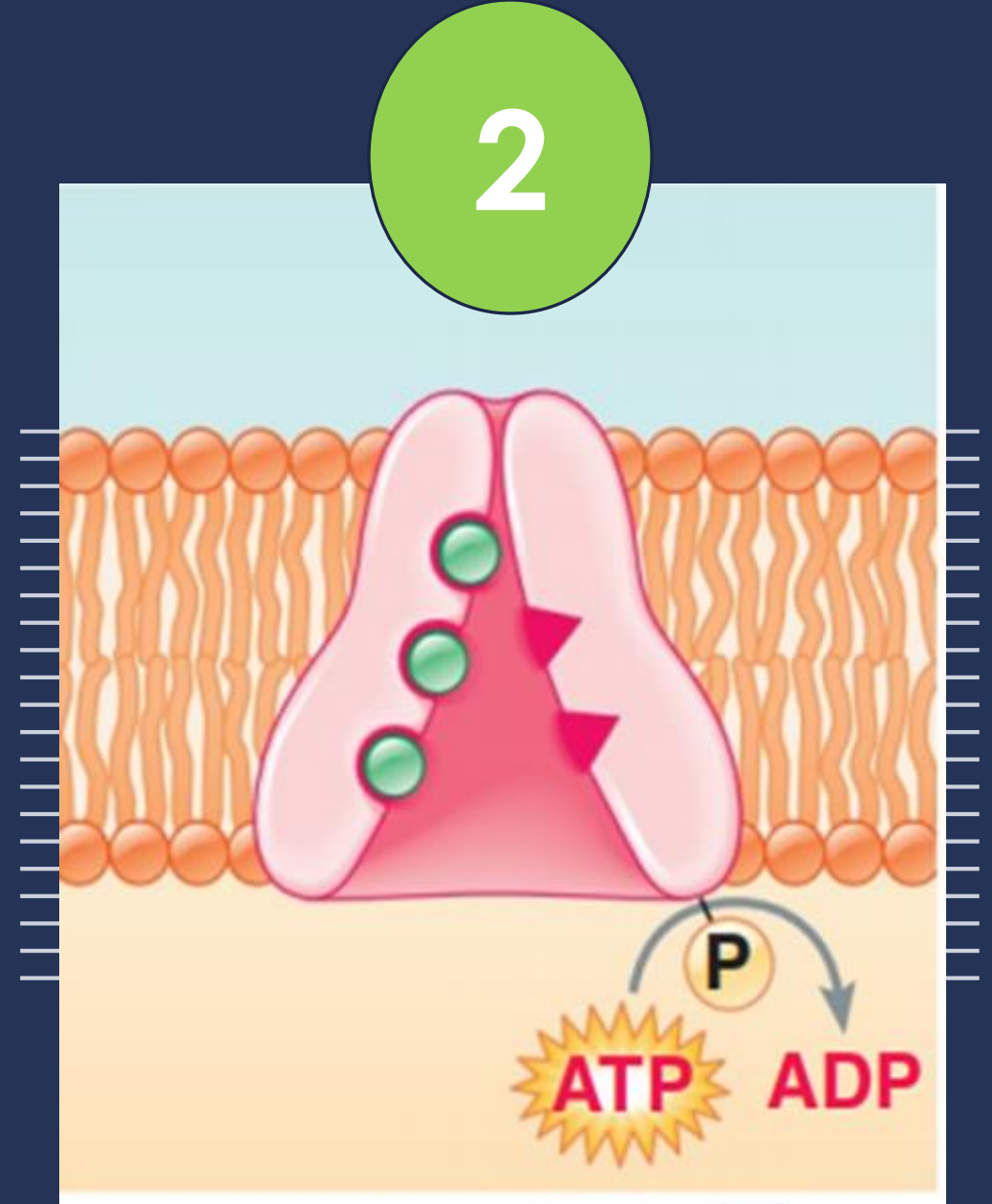
Primary Active Transport

- ❖ The **binding sites** have a **greater affinity** for the **passenger ion** on the **low-concentration side** where the ion is picked up and a lower affinity on the high-concentration side where the ion is dropped off.
- ❖ These active-transport mechanisms are often called “**pumps**,”

