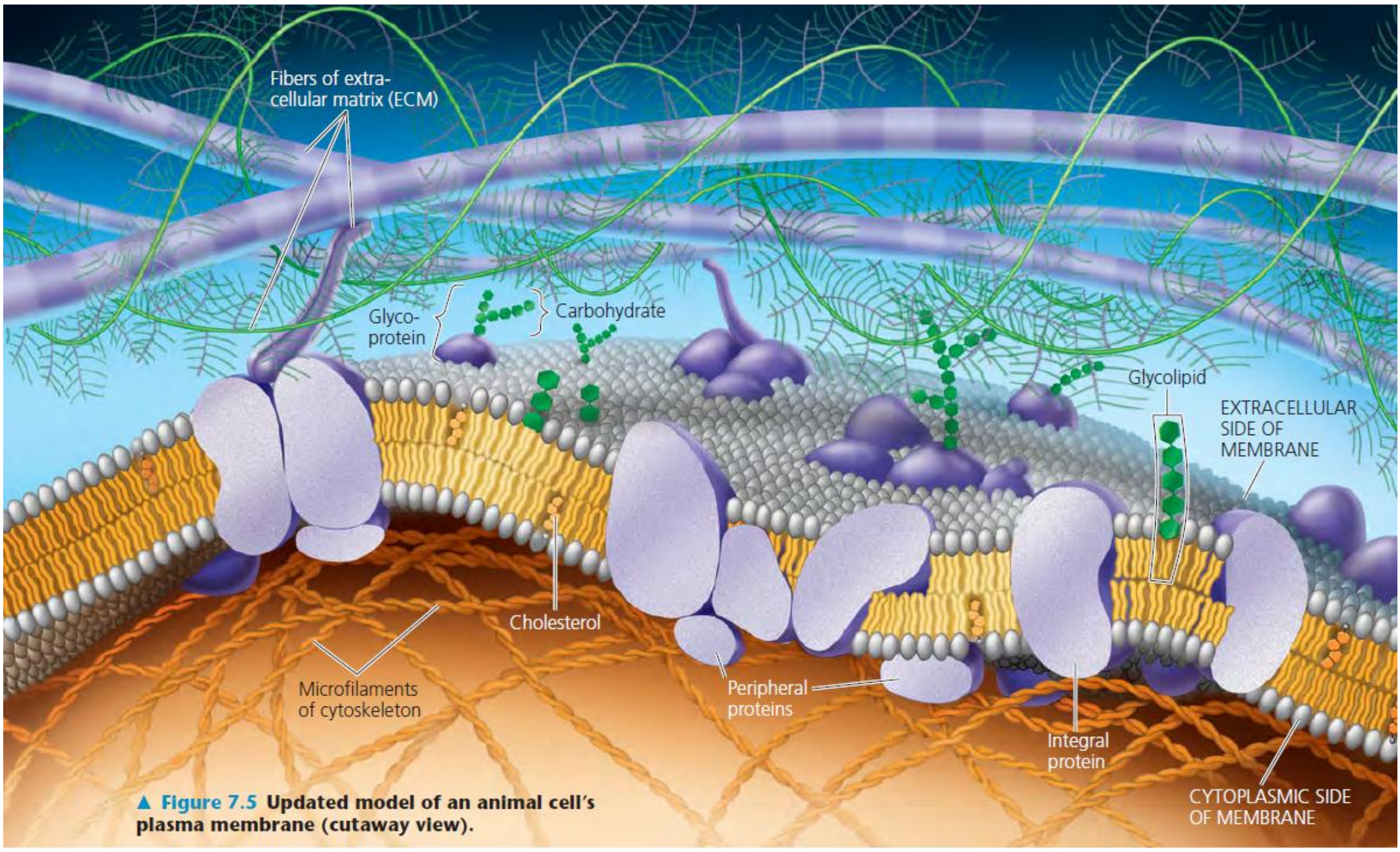
Оболочка клеток

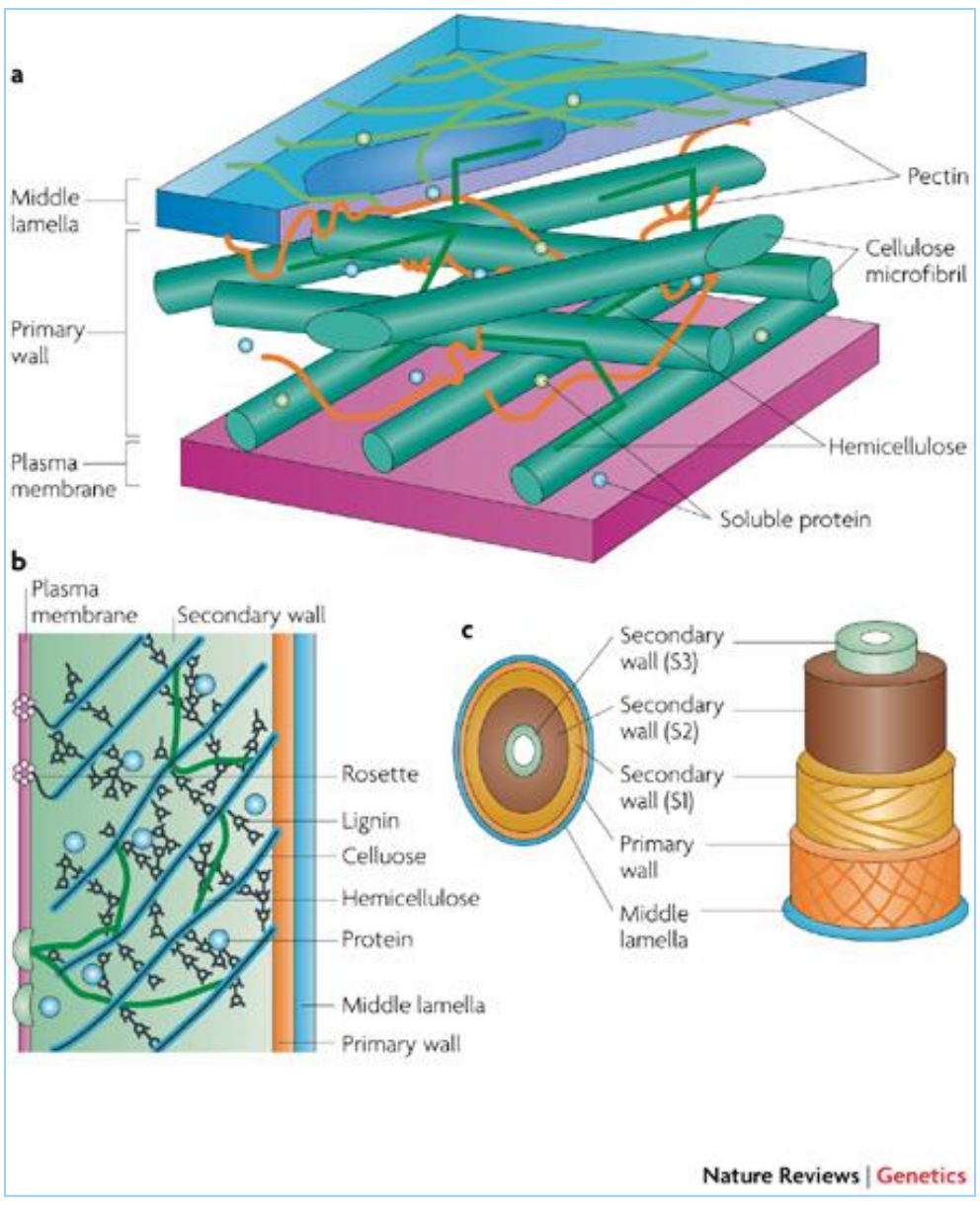
1. Поверхность животной клетки



▲ **Figure 7.5 Updated model of an animal cell's plasma membrane (cutaway view).**

(рис. из учебника Campbell Biology (9th Edition) Jane B. Reece (Author), Lisa A. Urry (Author), Michael L. Cain (Author), Steven A. Wasserman (Author), Peter V. Minorsky (Author), Robert B. Jackson (Author))

