TRANSPORT PHENOMENON
FICK'S LAW OF DIFFUSION
ATP-POWERED PUMPS
-III-

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TRANSPORT SYSTEMS
UNMEDİATED-MEDİATED TRANSPORT

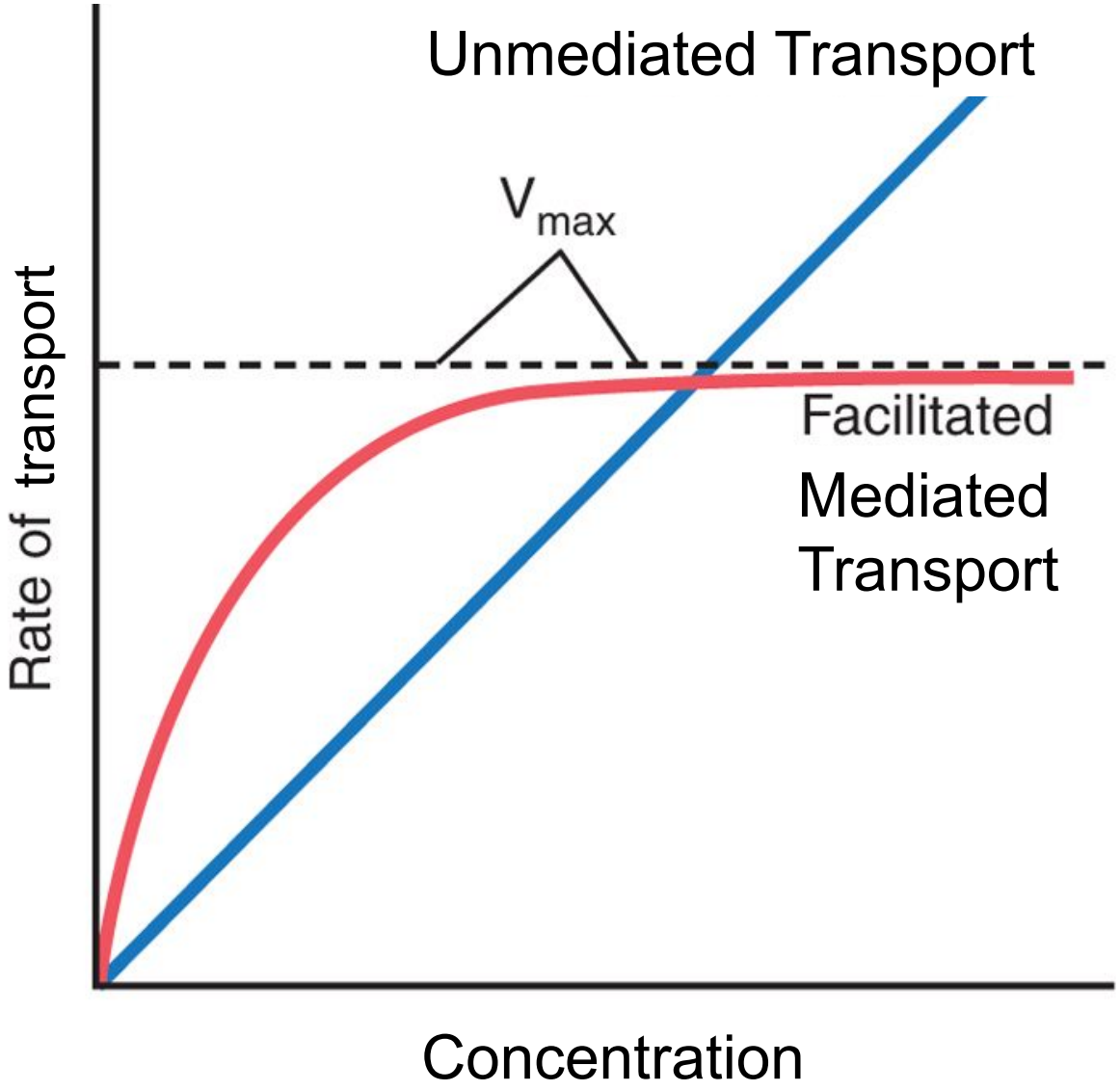
Unmediated Transport

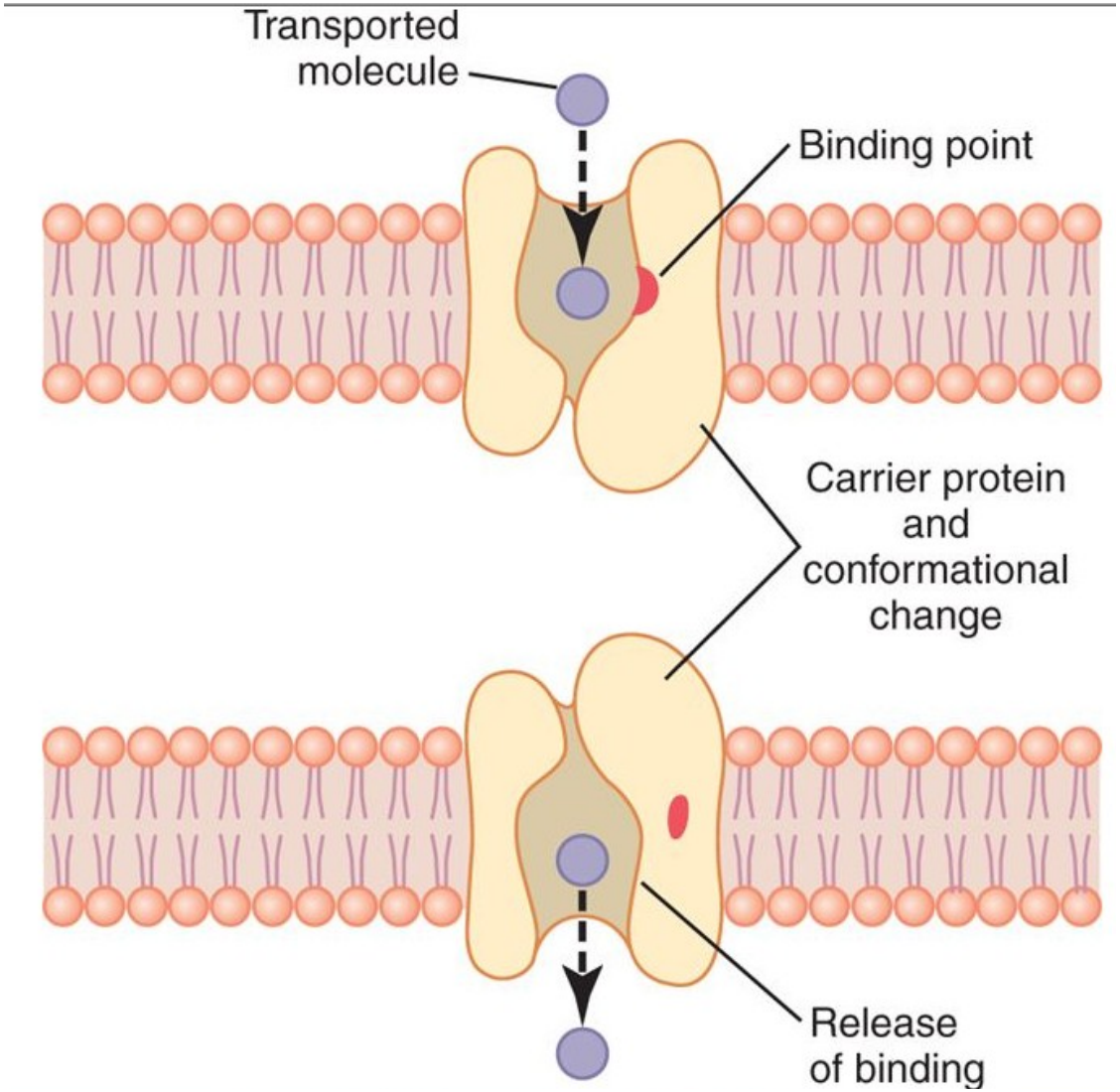
- Is a result of simple physical diffusion of solute molecules
  - The driving power of diffusion is the concentration/potential gradient
- transport rate is directly proportional with the concentration of solute
- solute molecules do not undergo a chemical change during transport

Mediated Transport

Facilitated Diffusion

- Shows saturation kinetics
  - The mediator may reach a saturation point for solute molecules.
  - In this case, transport rate is independent of the concentration of solute molecules
  - transport system has an active region (receptor) which can bind substrate in a reversible way
  - Transport rate can never be greater than the
    - binding rate of the substrate
    - rate of the transition substrate in the receptor
    - release rate of binding on the other side of the receptor


Unmediated Transport
V_{max}
Facilitated
Mediated
Transport
Rate of transport
Concentration


Transported molecule
Binding point
Carrier protein and conformational change
Release of binding

Mediated Transport

- Specific for the transported substance
  - Carrier system only shows activity for a particular substance or close equivalents
- Specific inhibition
  - agents which has similar stuructures as substrate can bind to the receptor (competitive inhibition) or
  - agents can bloke or alter the functional group of proteins
- Among the most important substances that cross cell membranes by facilitated/mediated transport are *glucose* and most of the *amino acids*.