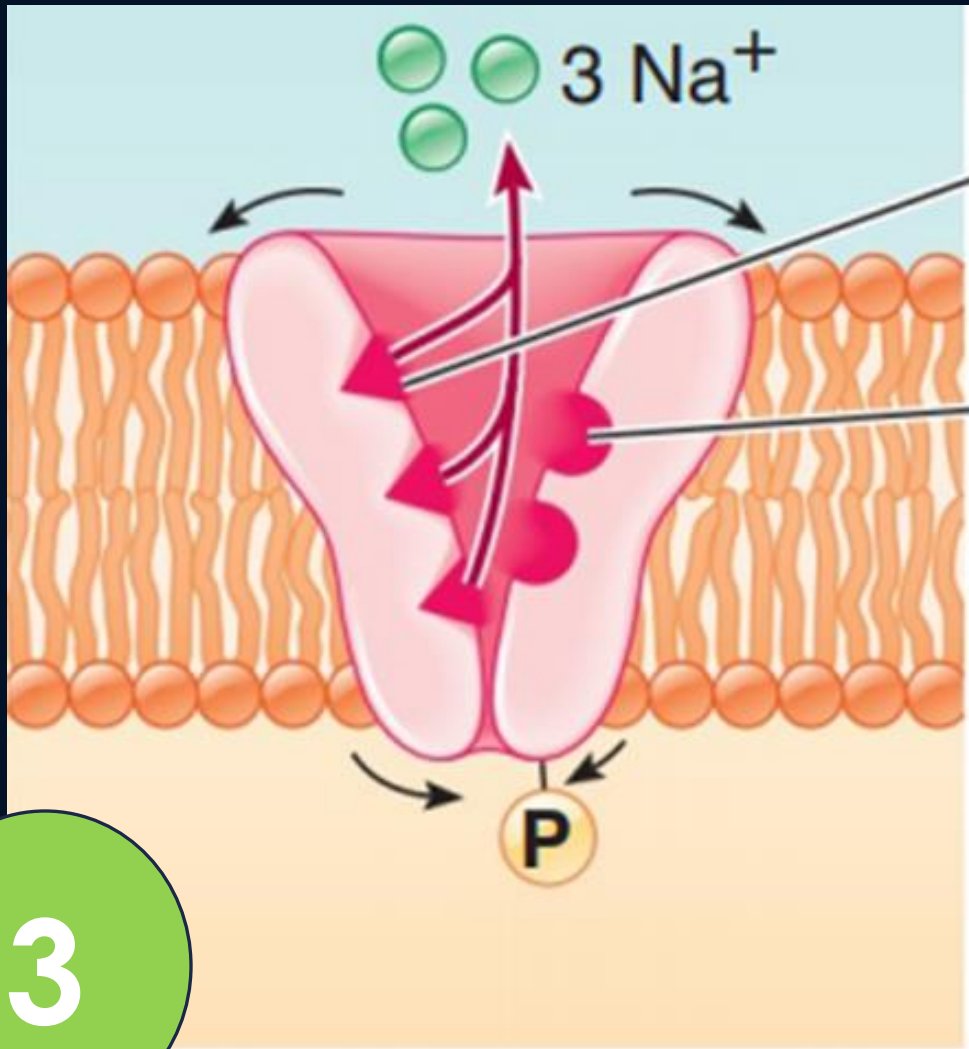


Primary Active Transport

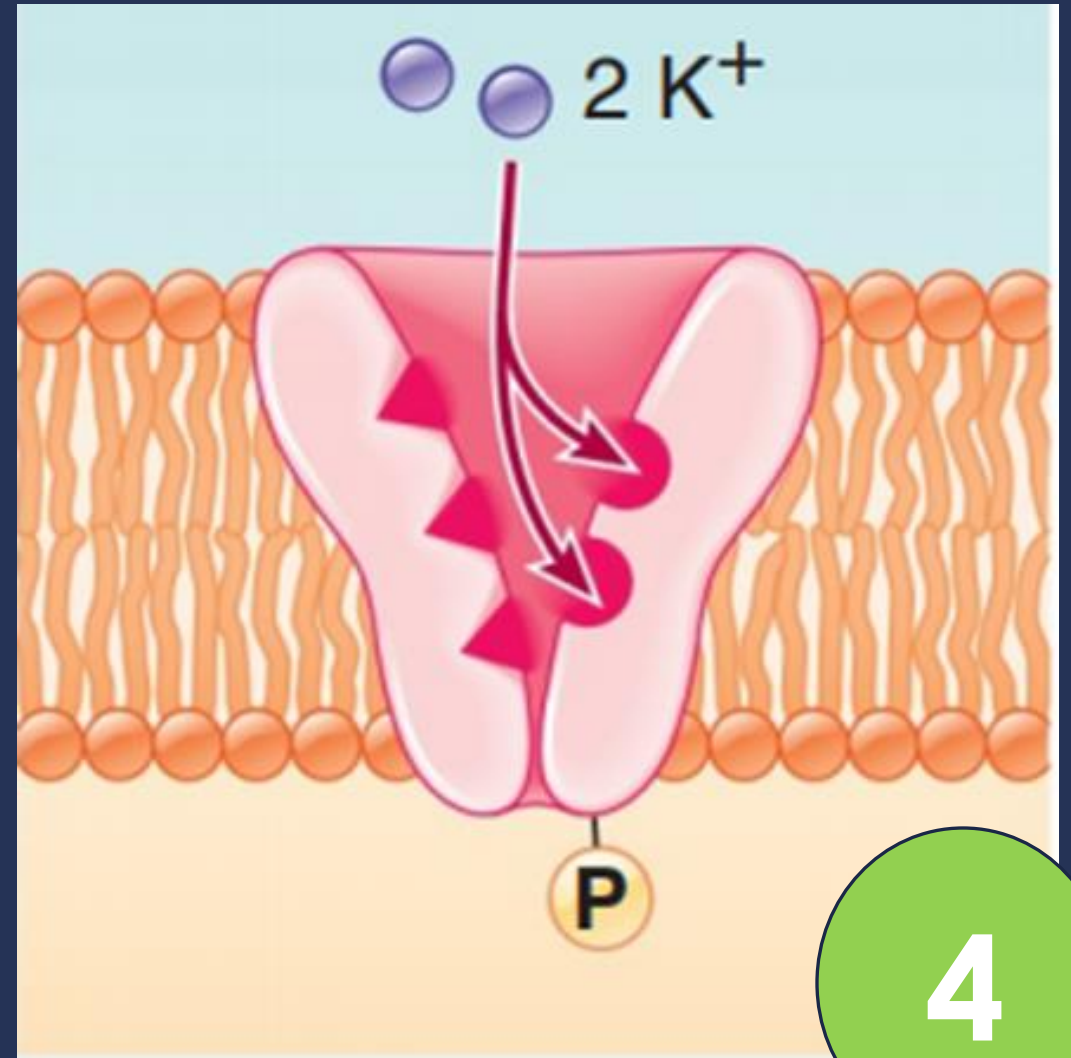
- ❖ All primary-active transport carriers act as enzymes that have **ATPase activity**.



