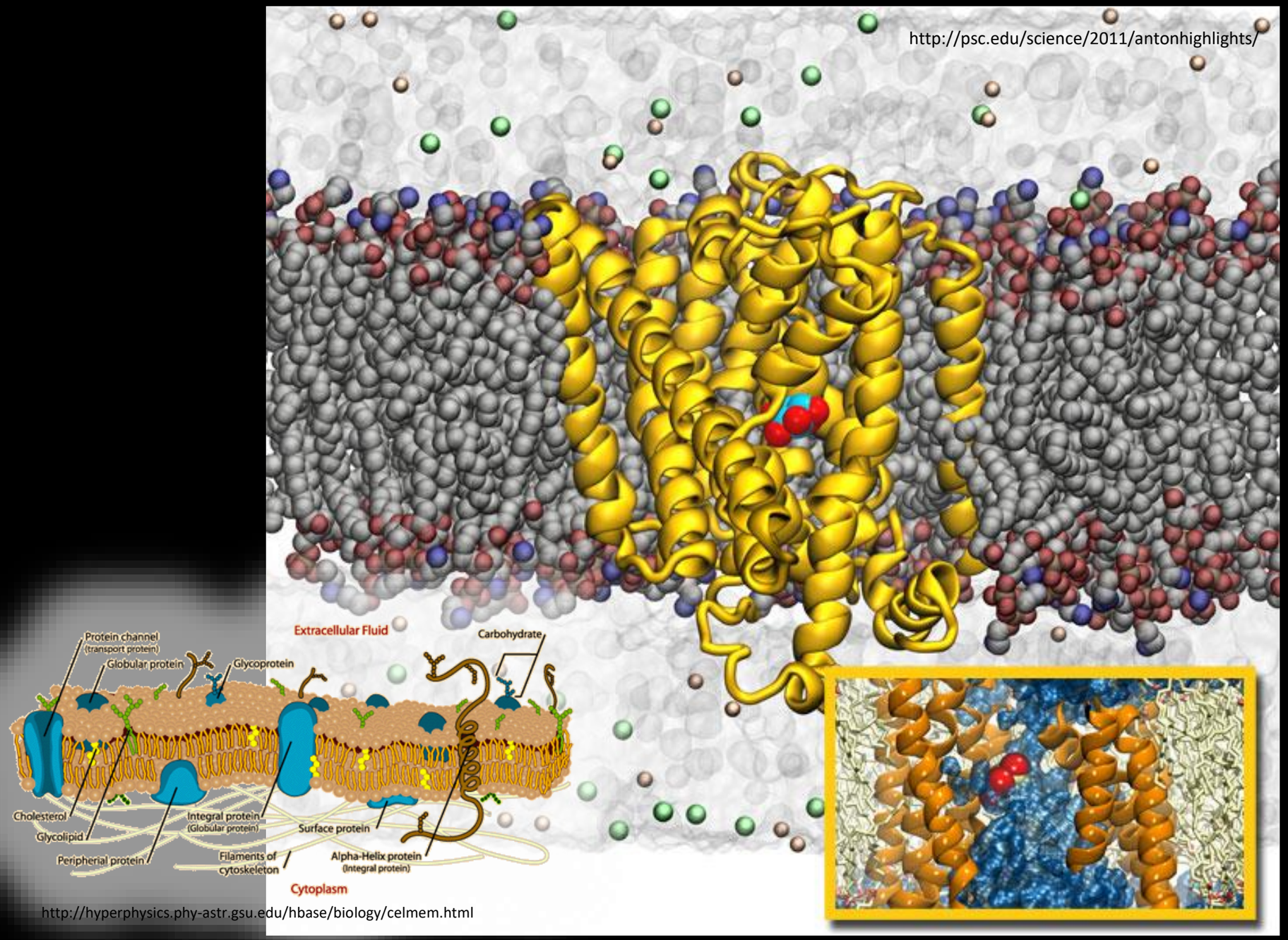
BIOLOGI SEL

PERTEMUAN 3

UMI BARAROH, S.Si., M.Biotek



STRUKTUR & FUNGSI MEMBRAN

Apa yang Membedakan Makluk Hidup & Lingkungan?

KONSEP KUNCI

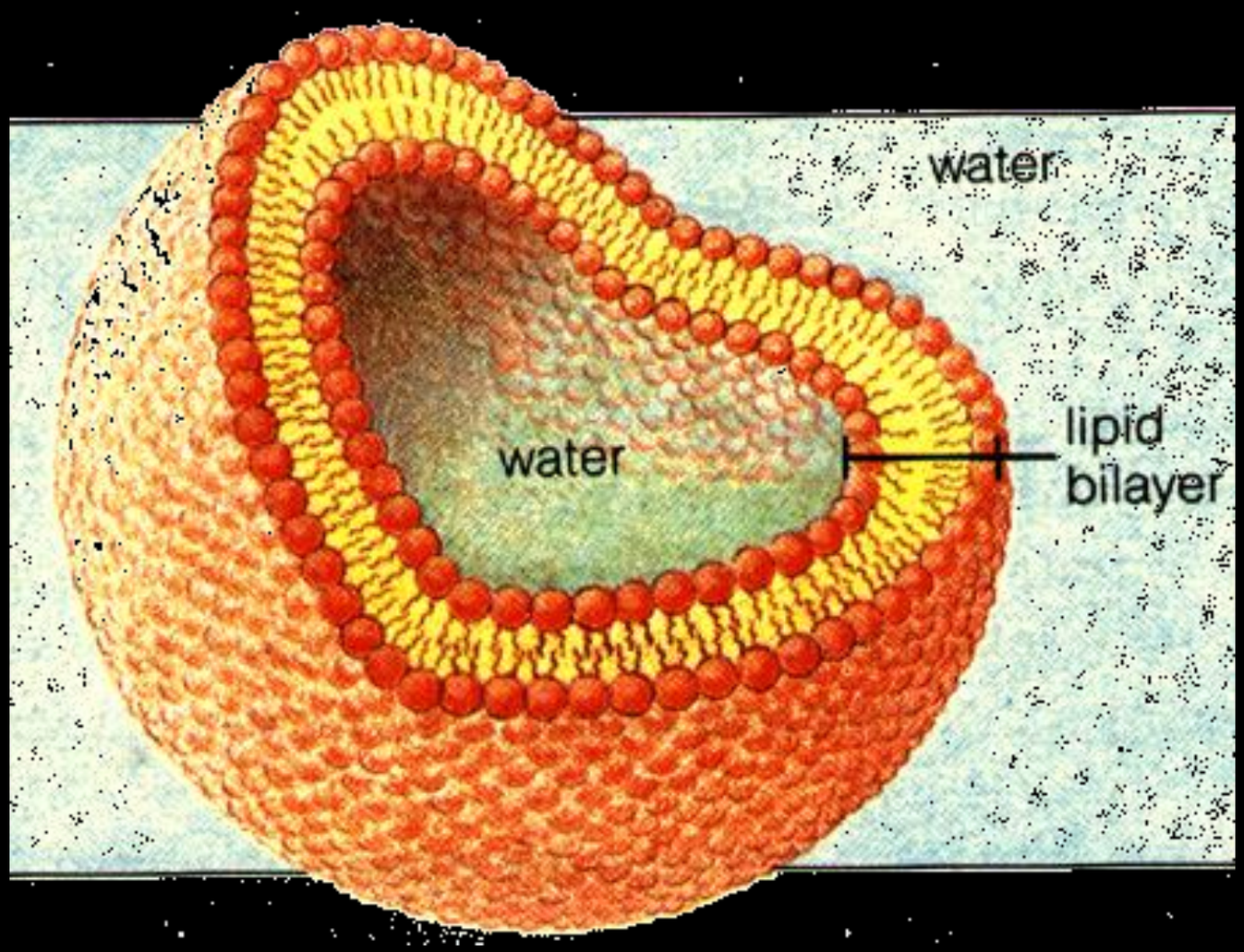
1. Membran sel adalah fluid mozaik dari lemak & protein

2. struktur membran menghasilkan selektif permeabel

3. transport pasif adalah difusi melewati membran tanpa penggunaan energi

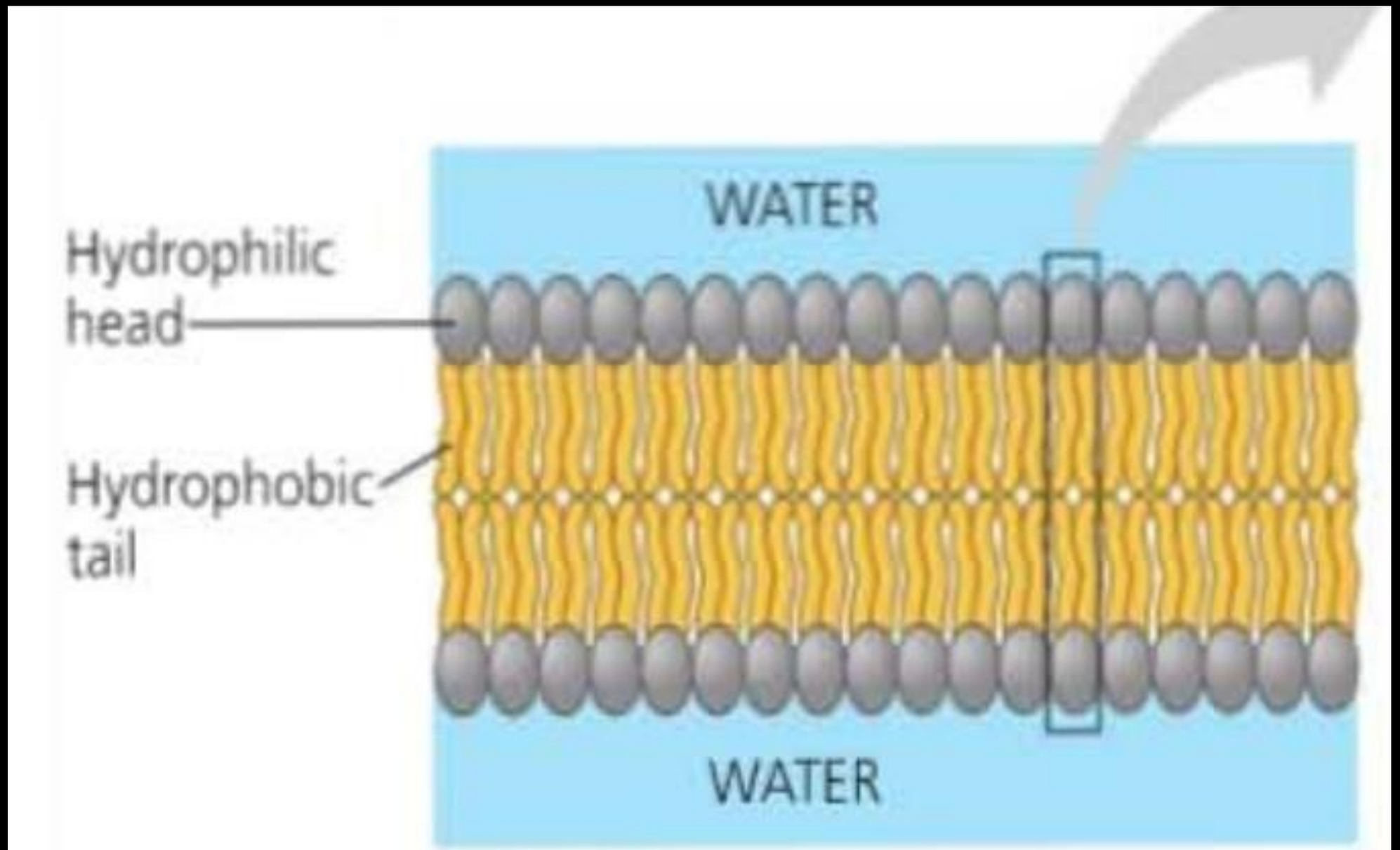
4. transport aktif menggunakan energi untuk bergerak melawan gradiennya

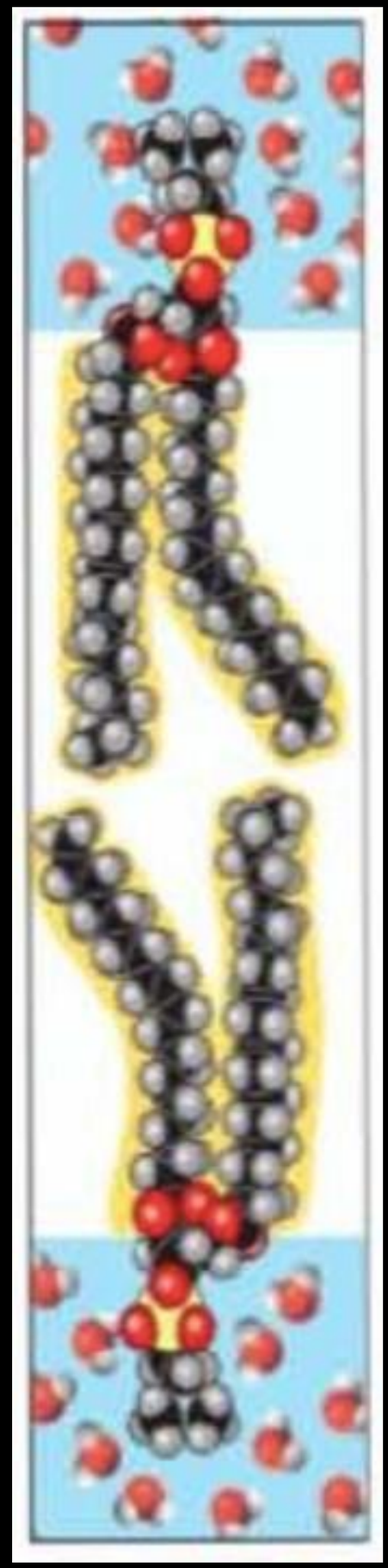
5. transport paket melewati Membran terjadi dengan cara eksositosis dan endositosis