2. Оболочка клеток зеленых растений



http://www.nature.com/nrg/journal/v9/n6/fig_tab/nrg2336_F1.html

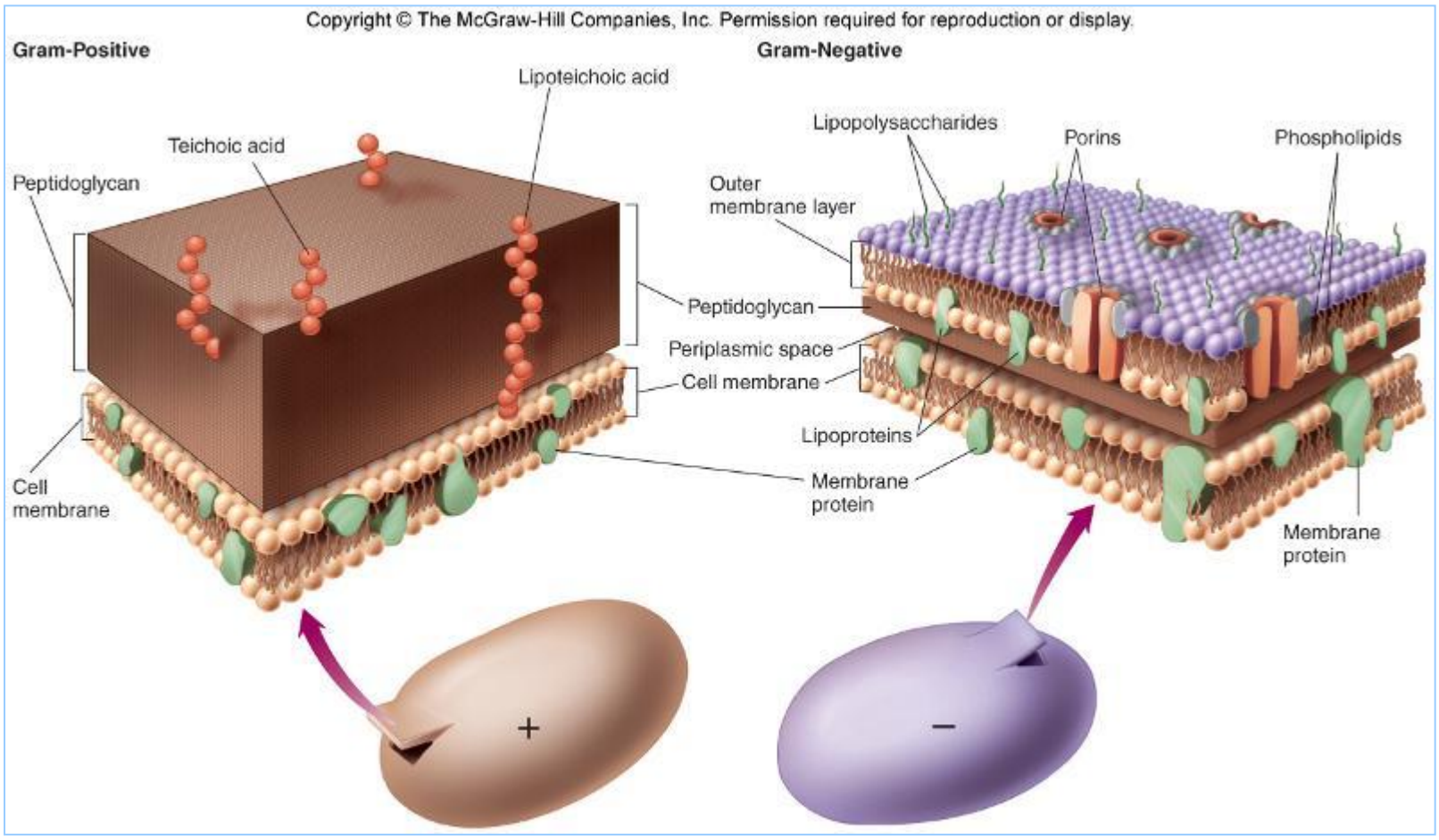
a | Cell wall containing cellulose microfibrils, hemicellulose, pectin, lignin and soluble proteins. **b** | Cellulose synthase enzymes are in the form of rosette complexes, which float in the plasma membrane. **c** | Lignification occurs in the S1, S2 and S3 layers of the cell wall.