Primary Active Transport

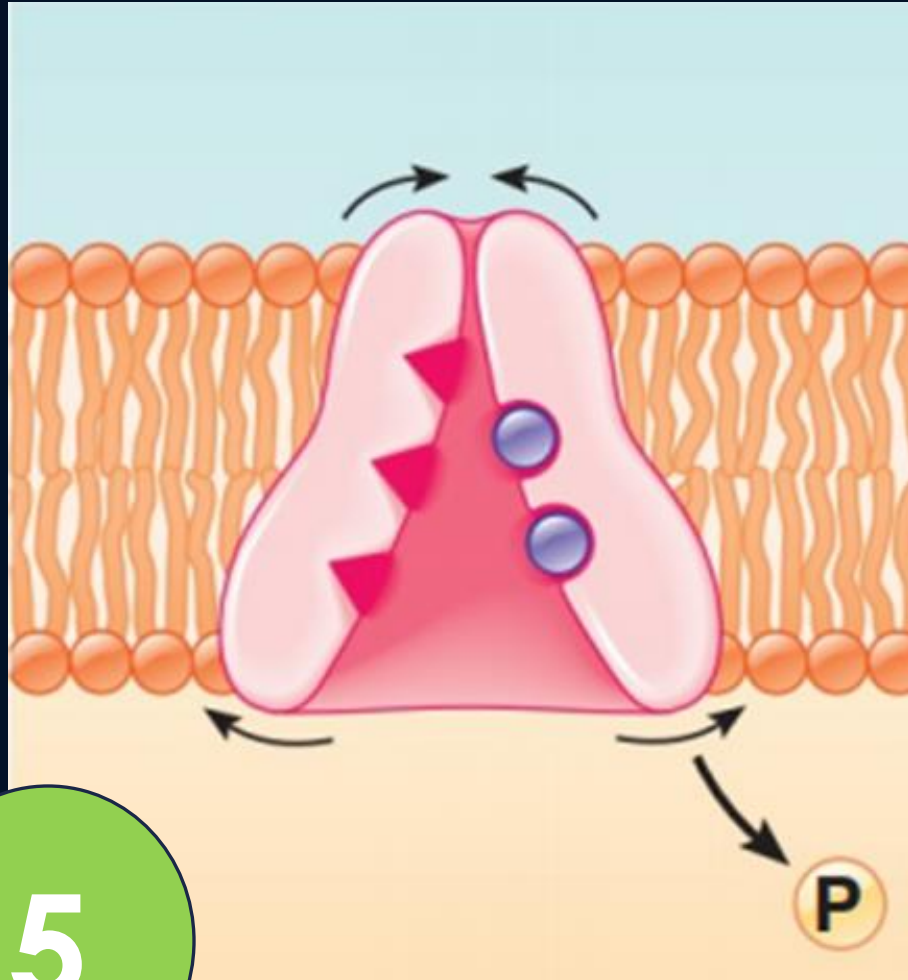


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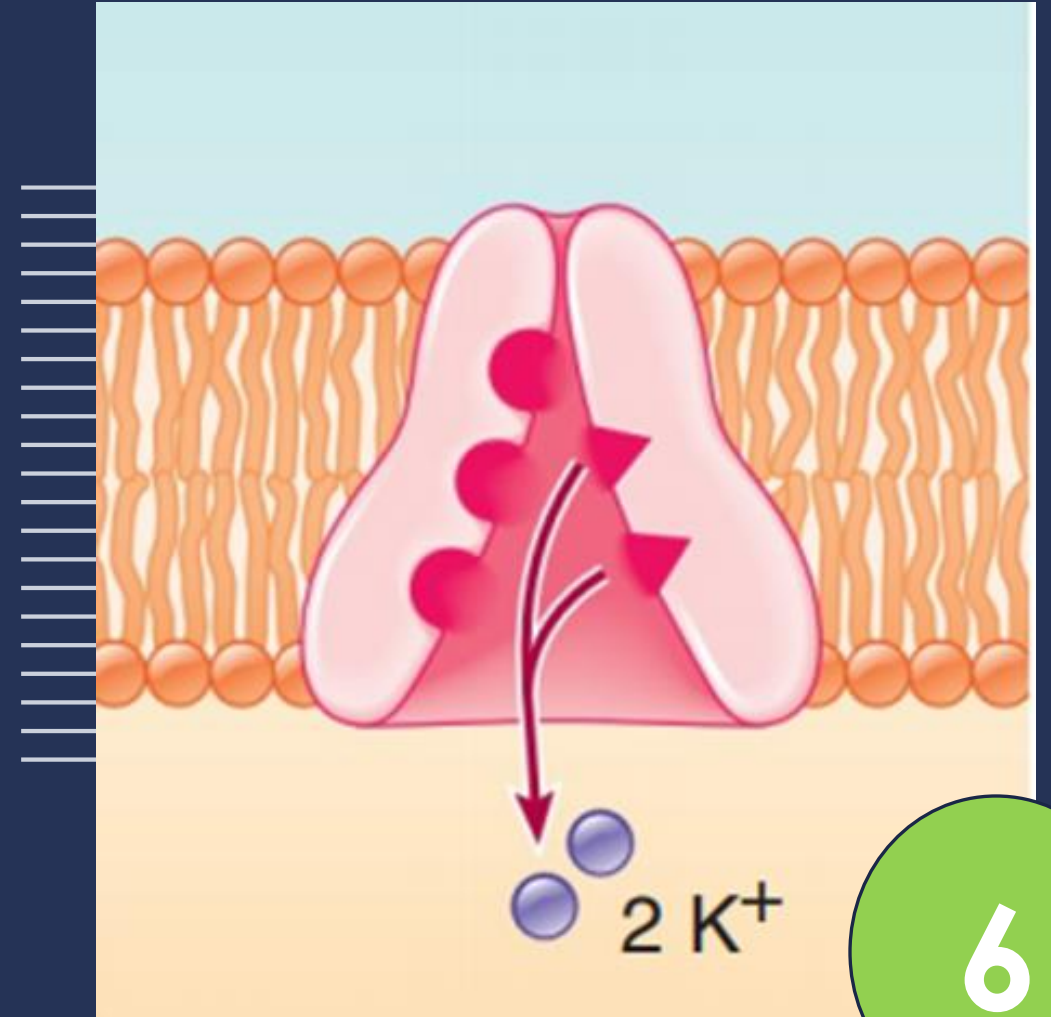


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Primary Active Transport



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Secondary Active Transport

Secondary Active Transport

- ❖ With secondary active transport, the carrier **does not directly split ATP** to move a substance against its concentration gradient.
- ❖ Instead, the movement of Na^+ into the cell down its concentration gradient (established by the ATP-splitting Na^+-K^+ pump) drives the uphill transport of another solute by a secondary active-transport carrier.
- ❖ This is efficient because Na^+ must be pumped out anyway to maintain the electrical and osmotic integrity of the cell.



Secondary Active Transport

- ❖ The transfer of the solute across the membrane is always **coupled** (occurs together) with the transfer of the ion that supplies the driving force.
- ❖ Na^+ as the main example. Secondary active transport carriers have **two binding sites**:
 1. one for the solute being moved
 2. one for Na^+