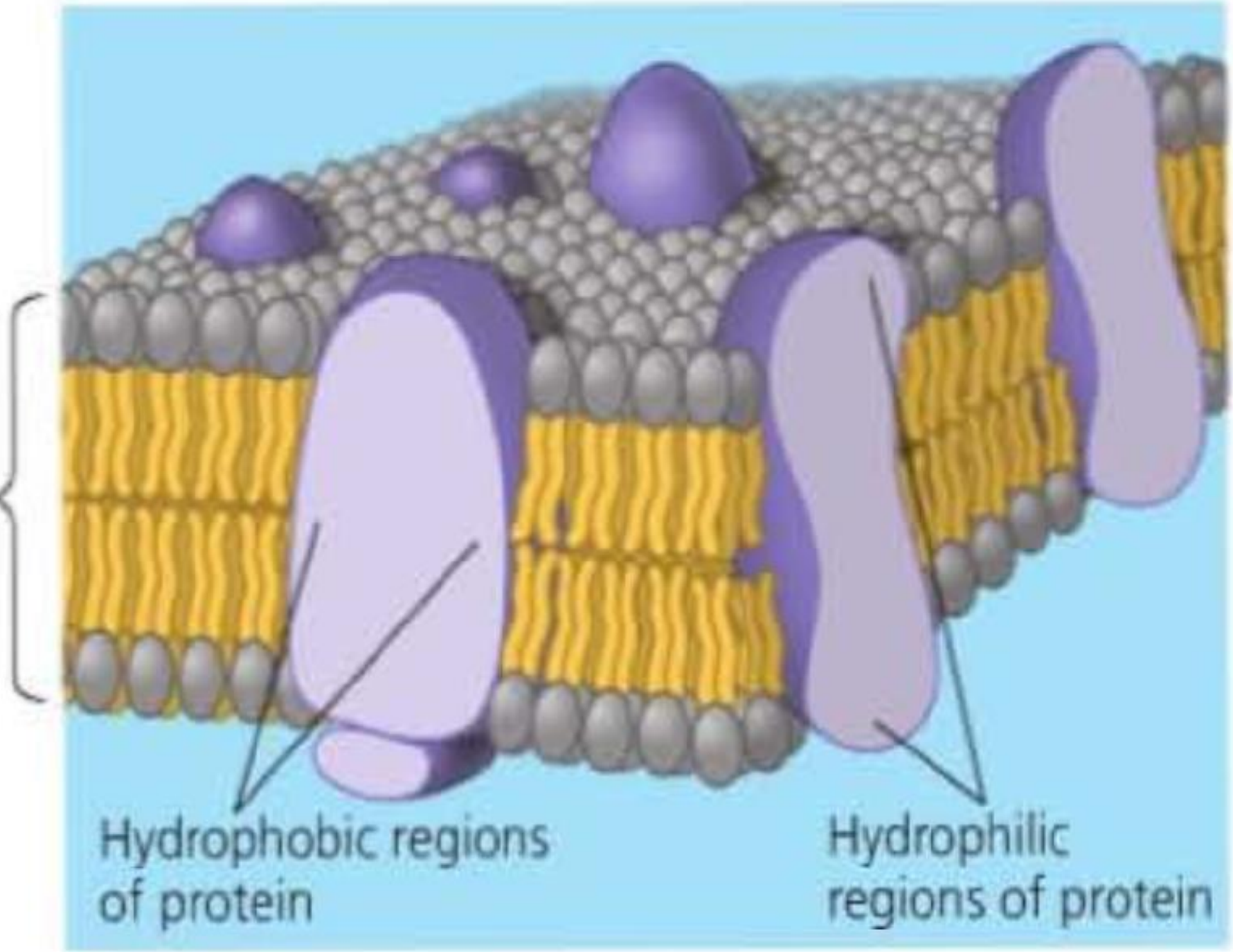


1. Membran sel adalah fluid mozaik dari lemak & protein

Model Membran: Penemuan Ilmiah







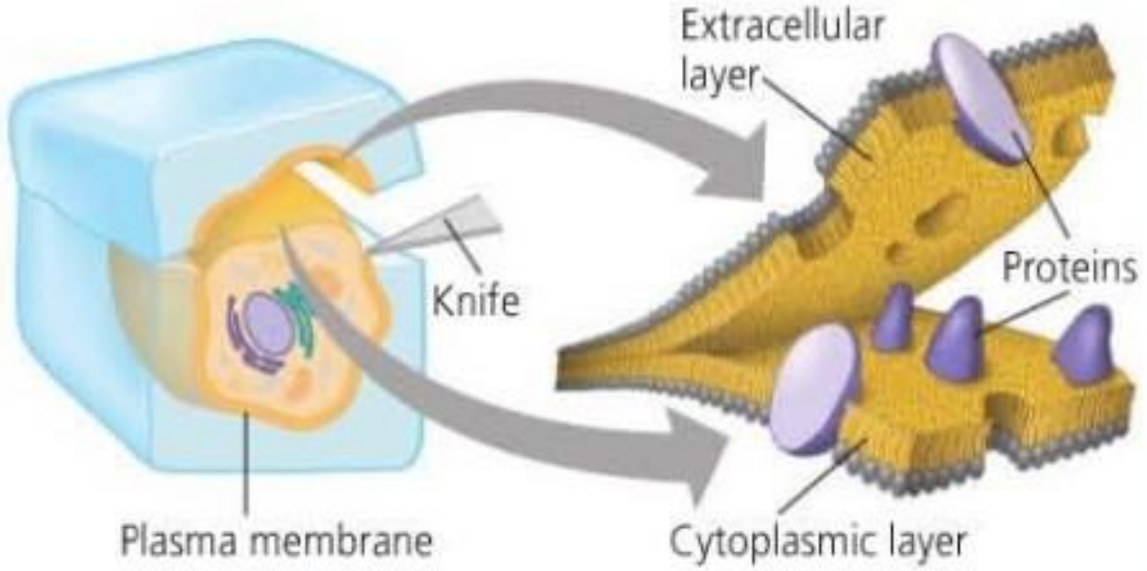
▲ **Figure 7.3 The fluid mosaic model for membranes.**

▼ Figure 7.4 Research Method

Freeze-Fracture

APPLICATION A cell membrane can be split into its two layers, revealing the ultrastructure of the membrane's interior.

TECHNIQUE A cell is frozen and fractured with a knife. The fracture plane often follows the hydrophobic interior of a membrane, splitting the phospholipid bilayer into two separated layers. The membrane proteins go wholly with one of the layers.

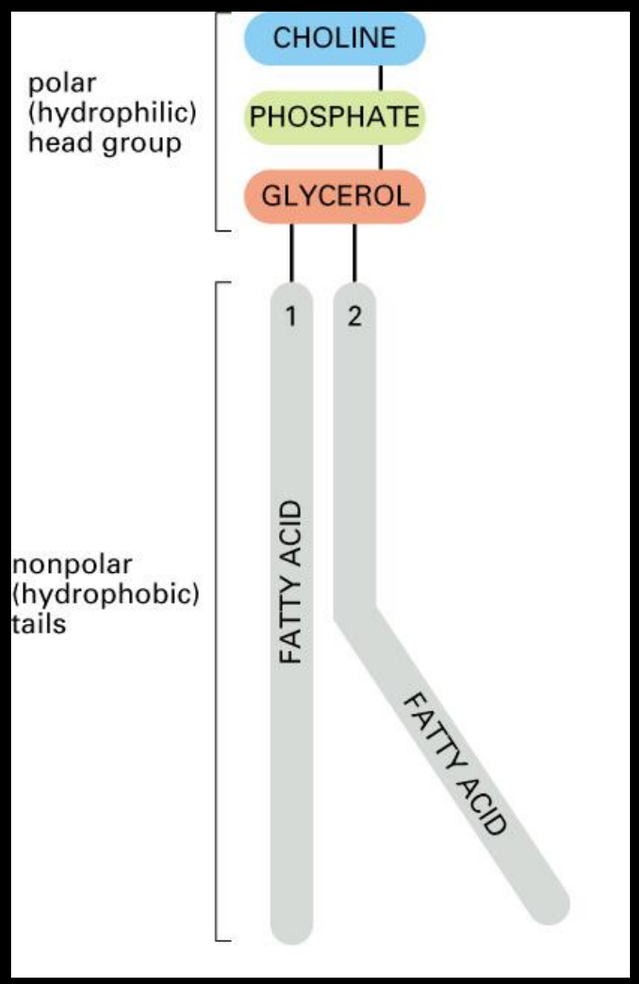


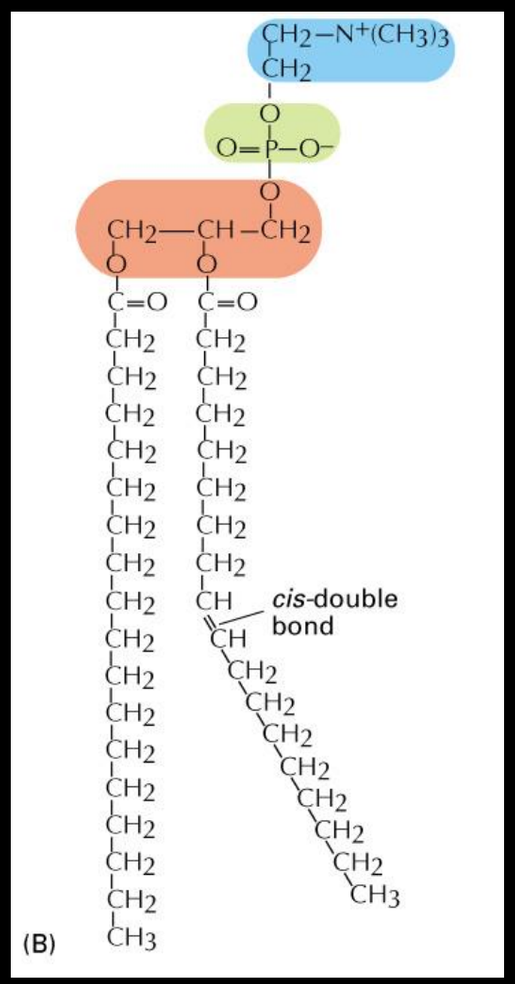
RESULTS These SEMs show membrane proteins (the "bumps") in the two layers, demonstrating that proteins are embedded in the phospholipid bilayer.

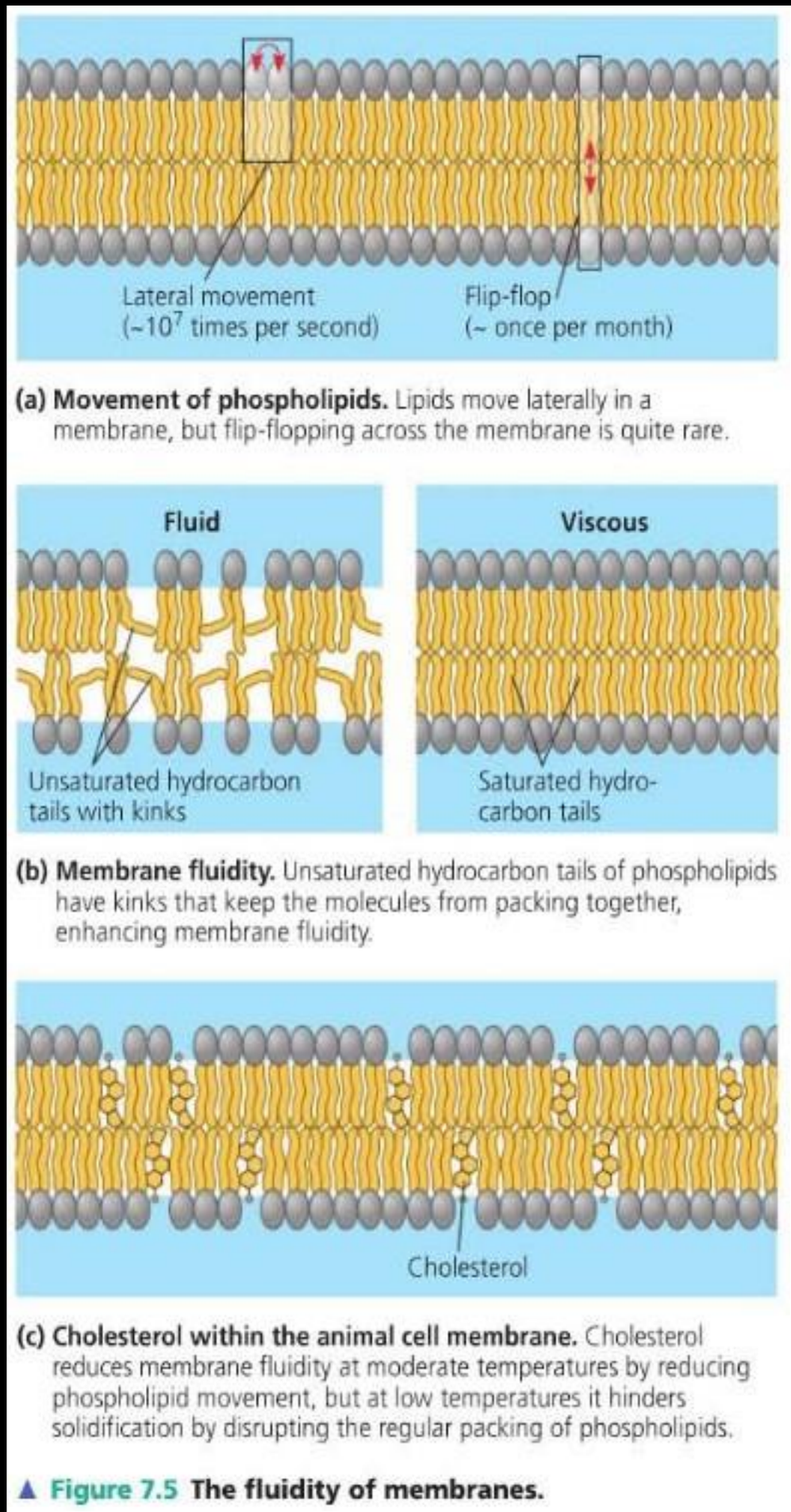
Inside of extracellular layer

Inside of cytoplasmic layer

Fluiditas Membran







(a) Movement of phospholipids. Lipids move laterally in a membrane, but flip-flopping across the membrane is quite rare.

(b) Membrane fluidity. Unsaturated hydrocarbon tails of phospholipids have kinks that keep the molecules from packing together, enhancing membrane fluidity.