Sticklen MB. Plant genetic engineering for biofuel production: towards affordable cellulosic ethanol. Nat Rev Genet. 2008 Jun;9(6):433-43

копия

http://elementy.ru/problems/374?page_design=print

3. Клеточная стенка бактерий



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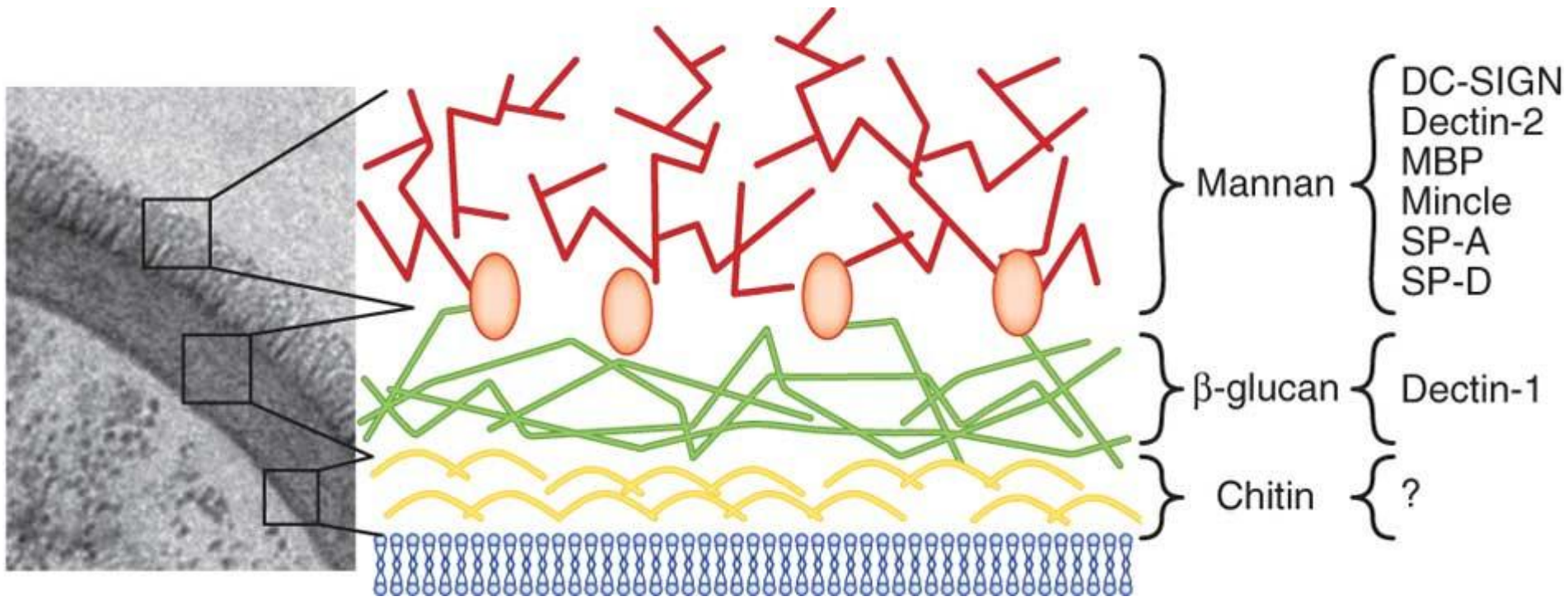
http://classes.midlandstech.edu/carterp/courses/bio225/chap04/lecture3.htm

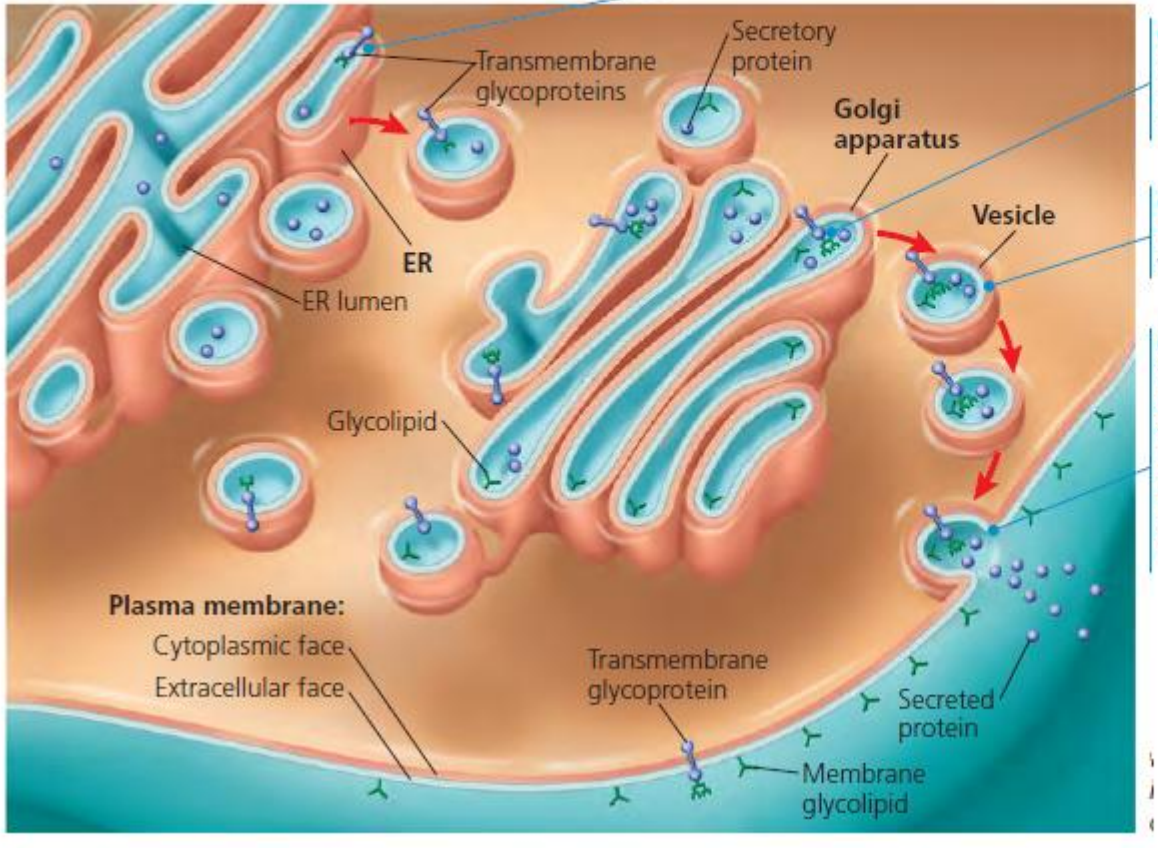
4. Клеточная стенка грибов



Electron micrograph of the fungal cell wall (*C. albicans*), with carbohydrate-rich layers of the fungal cell wall highlighted: mannan (mannosylated proteins), β-glucan and chitin. Although it provides a rigid framework, which gives these pathogens their shape and protection from the environment, the cell wall is a dynamic structure that changes considerably, particularly during the morphological transitions that many fungi can undergo (yeast to hyphae, for example). Furthermore, some of the internal components, such β-glucans, can be exposed on the fungal surface in specific areas, such as the bud scar in *C. albicans*[32]. The composition of the cell wall also varies between different fungal species. Several CLRs have been identified that recognize these cell-wall structures, including transmembrane and soluble CLRs. The latter group, consisting of surfactant protein (SP)-A, SP-D and mannose-binding lectin (MBP), opsonise fungi and facilitate their recognition (discussed elsewhere[38]). The micrograph was provided by J. Ene and N. Gow.