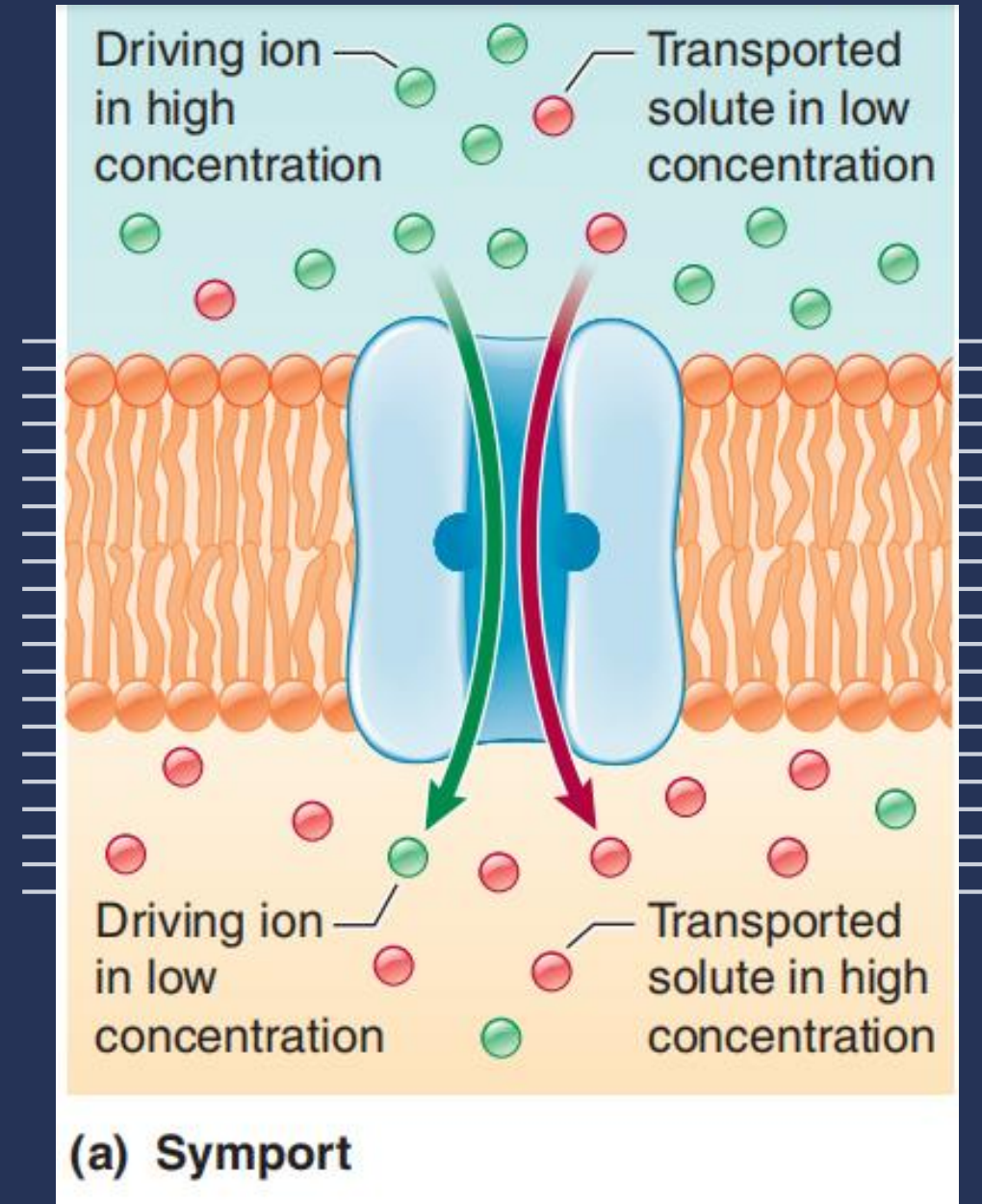
Secondary Active Transport

- ❖ It occurs by two mechanisms—**symport** and **antiport**—depending on the **direction** the transported solute moves in **relation** to Na^+ movement.