(c) Cholesterol within the animal cell membrane. Cholesterol reduces membrane fluidity at moderate temperatures by reducing phospholipid movement, but at low temperatures it hinders solidification by disrupting the regular packing of phospholipids.

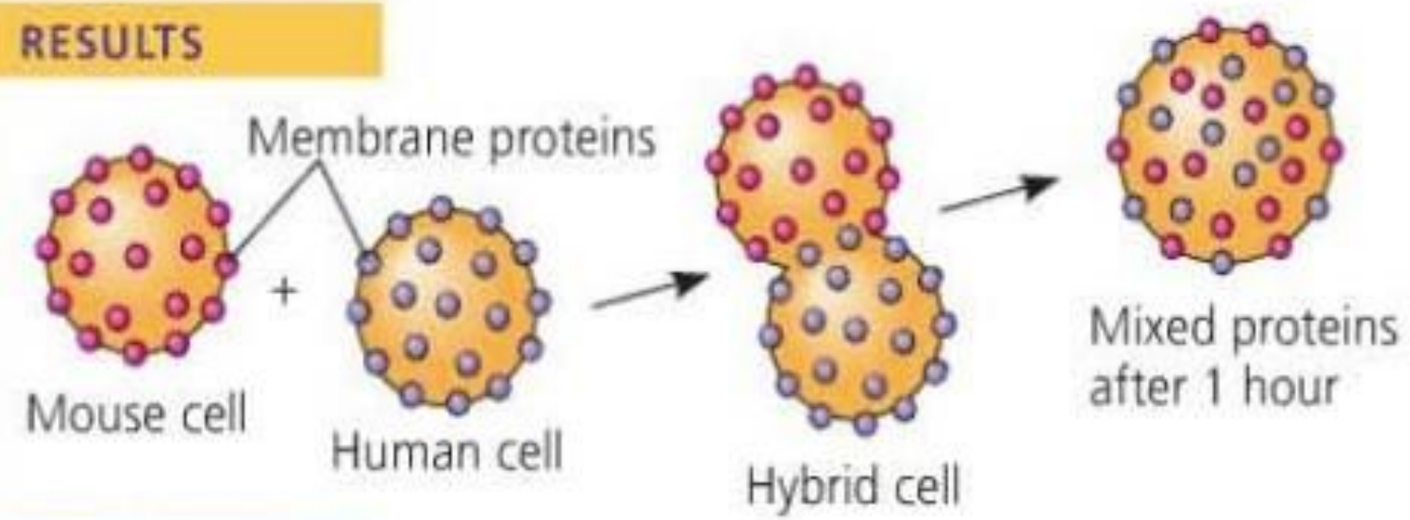
▲ **Figure 7.5 The fluidity of membranes.**

▼ Figure 7.6 Inquiry

Do membrane proteins move?

EXPERIMENT David Frye and Michael Edidin, at Johns Hopkins University, labeled the plasma membrane proteins of a mouse cell and a human cell with two different markers and fused the cells. Using a microscope, they observed the markers on the hybrid cell.

RESULTS

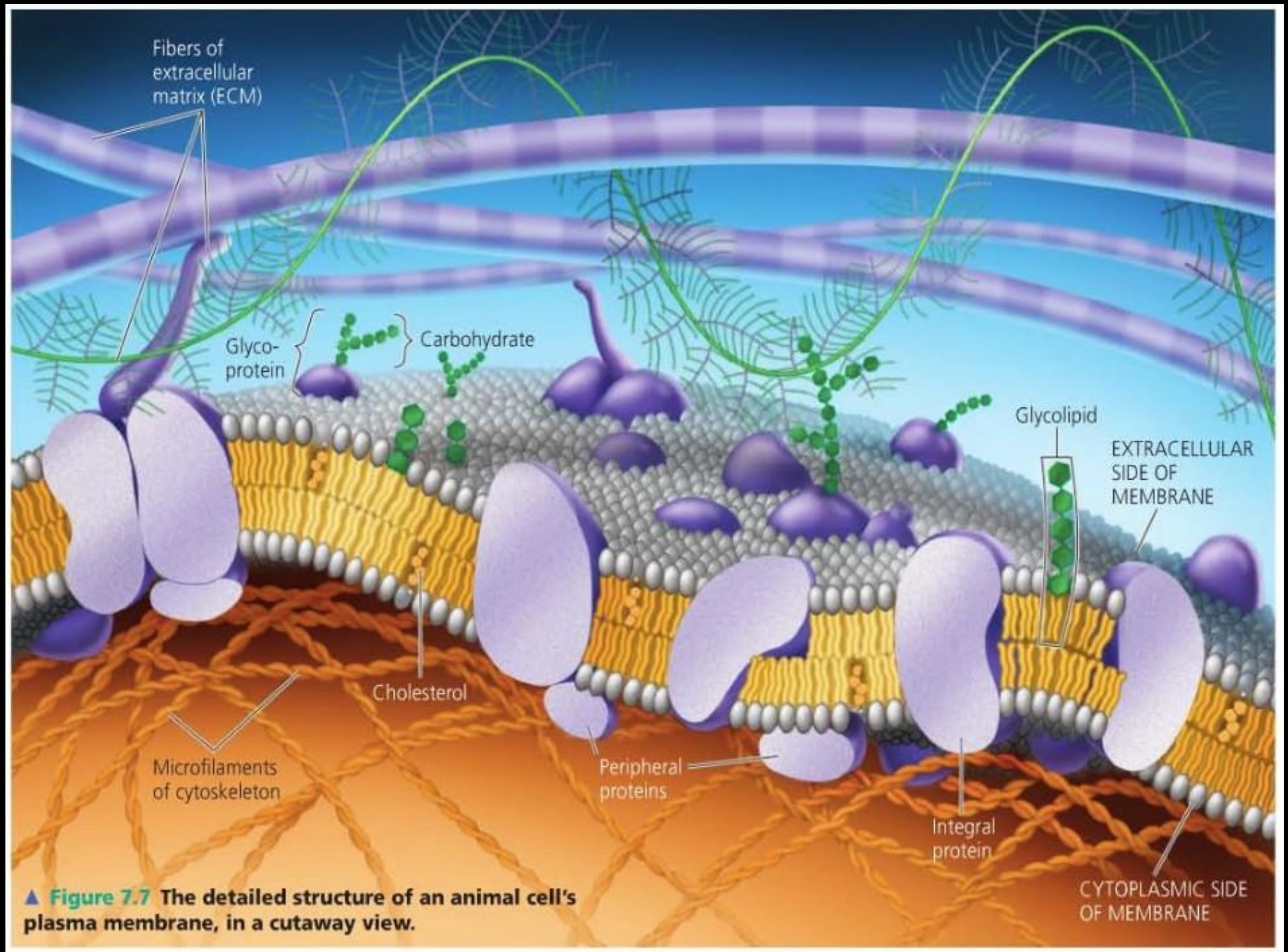


CONCLUSION The mixing of the mouse and human membrane proteins indicates that at least some membrane proteins move sideways within the plane of the plasma membrane.

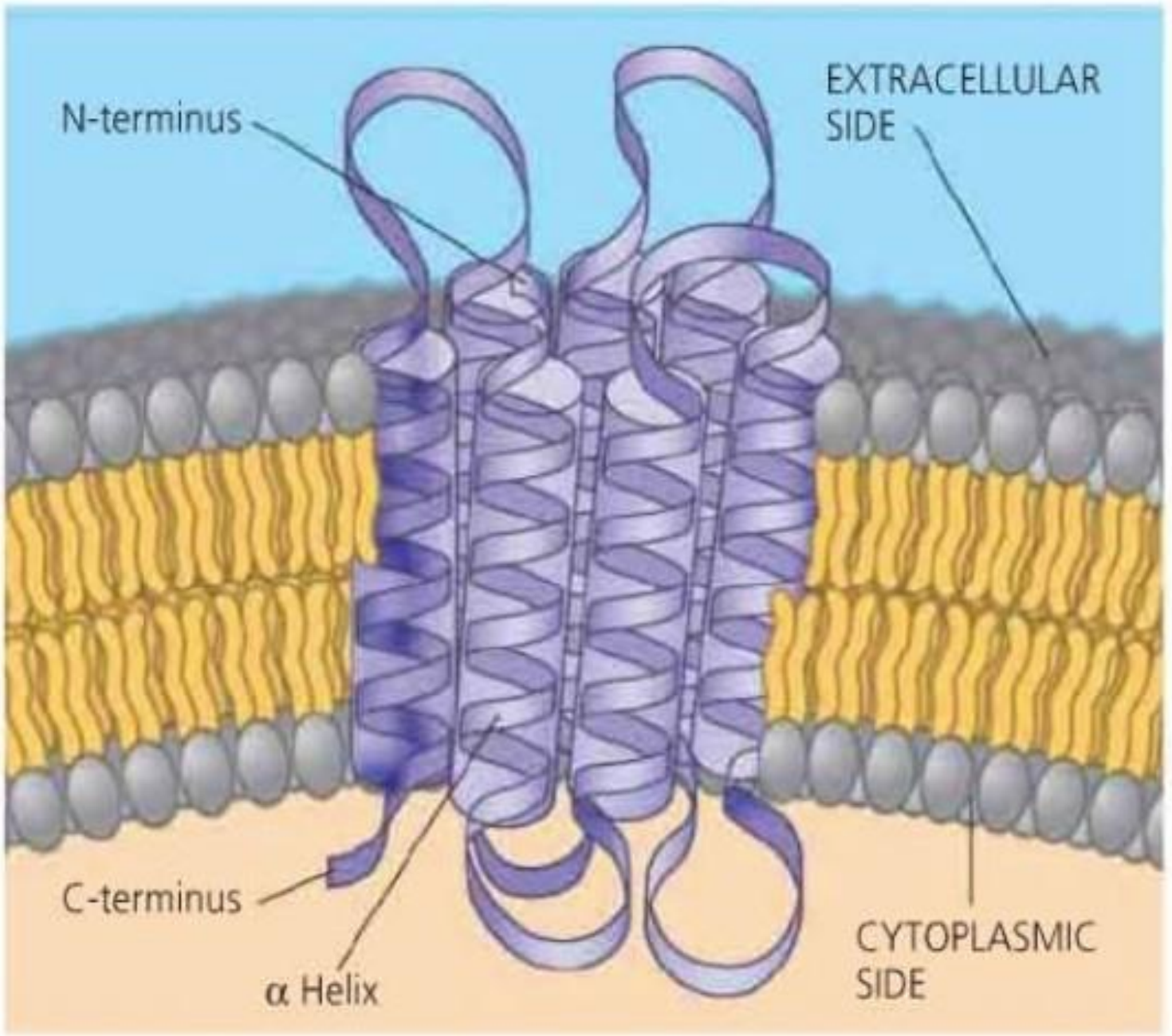
SOURCE L. D. Frye and M. Edidin, The rapid intermixing of cell surface antigens after formation of mouse-human heterokaryons, *J. Cell Sci.* 7:319 (1970).

WHAT IF? If, after many hours, the protein distribution still looked like that in the third image above, would you be able to conclude that proteins don't move within the membrane? What other explanation could there be?

Protein Membran & Fungsinya

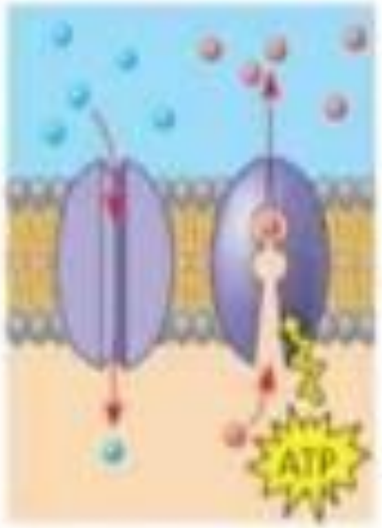


▲ **Figure 7.7 The detailed structure of an animal cell's plasma membrane, in a cutaway view.**

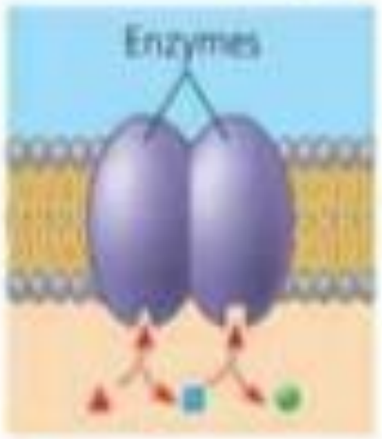


▲ **Figure 7.8 The structure of a transmembrane protein.** This protein, bacteriorhodopsin (a bacterial transport protein), has a distinct orientation in the membrane, with the N-terminus outside the cell and the C-terminus inside. This ribbon model highlights the α-helical secondary structure of the hydrophobic parts, which lie mostly within the hydrophobic core of the membrane. The protein includes seven transmembrane helices (outlined with cylinders for emphasis). The nonhelical hydrophilic segments are in contact with the aqueous solutions on the extracellular and cytoplasmic sides of the membrane.

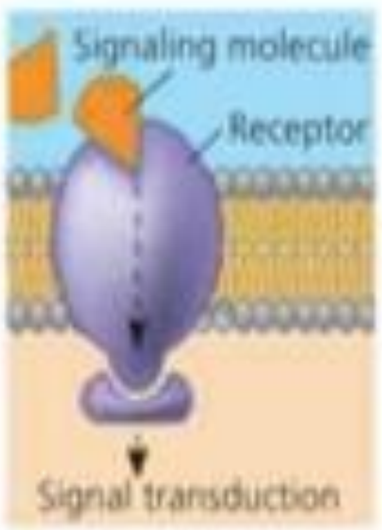
(a) Transport. *Left:* A protein that spans the membrane may provide a hydrophilic channel across the membrane that is selective for a particular solute. *Right:* Other transport proteins shuttle a substance from one side to the other by changing shape. Some of these proteins hydrolyze ATP as an energy source to actively pump substances across the membrane.



(b) Enzymatic activity. A protein built into the membrane may be an enzyme with its active site exposed to substances in the adjacent solution. In some cases, several enzymes in a membrane are organized as a team that carries out sequential steps of a metabolic pathway.