http://www.nature.com/ni/journal/v13/n9/fig_tab/ni.2369_F1.html

▼ **Figure 7.12 Synthesis of membrane components and their orientation in the membrane.** The cytoplasmic (orange) face of the plasma membrane differs from the extracellular (aqua) face. The latter arises from the inside face of ER, Golgi, and vesicle membranes.



1 Membrane proteins and lipids are synthesized in the endoplasmic reticulum (ER). Carbohydrates (green) are added to the transmembrane proteins (purple dumbbells), making them glycoproteins. The carbohydrate portions may then be modified.

2 Inside the Golgi apparatus, the glycoproteins undergo further carbohydrate modification, and lipids acquire carbohydrates, becoming glycolipids.

3 The glycoproteins, glycolipids, and secretory proteins (purple spheres) are transported in vesicles to the plasma membrane.

4 As vesicles fuse with the plasma membrane, the outside face of the vesicle becomes continuous with the inside (cytoplasmic) face of the plasma membrane. This releases the secretory proteins from the cell, a process called *exocytosis*, and positions the carbohydrates of membrane glycoproteins and glycolipids on the outside (extracellular) face of the plasma membrane.

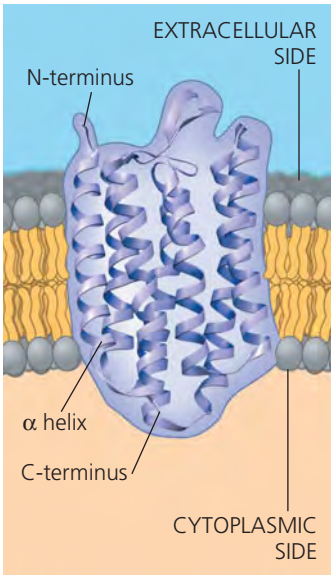
Membrane Proteins and Their Functions

Now we come to the *mosaic* aspect of the fluid mosaic model. Somewhat like a tile mosaic, a membrane is a collage of different proteins, often clustered together in groups, embedded in the fluid matrix of the lipid bilayer (see Figure 7.5). More than 50 kinds of proteins have been found so far in the plasma membrane of red blood cells, for example. Phospholipids form the main fabric of the membrane, but proteins determine most of the membrane's functions. Different types of cells contain different sets of membrane proteins, and the various membranes within a cell each have a unique collection of proteins.

Notice in Figure 7.5 that there are two major populations of membrane proteins: integral proteins and peripheral proteins. **Integral proteins** penetrate the hydrophobic interior of the lipid bilayer. The majority are *transmembrane proteins*, which span the membrane; other integral proteins extend only partway into the hydrophobic interior. The hydrophobic regions of an integral protein consist of one or more stretches of nonpolar amino acids (see Figure 5.16), usually coiled into α helices **(Figure 7.9)**. The hydrophilic parts of the molecule are exposed to the aqueous solutions on either side of the membrane. Some proteins also have a hydrophilic channel through their center that allows passage of hydrophilic substances (see Figure 7.1). **Peripheral proteins** are not embedded in the lipid bilayer at all; they are appendages loosely bound to the surface of the membrane, often to exposed parts of integral proteins (see Figure 7.5).

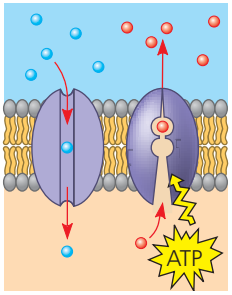
On the cytoplasmic side of the plasma membrane, some membrane proteins are held in place by attachment to the cytoskeleton. And on the extracellular side, certain membrane proteins are attached to fibers of the extracellular matrix (see Figure 6.30; *integrins* are one type of integral protein). These attachments combine to give animal cells a stronger framework than the plasma membrane alone could provide.

Figure 7.10 gives an overview of six major functions performed by proteins of the plasma membrane. A single cell

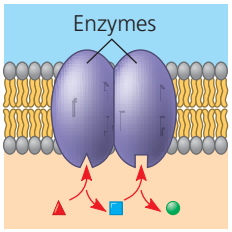


◀ **Figure 7.9 The structure of a transmembrane protein.** Bacteriorhodopsin (a bacterial transport protein) has a distinct orientation in the membrane, with its N-terminus outside the cell and its C-terminus inside. This ribbon model highlights the α-helical secondary structure of the hydrophobic parts, which lie mostly within the hydrophobic interior of the membrane. The protein includes seven transmembrane helices. The nonhelical hydrophilic segments are in contact with the aqueous solutions on the extracellular and cytoplasmic sides of the membrane.

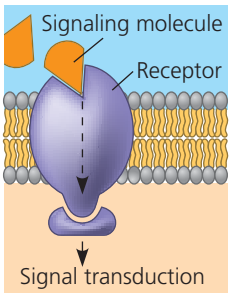
(a) Transport. *Left:* A protein that spans the membrane may provide a hydrophilic channel across the membrane that is selective for a particular solute. *Right:* Other transport proteins shuttle a substance from one side to the other by changing shape (see Figure 7.17). Some of these proteins hydrolyze ATP as an energy source to actively pump substances across the membrane.



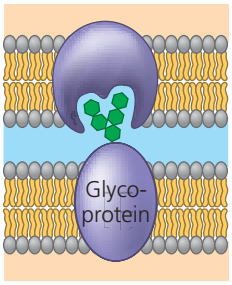
(b) Enzymatic activity. A protein built into the membrane may be an enzyme with its active site exposed to substances in the adjacent solution. In some cases, several enzymes in a membrane are organized as a team that carries out sequential steps of a metabolic pathway.