Active and Passive Mediated Transport

- A transport system can be specified as active or passive according to the following factors:
  - Transport downhill **with** the concentration gradient or uphill **against** the concentration gradient
  - Requires metabolic energy or not
  - Transport only in one direction

Active Transport Systems

- There are three major active transport systems in animal cells;
  - Na^+- K^+ pump
  - Transport system for glucose and other carbohydrates
  - Transport system for amino acids

Na^+- K^+ pump

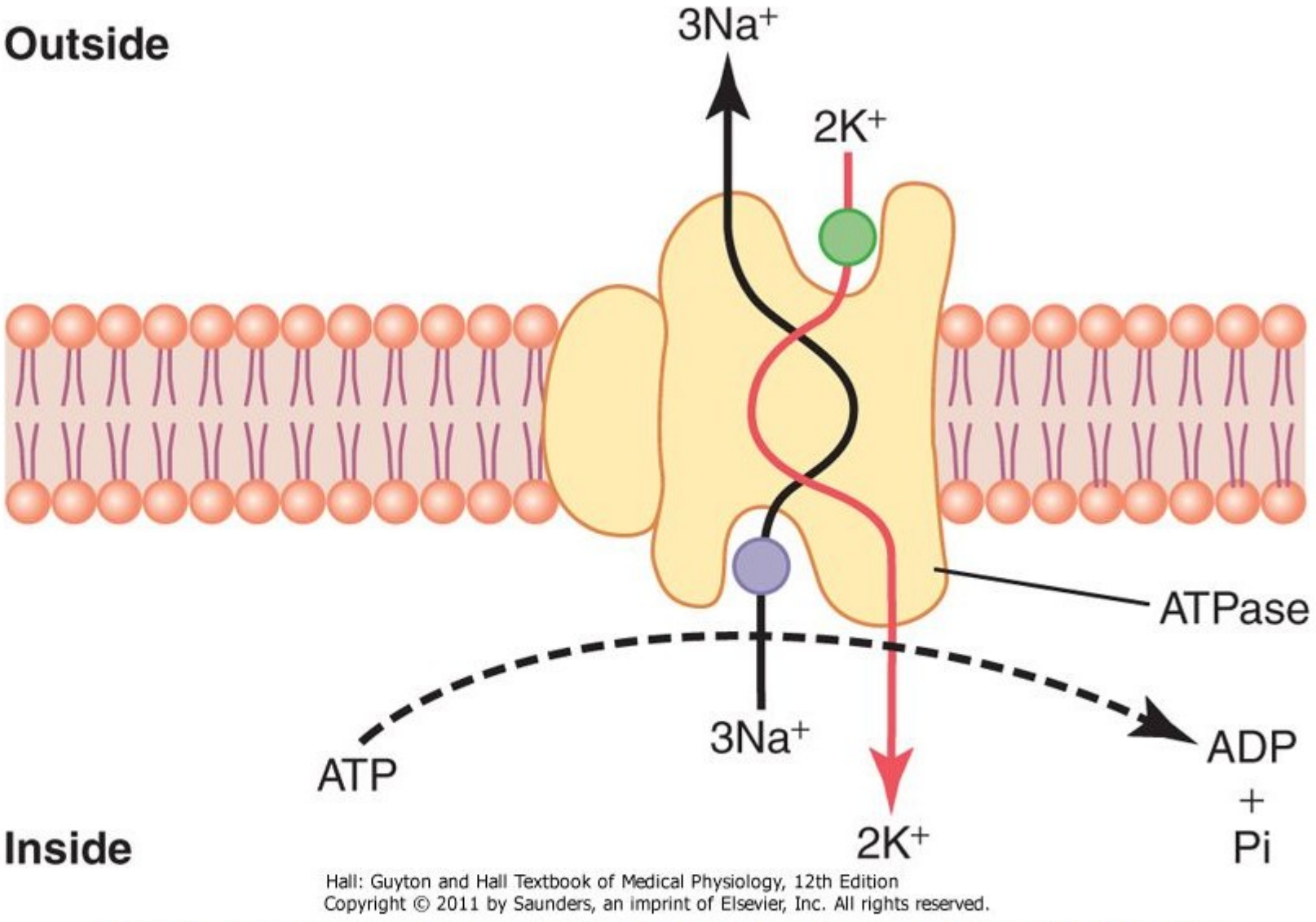
- It is the most active and widespread transport system among active transport systems.
- Found in almost all animal cell membranes.
- Low intracellular Na^+ concentration and high extracellular Na^+ concentration
  - intracellular Na^+ concentration ~10 mM
  - extracellular Na^+ concentration ~150 mM
- High intracellular K^+ concentration and low extracellular K^+ concentration
  - intracellular K^+ concentration ~ 120 to 160 mM
  - extracellular K^+ concentration ~ 4 mM