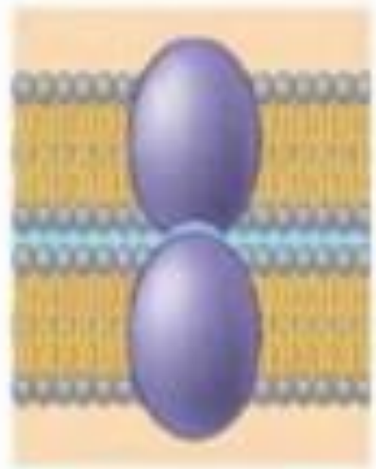


(c) Signal transduction. A membrane protein (receptor) may have a binding site with a specific shape that fits the shape of a chemical messenger, such as a hormone. The external messenger (signaling molecule) may cause a shape change in the protein that relays the message to the inside of the cell, usually by binding to a cytoplasmic protein. (See Figure 11.6.)

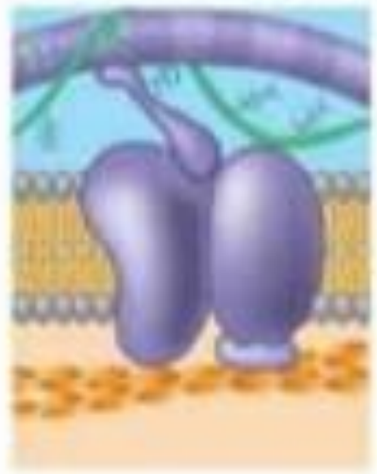


(d) Cell-cell recognition. Some glycoproteins serve as identification tags that are specifically recognized by membrane proteins of other cells.

(e) Intercellular joining. Membrane proteins of adjacent cells may hook together in various kinds of junctions, such as gap junctions or tight junctions (see Figure 6.32).



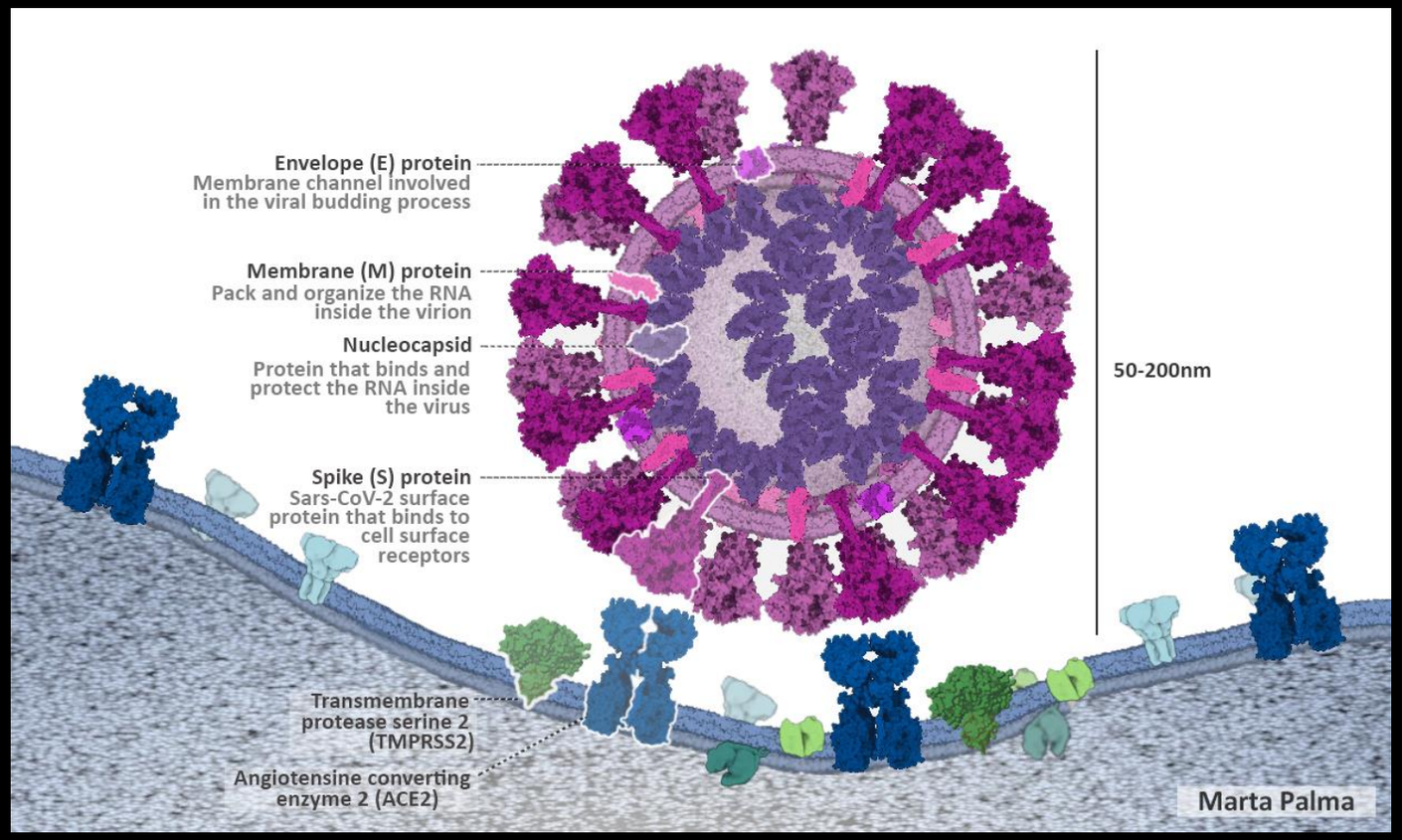
(f) Attachment to the cytoskeleton and extracellular matrix (ECM). Microfilaments or other elements of the cytoskeleton may be noncovalently bound to membrane proteins, a function that helps maintain cell shape and stabilizes the location of certain membrane proteins. Proteins that can bind to ECM molecules can coordinate extracellular and intracellular changes (see Figure 6.30).

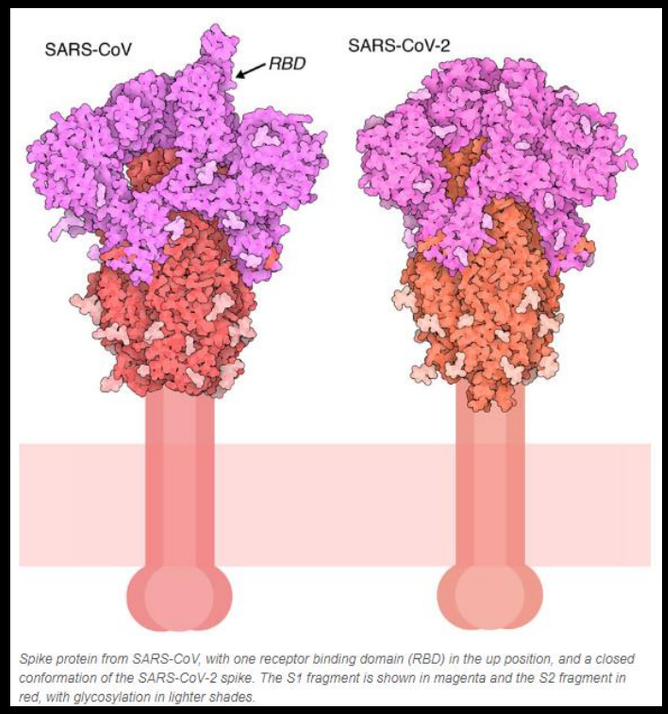


▲ **Figure 7.9 Some functions of membrane proteins.** In many cases, a single protein performs multiple tasks.

? *Some transmembrane proteins can bind to a particular ECM molecule and, when bound, transmit a signal into the cell. Use the proteins shown here to explain how this might occur.*

SARS-CoV-2 Spike





Spike protein from SARS-CoV, with one receptor binding domain (RBD) in the up position, and a closed conformation of the SARS-CoV-2 spike. The S1 fragment is shown in magenta and the S2 fragment in red, with glycosylation in lighter shades.

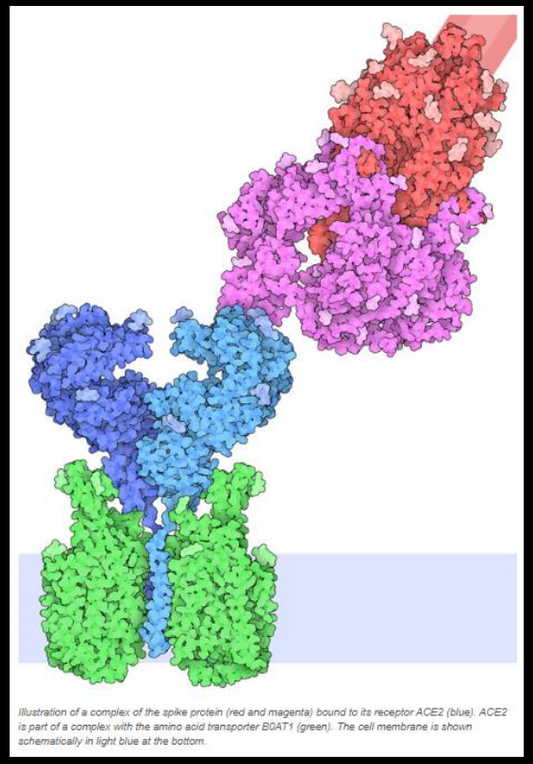
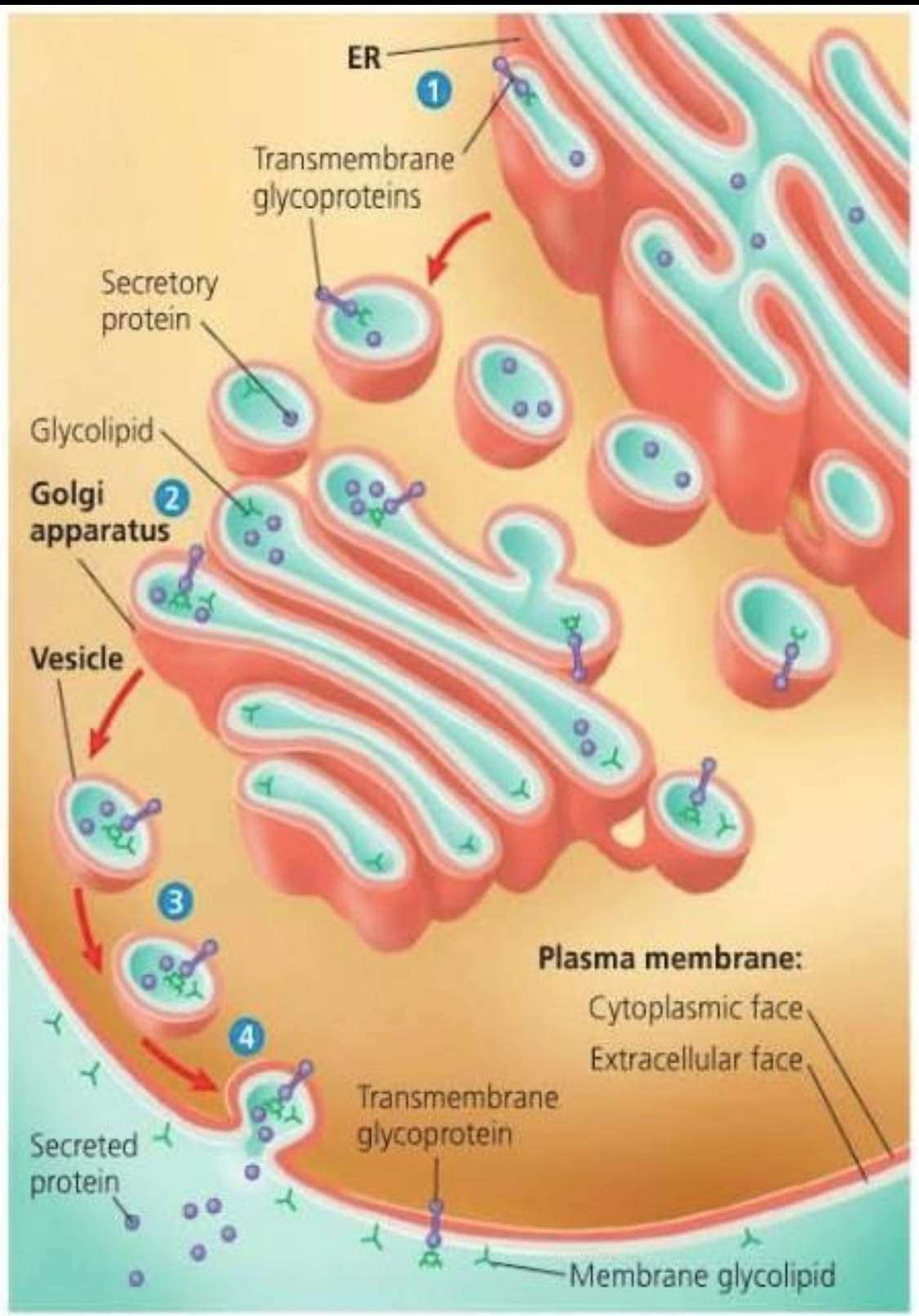


Illustration of a complex of the spike protein (red and magenta) bound to its receptor ACE2 (blue). ACE2 is part of a complex with the amino acid transporter B0AT1 (green). The cell membrane is shown schematically in light blue at the bottom.