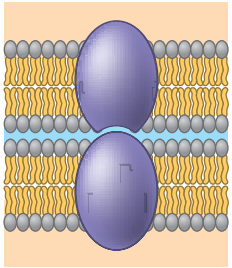
(c) Signal transduction. A membrane protein (receptor) may have a binding site with a specific shape that fits the shape of a chemical messenger, such as a hormone. The external messenger (signaling molecule) may cause the protein to change shape, allowing it to relay the message to the inside of the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



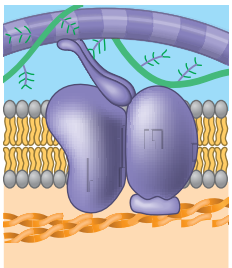
(d) Cell-cell recognition. Some glycoproteins serve as identification tags that are specifically recognized by membrane proteins of other cells. This type of cell-cell binding is usually short-lived compared to that shown in (e).



(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). This type of binding is more long-lasting than that shown in (d).



(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 7.10 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.*

Как транспортируются вещества через клеточную мембрану?

1. Липидный бислой проницаем только для небольших и неполярных молекул

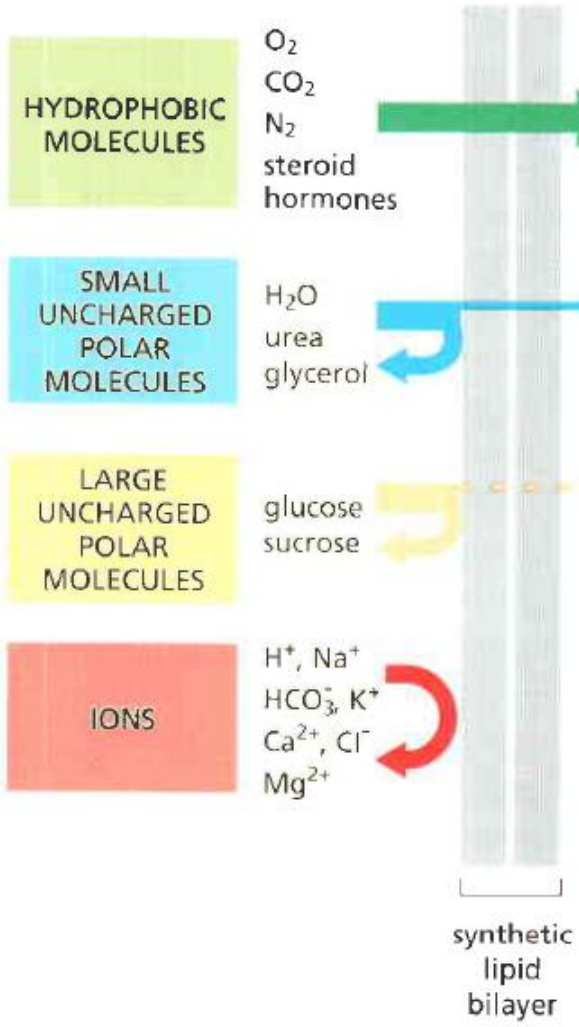
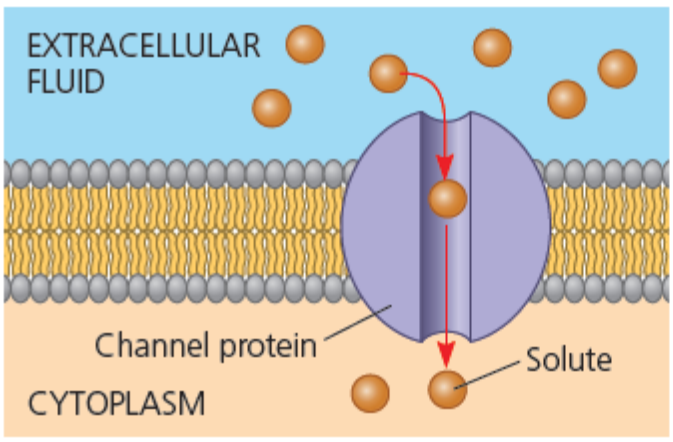


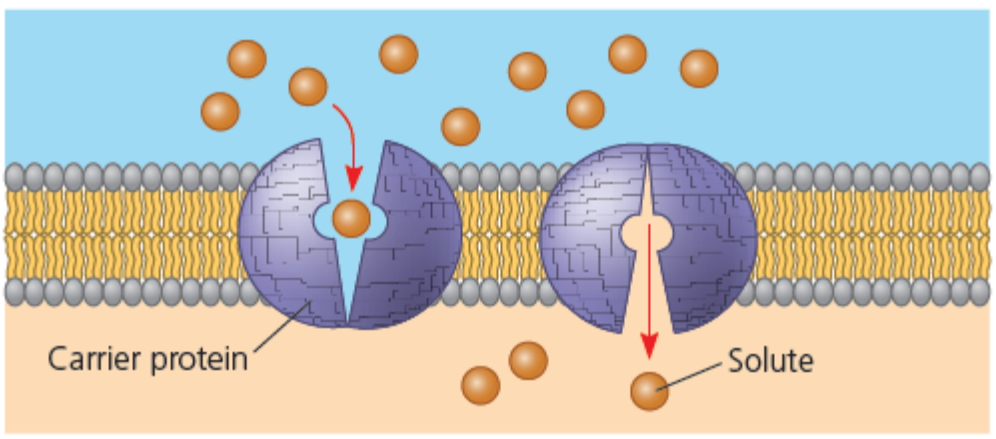
Figure 11–1 **The relative permeability of a synthetic lipid bilayer to different classes of molecules.** The smaller the molecule and, more importantly, the less strongly it associates with water, the more rapidly the molecule diffuses across the bilayer.

2. Существуют 2 типа транспортных белков

рис. из учебника Campbell Biology (9th Edition)



(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 7.17 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.