Na^+- K^+ pump

- Distribution of intra-and extracellular Na^+ and K^+ ions is vital in terms of some cellular processes.
- High intracellular K^+ concentration is essential for;
  - the synthesis of protein in the ribosomes
  - the maximum activity level of some enzymes
  - the production of the necessary impulse in excitable cells such as nerve and muscle cells. Because the membrane potential depends on the concentration gradients of Na^+ and K^+ ions, stimulating a cell will suddenly change the permeability of the membrane and thus impulse generation occurs for the information transmission between cells.

Na^+- K^+ pump

- Intracellular K^+ concentration is kept high by means of the enzyme Na^+K^+-ATPase
  - (Na^+-K^+) pump, pumps 3 Na^+ outward through the cell membrane of all cells and at the same time pumps 2 K^+ from the outside to the inside
  - Required energy -for the work done against the electrochemical gradient- is derived directly from breakdown of adenosine triphosphate (ATP).
  - Because the energy is derived directly from ATP, this kind of transport mechanisms are called *primary active transport.*

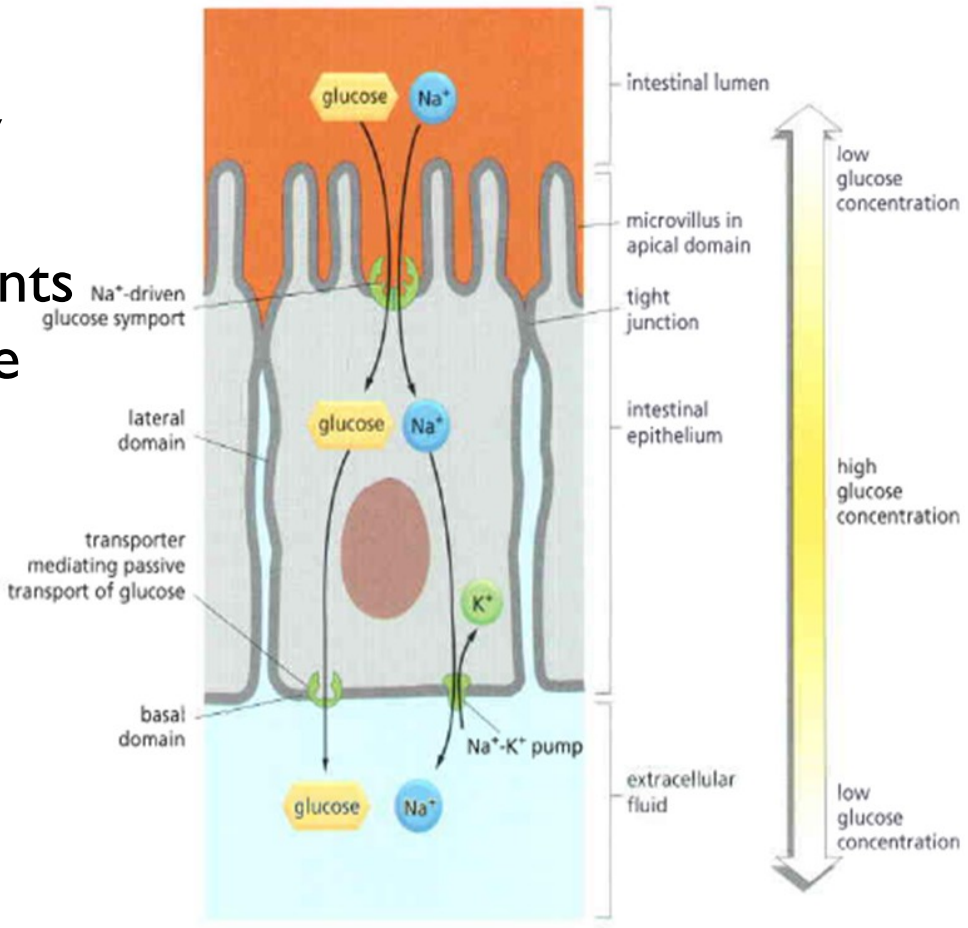


Mechanism of the sodium-potassium pump.