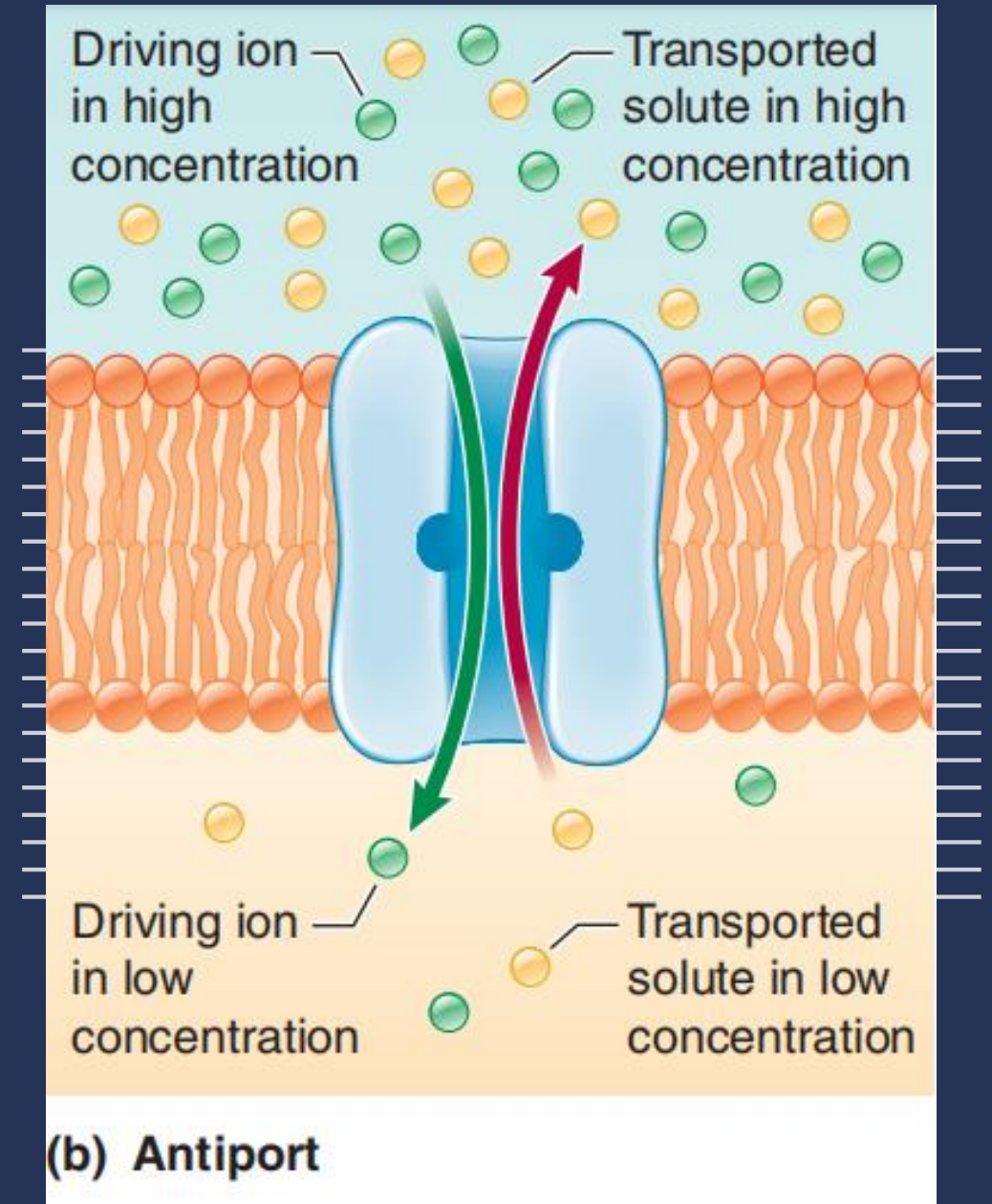
Symport (cotransport)