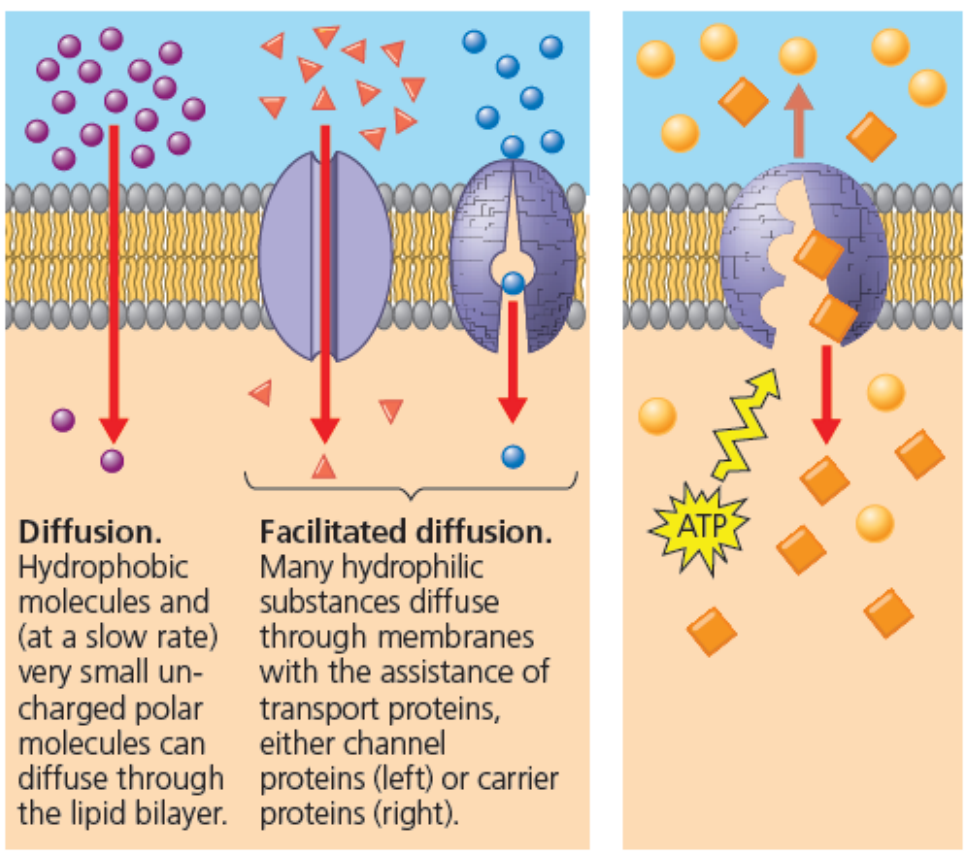
3. Транспорт бывает активный и пассивный

рис. из учебника Campbell Biology (9th Edition)

▼ **Figure 7.19 Review: passive and active transport.**

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.

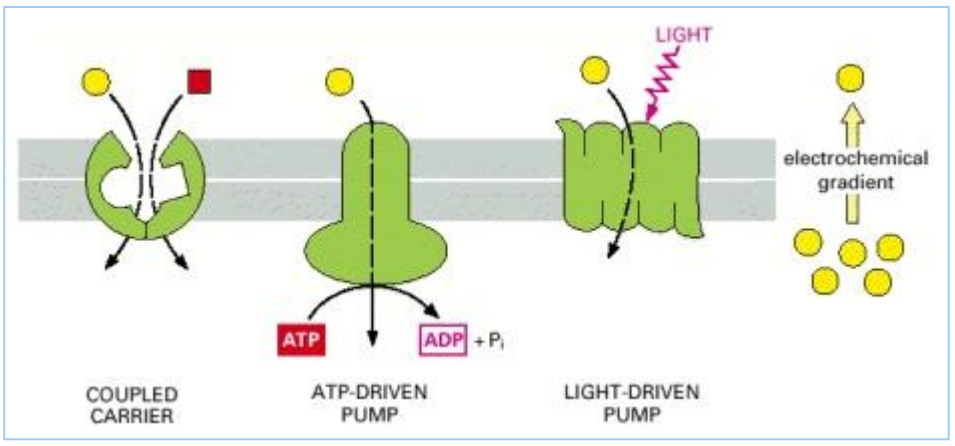
Active transport. Some transport proteins act as pumps, moving substances across a membrane against their concentration (or electrochemical) gradients. Energy for this work is usually supplied by ATP.



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 proteins (left) or carrier proteins (right).