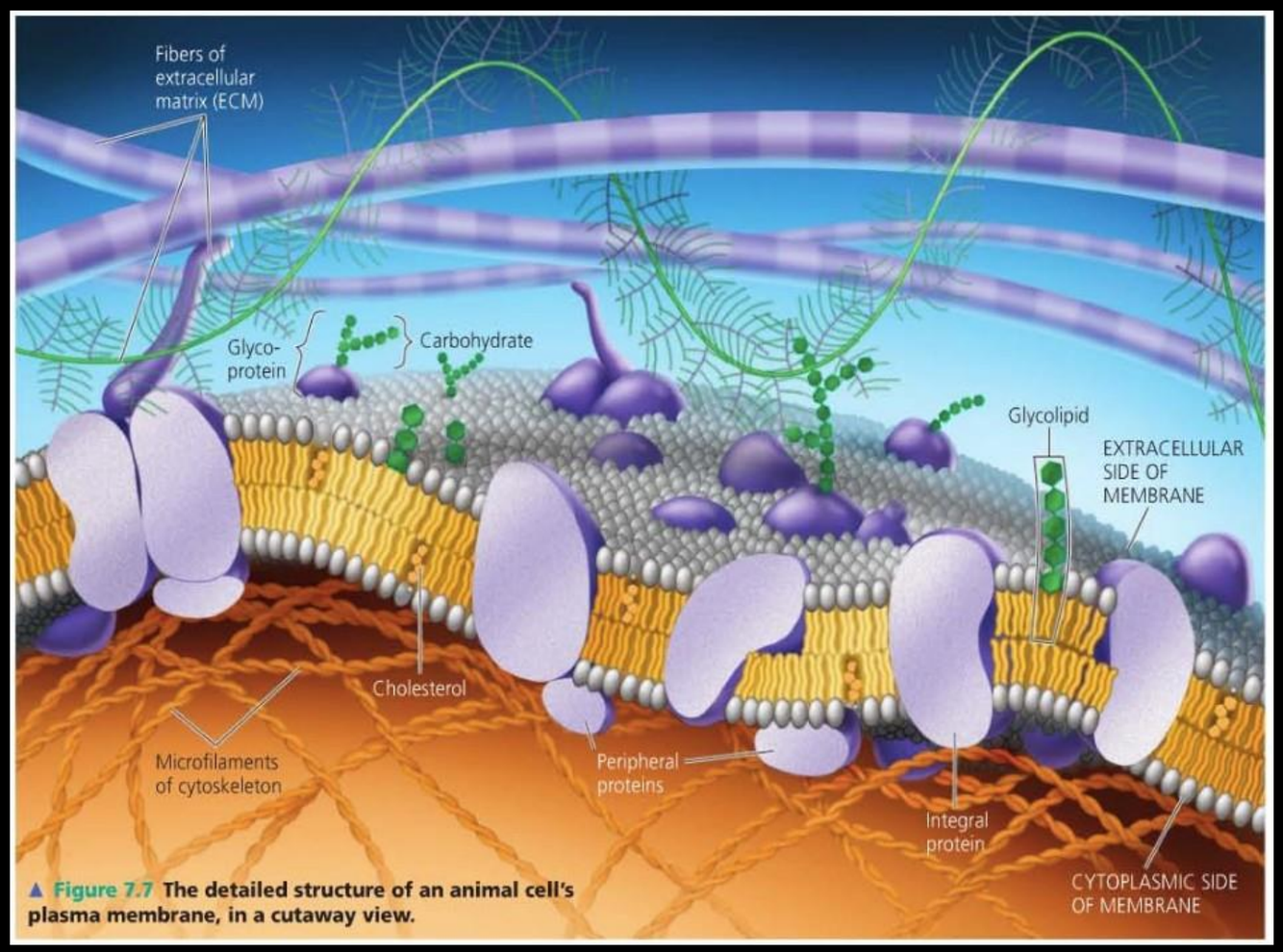
Peran karbohidrat Membran dalam Pengenalan Sel-Sel



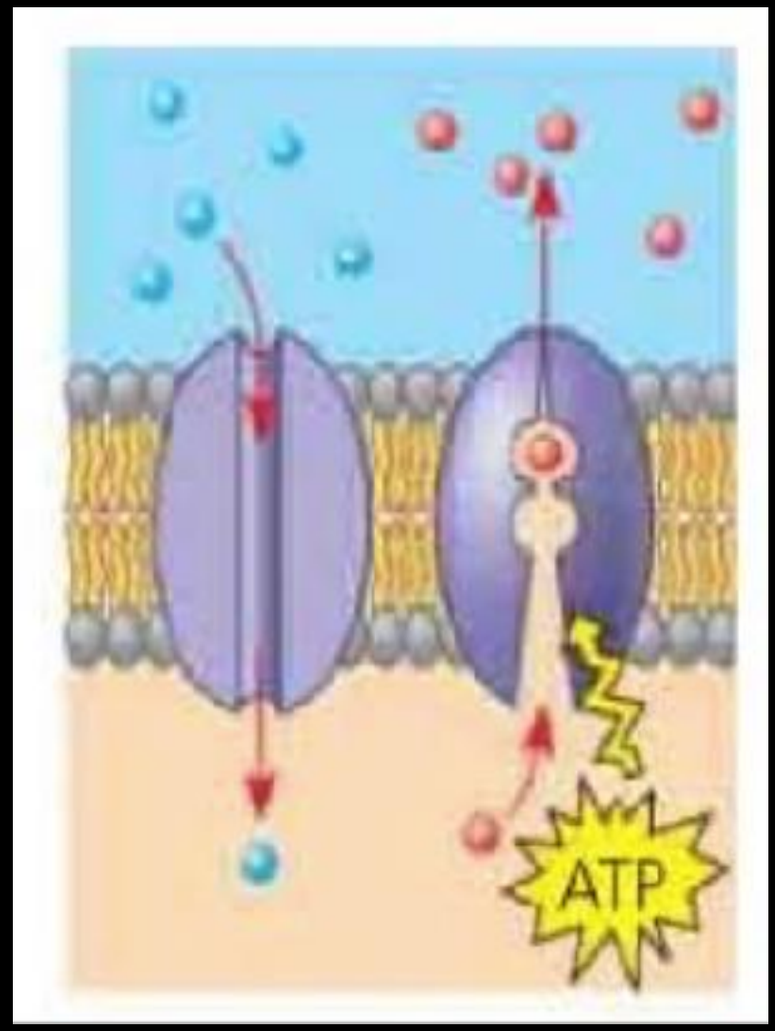
▲ **Figure 7.10 Synthesis of membrane components and their orientation on the resulting membrane.** The plasma membrane has distinct cytoplasmic (orange) and extracellular (aqua) faces, with the extracellular face arising from the inside face of ER, Golgi, and vesicle membranes.

2. STRUKTUR MEMBRAN MENGHASILKAN SELEKTIF PERMEABEL

Permeabilitas Lipid Bilayer & Protein Transport

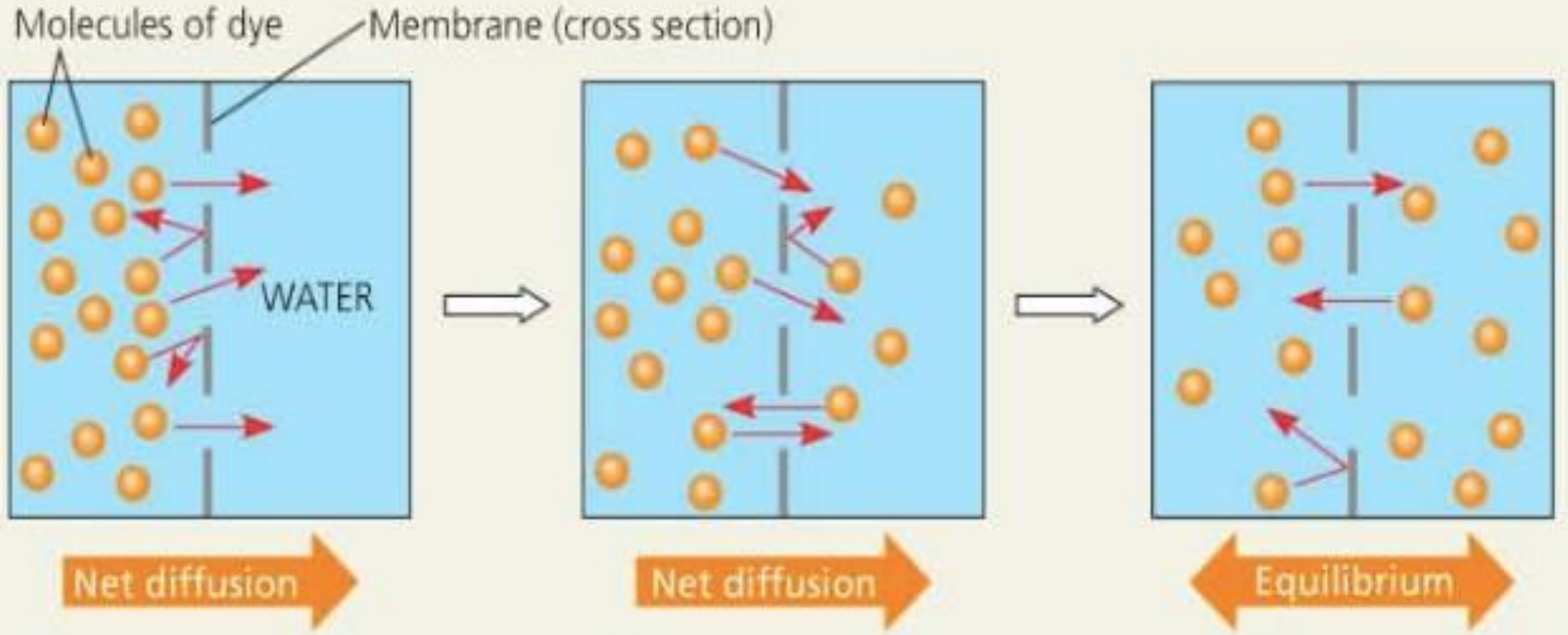


▲ **Figure 7.7** **The detailed structure of an animal cell's plasma membrane, in a cutaway view.**

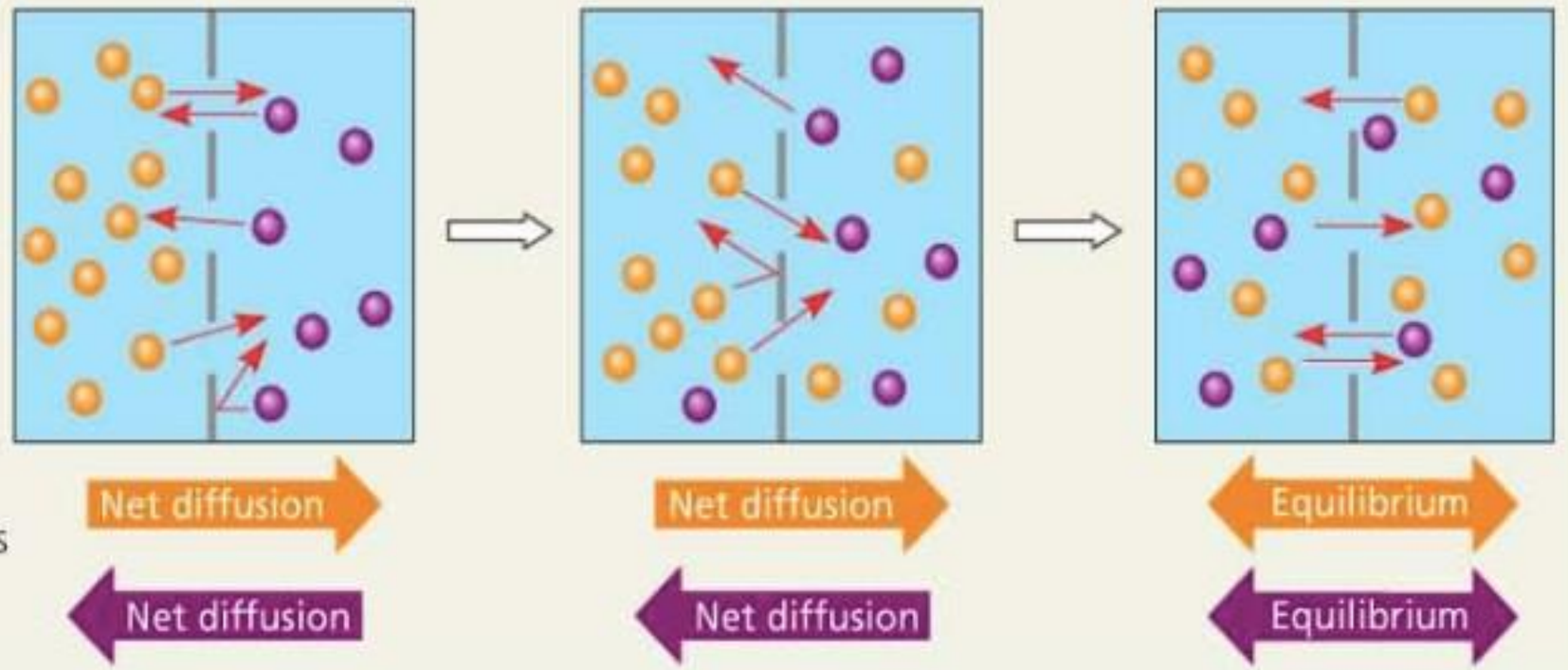


3. TRANSPORT PASIF ADALAH DIFUSI ZAT MELEWATI MEMBRAN TANPA MENGGUNAKAN ENERGI

(a) Diffusion of one solute. The membrane has pores large enough for molecules of dye to pass through. Random movement of dye molecules will cause some to pass through the pores; this will happen more often on the side with more molecules. The dye diffuses from where it is more concentrated to where it is less concentrated (called diffusing down a concentration gradient). This leads to a dynamic equilibrium: The solute molecules continue to cross the membrane, but at equal rates in both directions.