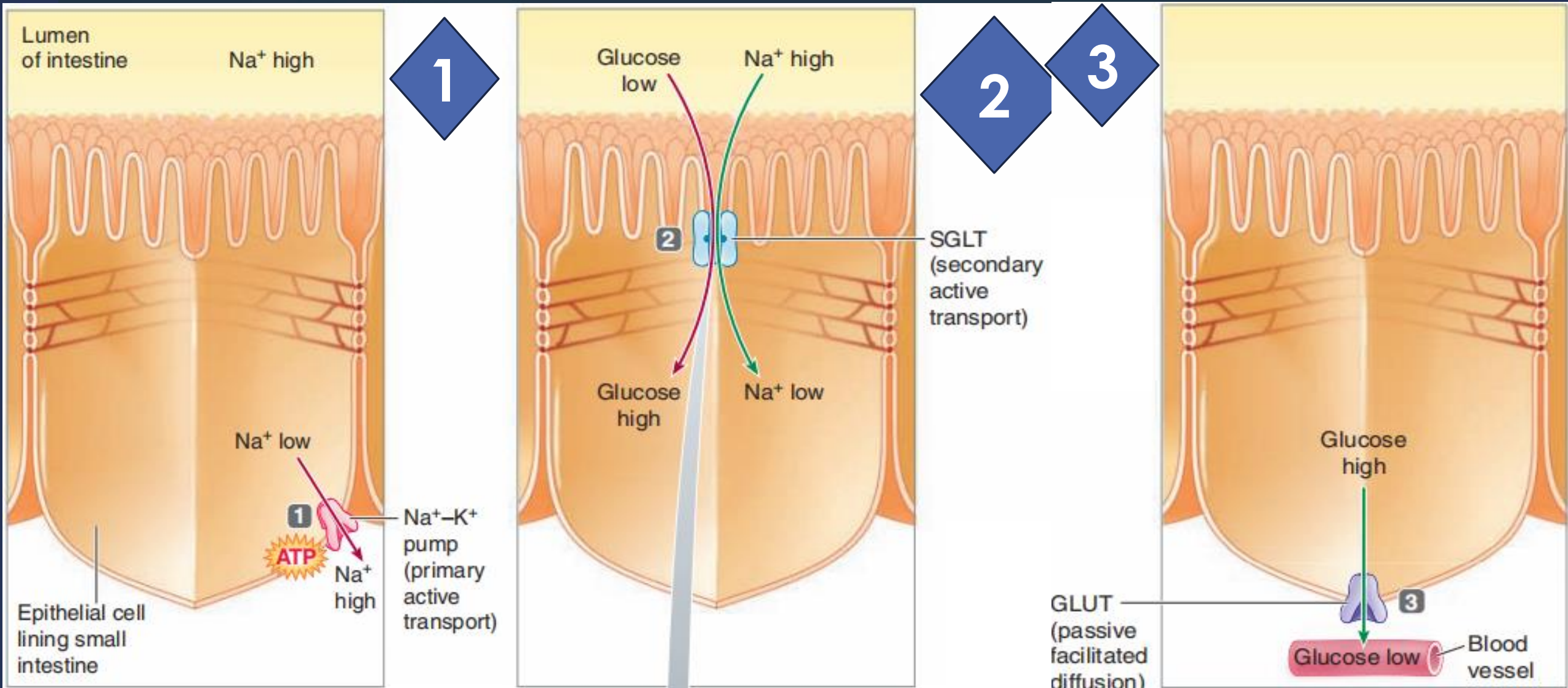
- ❖ In symport, the solute and Na^+ move through the membrane in the **same direction**—that is, into the cell (sym means “together”; co means “with”).
- ❖ **Glucose and amino acids** are examples of molecules transported by symport in intestinal and kidney cells.
- ❖ **Sodium and glucose cotransporter or SGLT**, is located in the luminal membrane (the membrane facing the intestinal lumen).



Antiport (counter transport)

- ❖ In antiport, the solute and Na^+ move through the membrane in **opposite directions**—that is, **Na^+ into** and the **solute out** of the cell (anti means “opposite”; counter means “against”).
- ❖ For example, cells exchange **Na^+ and H^+** by means of antiport.





1 Na⁺-K⁺ pump uses energy to drive Na⁺ uphill out of cell.

3 GLUT passively moves glucose downhill out of cell into blood.

Thank You