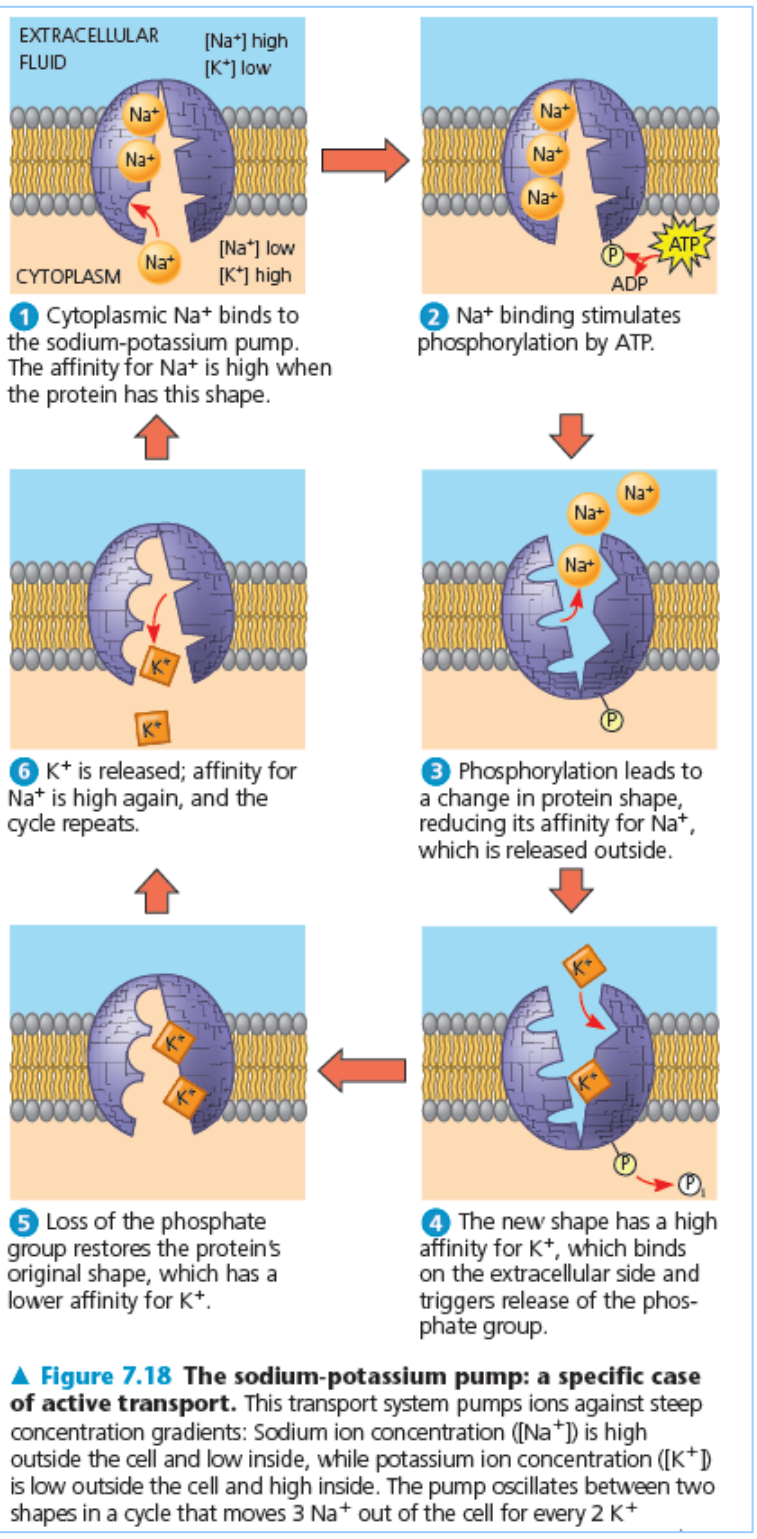
4. Способы активного транспорта



Molecular Biology of the Cell. 4th edition.
Alberts B, Johnson A, Lewis J, et al.
New York:

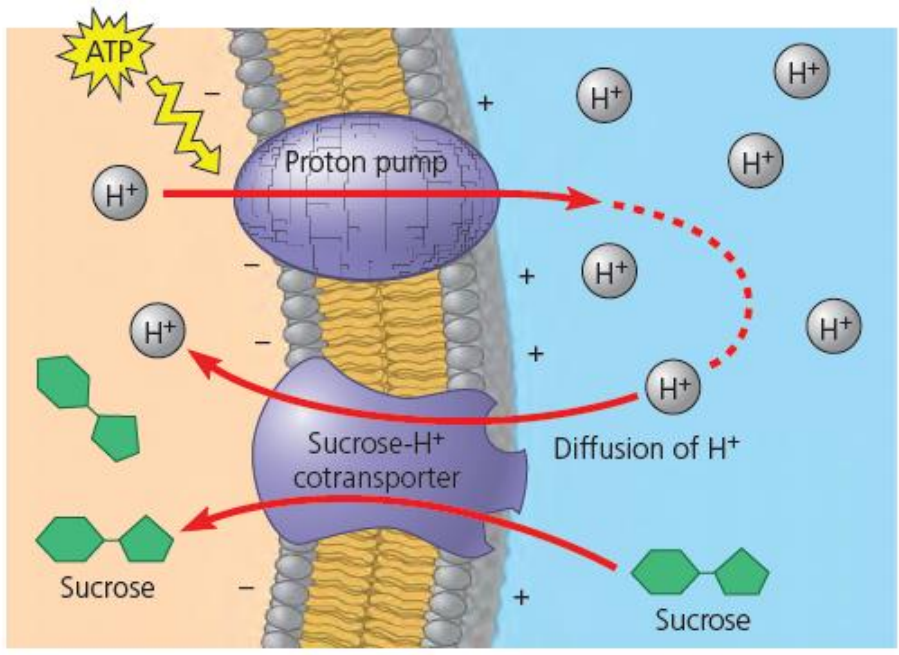
5. Примеры активного транспорта (*рис. из учебника Campbell Biology (9th Edition)*

Пример 1. K^+ -Na^+-АТФаза



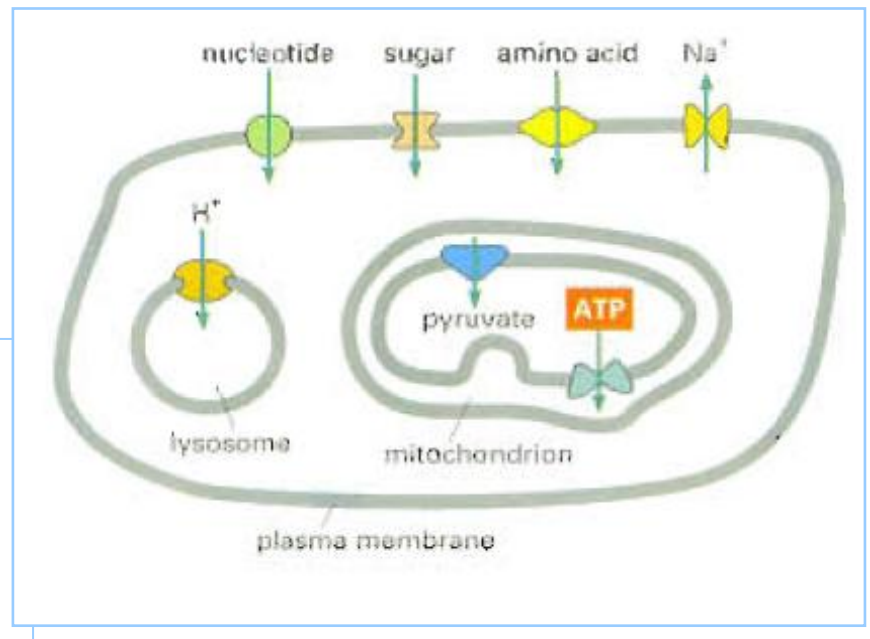
▲ **Figure 7.18 The sodium-potassium pump: a specific case of active transport.** This transport system pumps ions against steep concentration gradients: Sodium ion concentration ($[Na^+]$) is high outside the cell and low inside, while potassium ion concentration ($[K^+]$) is low outside the cell and high inside. The pump oscillates between two shapes in a cycle that moves 3 Na^+ out of the cell for every 2 K^+

Пример 2. Транспорт лактозы



▲ **Figure 7.21 Cotransport: active transport driven by a concentration gradient.** A carrier protein, such as this sucrose-H^+ cotransporter in a plant cell, 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 indirectly provides the energy necessary for cotransport. (The cell wall is not shown.)