ADP, adenosine diphosphate; ATP, adenosine triphosphate; Pi, phosphate ion.

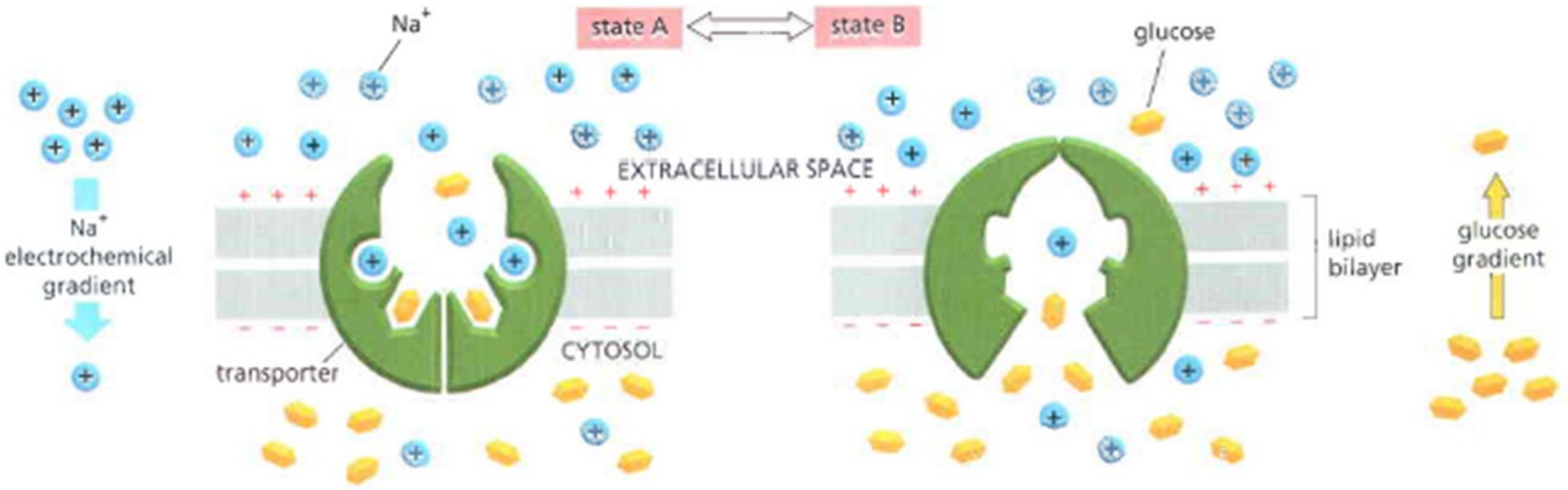
Active transport of glucose

- During the absorption of carbohydrates from small intestine into the blood, glucose transport is done against the glucose concentration gradient.
- This transport is achieved by means of a carrier protein which serves attachment points for both Na+ ion and glucose molecule.



Active transport of glucose

- When Na^+ ions are transported out of cells by primary active transport, a large concentration gradient of Na^+ ions across the cell membrane usually develops-high concentration outside the cell and low concentration inside. This gradient represents a storehouse of energy because the excess Na^+ outside the cell membrane is always attempting to diffuse to the interior.
- This diffusion energy of Na^+ can pull glucose along with the Na^+ through the cell membrane.
- This phenomenon is called co-transport or symport.
- Thus, a glucose gradient develops towards the outside of the cell.
- In this case, for the transport of glucose against the concentration gradient, ATP energy is used indirectly. This type of transport is called as *secondary active transport.*
- The same transport mechanism is valid for amino acids.


Na+
electrochemical
gradient
Na+
state A
state B
glucose
EXTRACELLULAR SPACE
lipid
bilayer
glucose
gradient
transporter
CYTOSOL

References

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