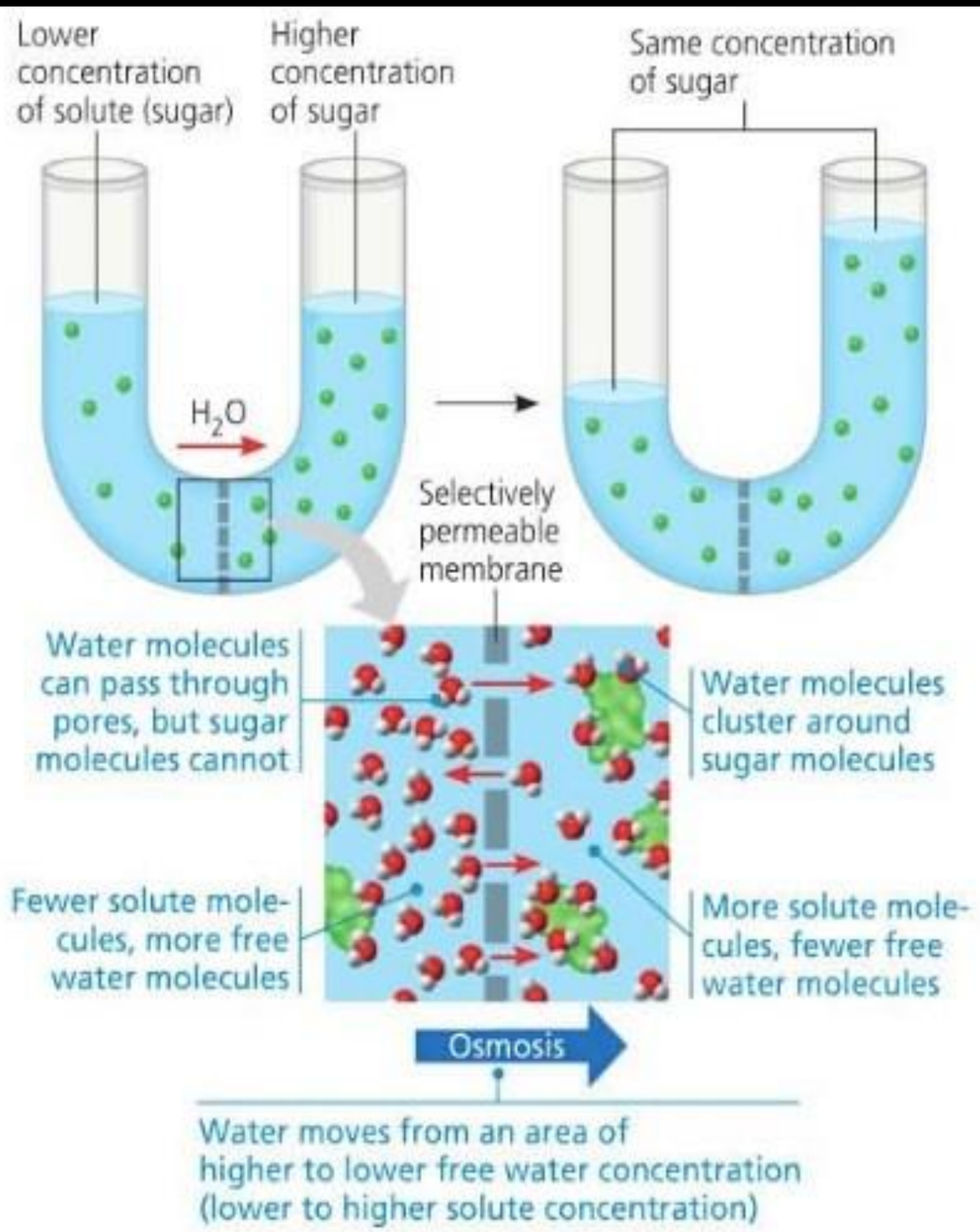


(b) Diffusion of two solutes. Solutions of two different dyes are separated by a membrane that is permeable to both. Each dye diffuses down its own concentration gradient. There will be a net diffusion of the purple dye toward the left, even though the *total* solute concentration was initially greater on the left side.



▲ **Figure 7.11 The diffusion of solutes across a membrane.** Each of the large arrows under the diagrams shows the net diffusion of the dye molecules of that color.

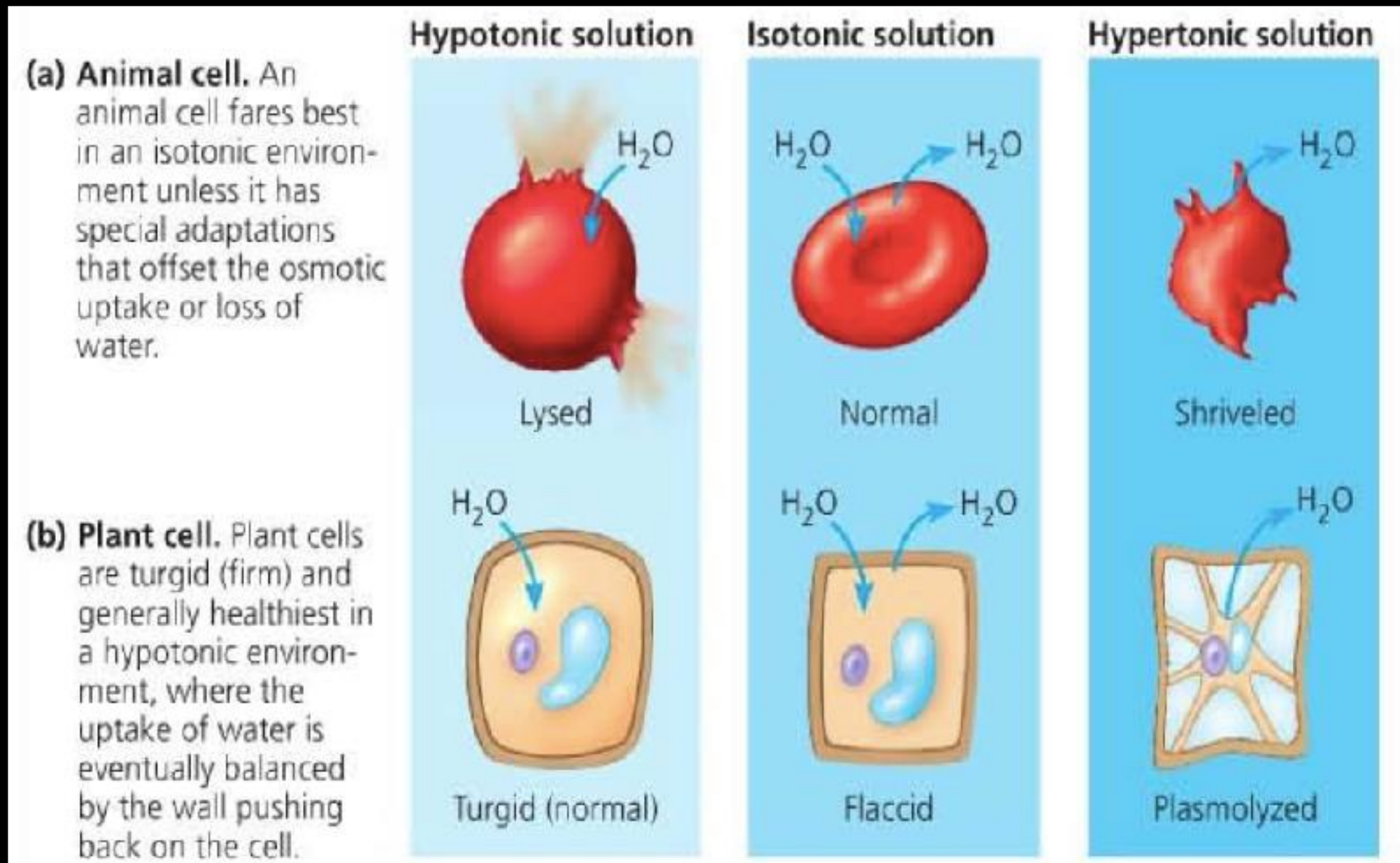
Efek Osmosis pada Kesetimbangan Air



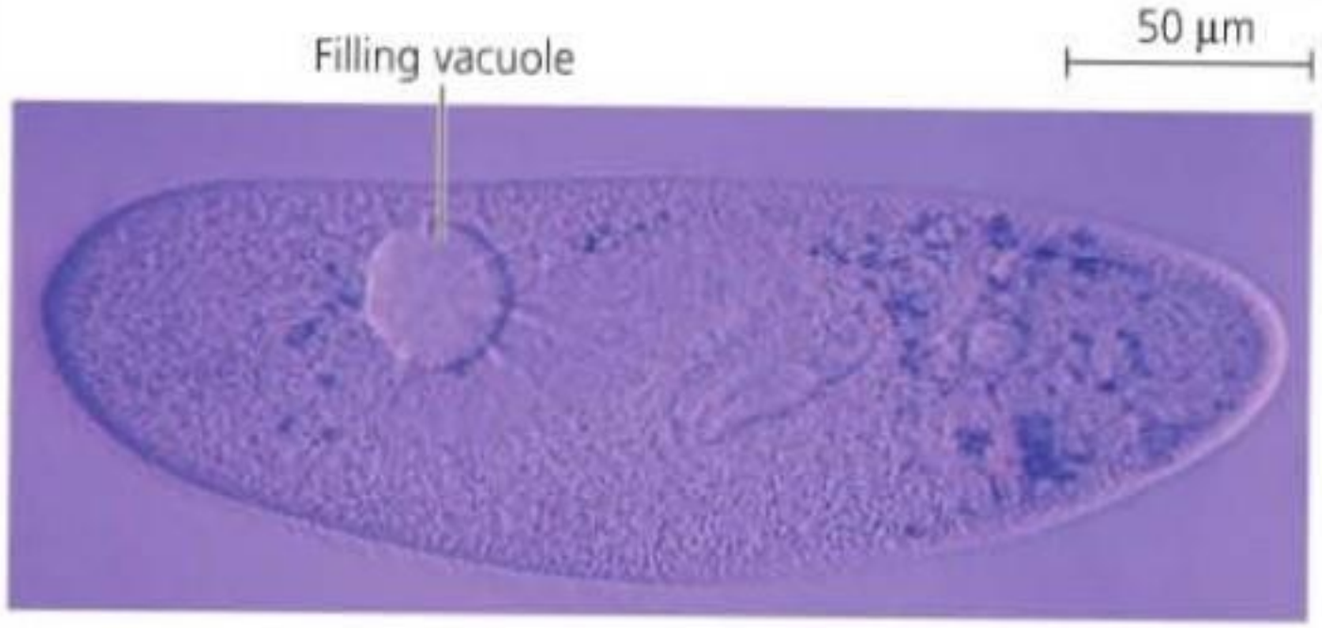
▲ **Figure 7.12 Osmosis.** Two sugar solutions of different concentrations are separated by a membrane, which the solvent (water) can pass through but the solute (sugar) cannot. Water molecules move randomly and may cross in either direction, but overall, water diffuses from the solution with less concentrated solute to that with more concentrated solute. This transport of water, or osmosis, equalizes the sugar concentrations on both sides.

WHAT IF? *If an orange dye capable of passing through the membrane was added to the left side of the tube above, how would it be distributed at the end of the process? (See Figure 7.11.) Would the solution levels in the tube on the right be affected?*

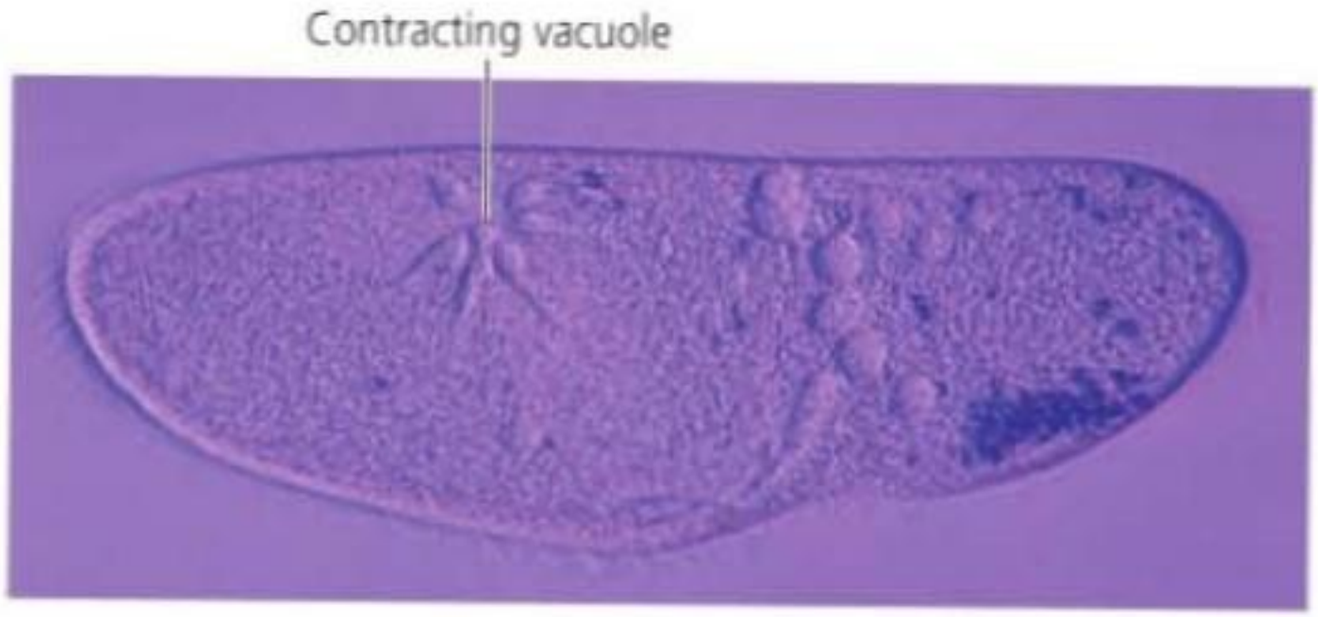
Kesetimbangan Air pada Sel Dengan/Tanpa Dinding



▲ **Figure 7.13 The water balance of living cells.** How living cells react to changes in the solute concentration of their environment depends on whether or not they have cell walls. **(a)** Animal cells, such as this red blood cell, do not have cell walls. **(b)** Plant cells do. (Arrows indicate net water movement after the cells were first placed in these solutions.)



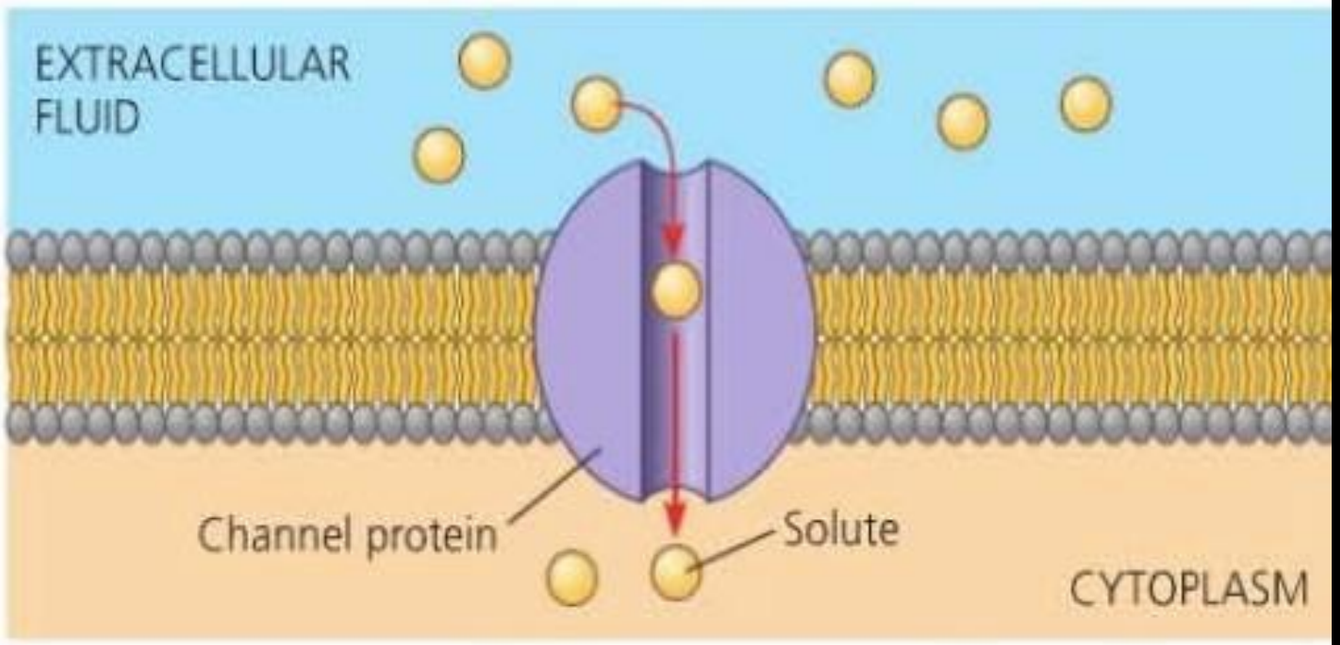
(a) A contractile vacuole fills with fluid that enters from a system of canals radiating throughout the cytoplasm.



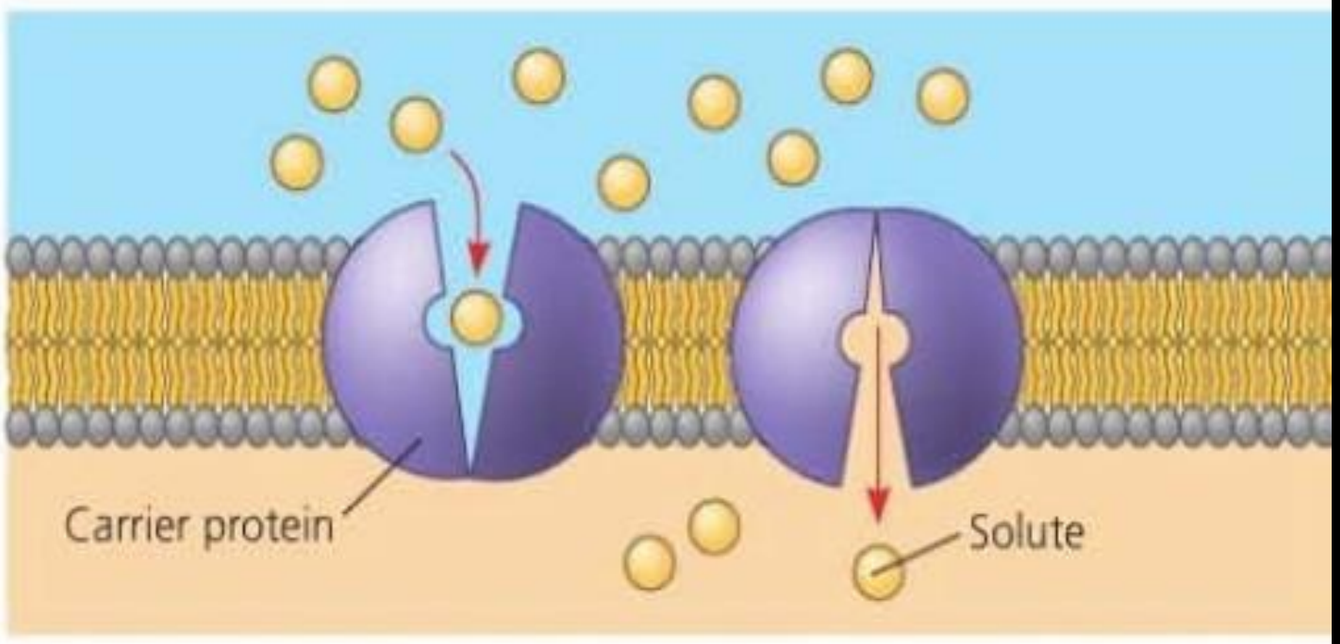
(b) When full, the vacuole and canals contract, expelling fluid from the cell.

▲ **Figure 7.14 The contractile vacuole of *Paramecium*: an evolutionary adaptation for osmoregulation.** The contractile vacuole of this freshwater protist offsets osmosis by pumping water out of the cell (LM).

Difusi Terfasilitasi: Transport Pasif yang Dibantu Protein



(a) A channel protein (purple) has a channel through which water molecules or a specific solute can pass.

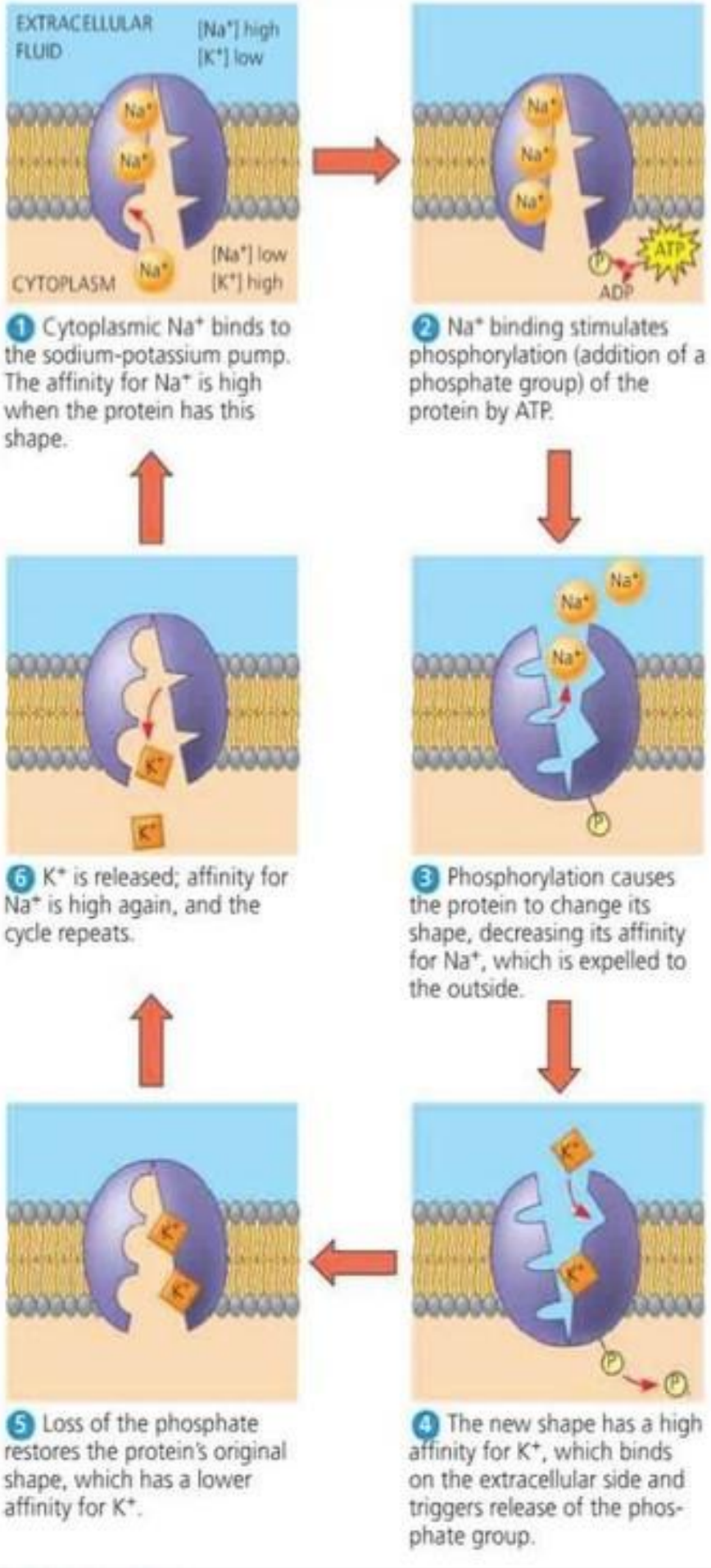


(b) A carrier protein alternates between two shapes, moving a solute across the membrane during the shape change.

▲ **Figure 7.15 Two types of transport proteins that carry out facilitated diffusion.** In both cases, the protein can transport the solute in either direction, but the net movement is down the concentration gradient of the solute.

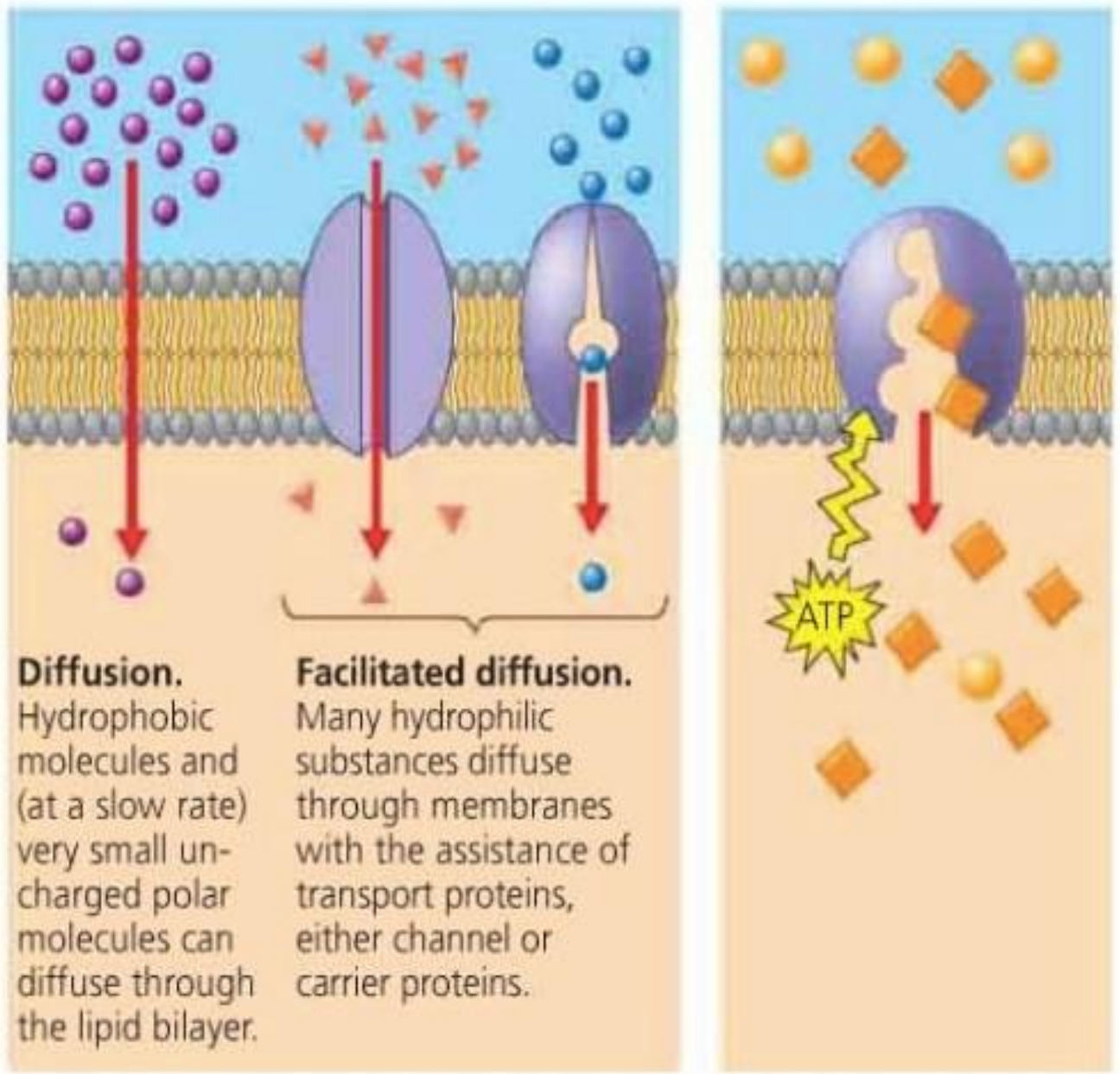
4. TRANSPORT AKTIF MENGGUNAKAN ENERGI UNTUK BERGERAK MELAWAN GRADIENNYA

Kebutuhan Energi dalam Transport Aktif



Passive transport. Substances diffuse spontaneously down their concentration gradients, crossing a membrane with no expenditure of energy by the cell. The rate of diffusion can be greatly increased by transport proteins in the membrane.

Active transport. Some transport proteins act as pumps, moving substances across a membrane against their concentration (or electrochemical) gradients. Energy for this work is usually supplied by ATP.

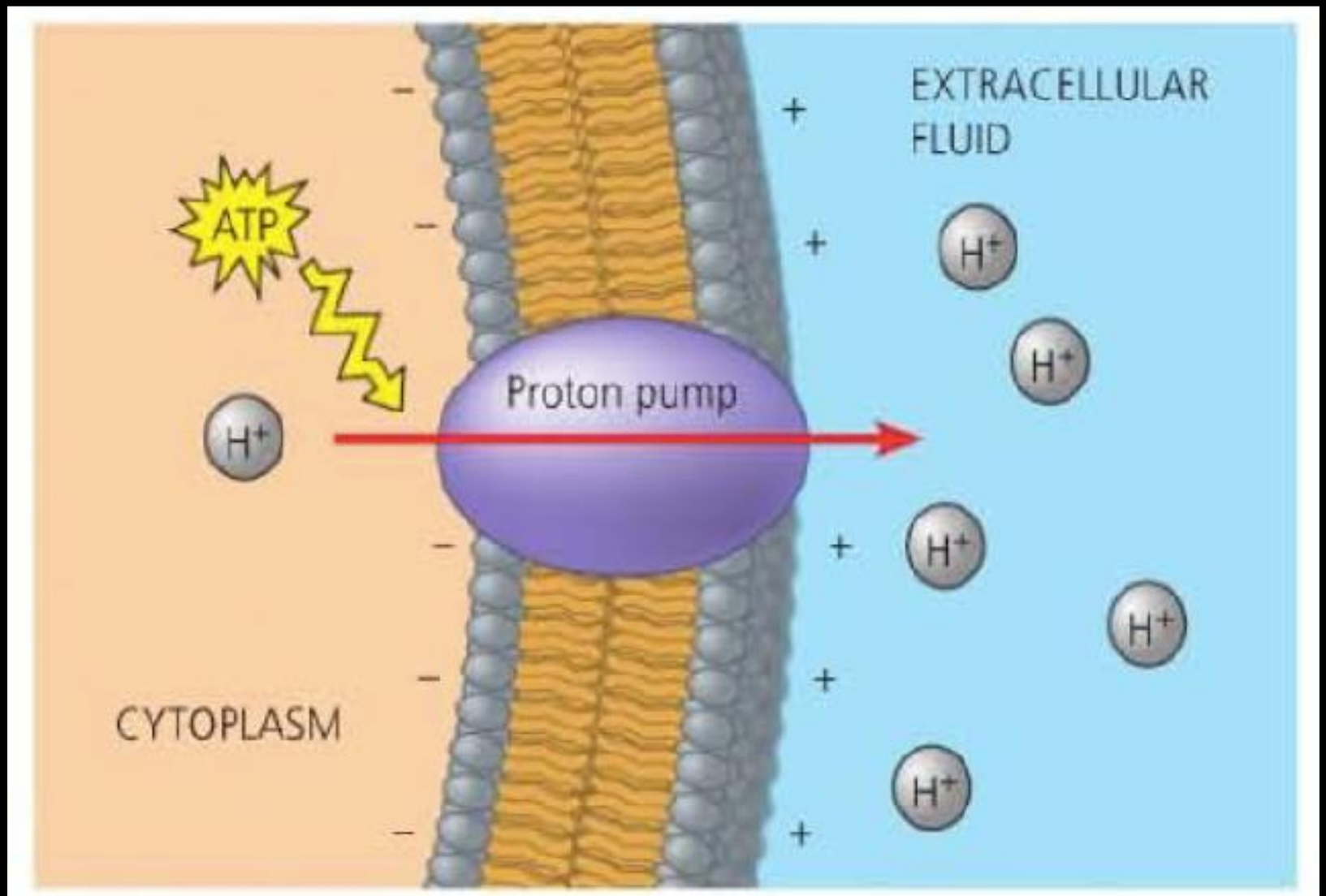


Diffusion. Hydrophobic molecules and (at a slow rate) very small uncharged polar molecules can diffuse through the lipid bilayer.

Facilitated diffusion. Many hydrophilic substances diffuse through membranes with the assistance of transport proteins, either channel or carrier proteins.

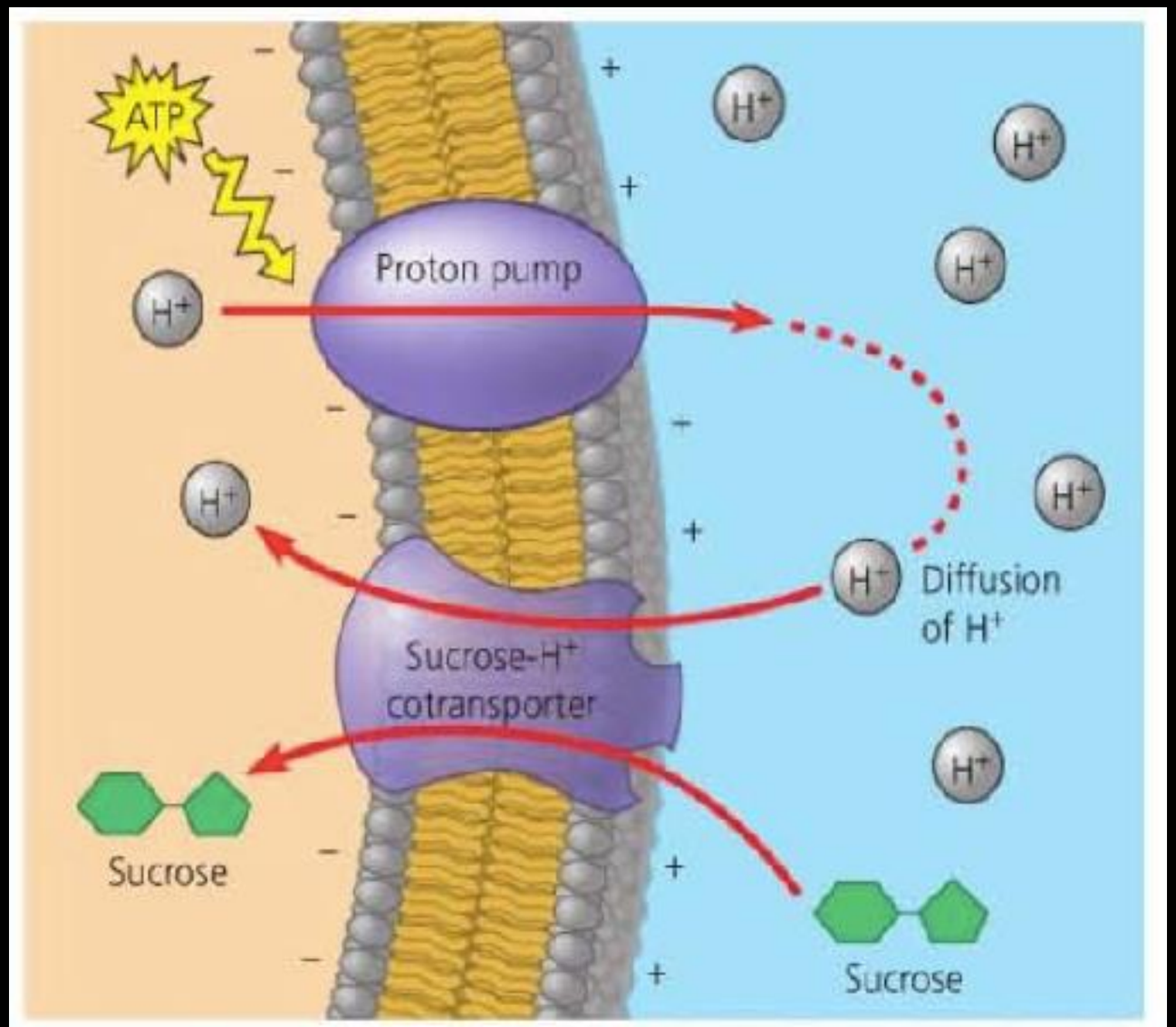
▲ **Figure 7.17 Review: passive and active transport.**

Bagaimana Pompa Ion Menjaga Membran Potensial



▲ **Figure 7.18 An electrogenic pump.** Proton pumps, the main electrogenic pumps of plants, fungi, and bacteria, are membrane proteins that store energy by generating voltage (charge separation) across membranes. Using ATP for power, a proton pump translocates positive charge in the form of hydrogen ions. The voltage and H^+ concentration gradient represent a dual energy source that can drive other processes, such as the uptake of nutrients.

Kotransport: Transport Pasangan oleh Protein Membran



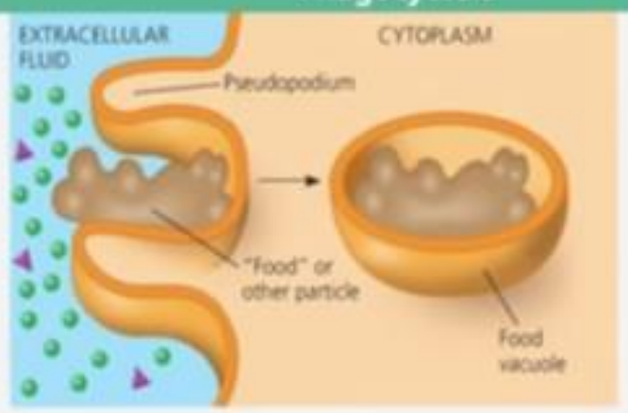
▲ **Figure 7.19 Cotransport: active transport driven by a concentration gradient.** A carrier protein such as this sucrose-H^+ cotransporter is able to use the diffusion of H^+ down its electrochemical gradient into the cell to drive the uptake of sucrose. The H^+ gradient is maintained by an ATP-driven proton pump that concentrates H^+ outside the cell, thus storing potential energy that can be used for active transport, in this case of sucrose. Thus, ATP is indirectly providing the energy necessary for cotransport.

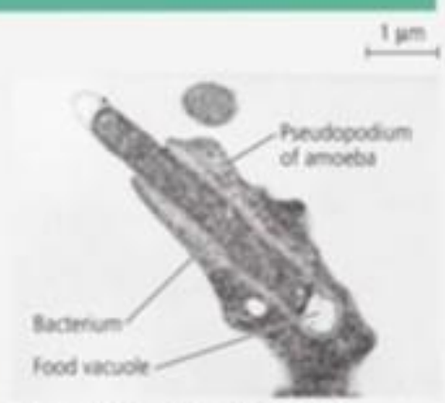
5. TRANSPORT SEPAKET MELEWATI MEMBRAN PLASMA TERJADI SECARA EKSOSITOSIS & ENDOSITOSIS

Exploring Endocytosis in Animal Cells

Phagocytosis

In **phagocytosis**, a cell engulfs a particle by wrapping pseudopodia (singular, *pseudopodium*) around it and packaging it within a membrane-enclosed sac that can be large enough to be classified as a vacuole. The particle is digested after the vacuole fuses with a lysosome containing hydrolytic enzymes.

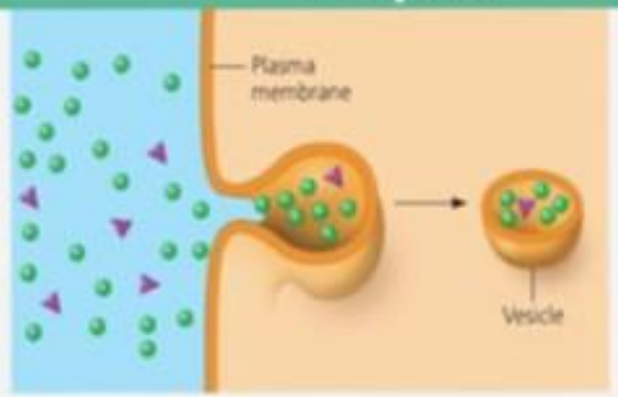


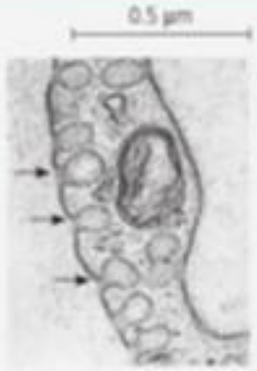


An amoeba engulfing a bacterium via phagocytosis (TEM)

Pinocytosis

In **pinocytosis**, the cell "gulps" droplets of extracellular fluid into tiny vesicles. It is not the fluid itself that is needed by the cell, but the molecules dissolved in the droplets. Because any and all included solutes are taken into the cell, pinocytosis is nonspecific in the substances it transports.

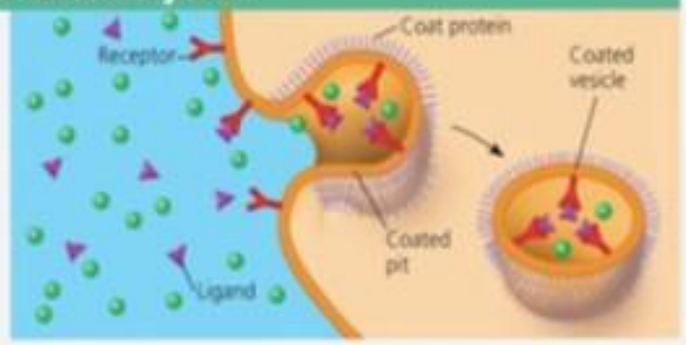


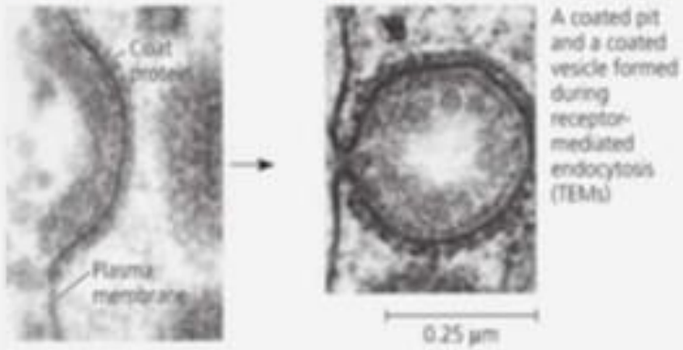


Pinocytosis vesicles forming (arrows) in a cell lining a small blood vessel (TEM)

Receptor-Mediated Endocytosis

Receptor-mediated endocytosis enables the cell to acquire bulk quantities of specific substances, even though those substances may not be very concentrated in the extracellular fluid. Embedded in the membrane are proteins with specific receptor sites exposed to the extracellular fluid. The receptor proteins are usually already clustered in regions of the membrane called coated pits, which are lined on their cytoplasmic side by a fuzzy layer of coat proteins. The specific substances (ligands) bind to these receptors. When binding occurs, the coated pit forms a vesicle containing the ligand molecules. Notice that there are relatively more bound molecules (purple) inside the vesicle, but other molecules (green) are also present. After this ingested material is liberated from the vesicle, the receptors are recycled to the plasma membrane by the same vesicle.





A coated pit and a coated vesicle formed during receptor-mediated endocytosis (TEMs)

DAFTAR PUSTAKA

- Campbell, Neil A., Jane B. Reece. 2008. Biology. 8th ed. Pearson Benjamin Cummings, San Francisco.
https://youtu.be/re4kAtxViiQ
https://youtu.be/yAXnYcUjn5k
https://youtu.be/_bPFKDdWlCg