6. Каждая клеточная мембрана содержит свой набор транспортных белков



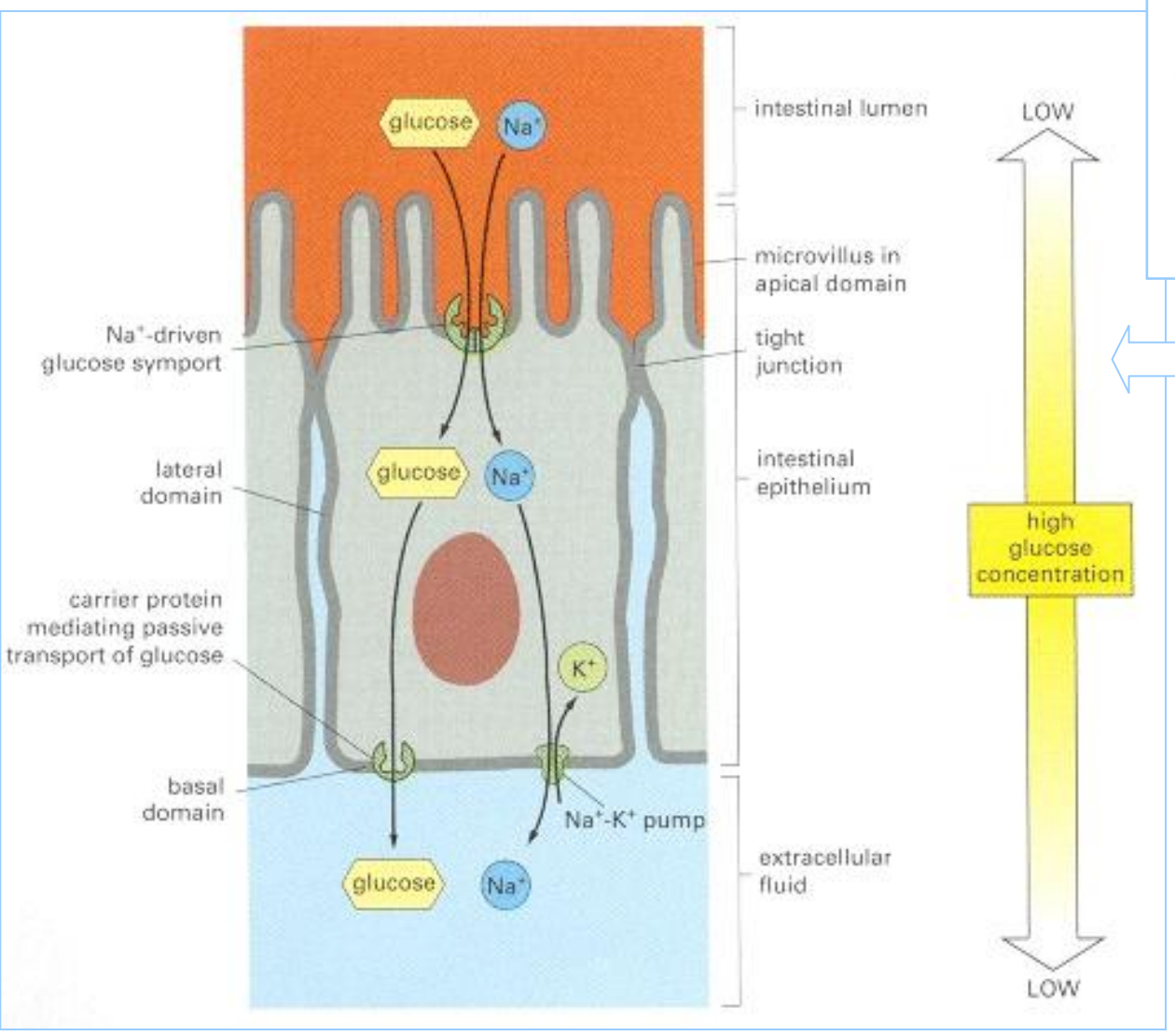


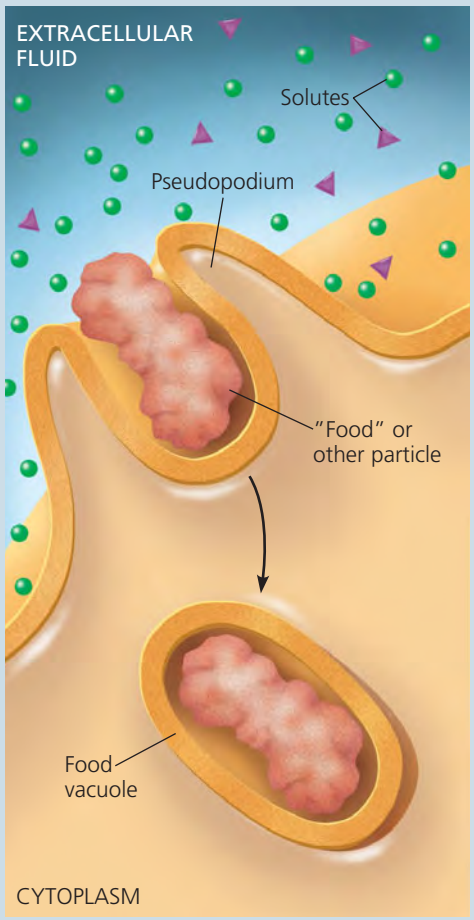
Figure 11-12Transcellular transport

The transcellular transport of glucose across an intestinal epithelial cell depends on the nonuniform distribution of transport proteins in the cell's plasma membrane. The process shown here results in the transport of glucose from the intestinal lumen to the extracellular fluid (from where it passes into the blood). Glucose is pumped into the cell through the apical domain of the membrane by a Na+ -powered glucose symport. Glucose passes out of the cell (down its concentration gradient) by passive transport mediated by a different glucosecarrier protein in the basal and lateral membrane domains. The Na+ gradient driving the glucose symport is maintained by a Na+ pump in the basal and lateral plasma membrane domains, which keeps the internal concentration of Na+ low. Adjacent cells are connected by impermeable tight junctions, which have a dual function in the transport process illustrated: they prevent solutes from crossing the epithelium between cells, allowing a concentration gradient of glucose to be maintained across the cell sheet, and they also serve as diffusion barriers within the plasma membrane, which help confine the various carrier proteins to their respective membrane domains (see Figure 10-41).

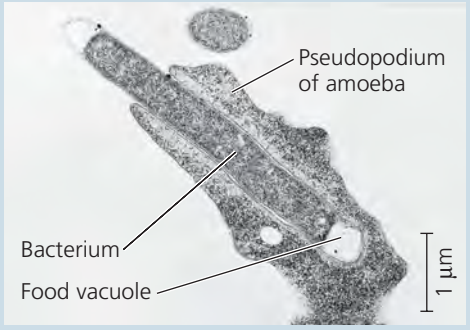
▼ Figure 7.22

Exploring Endocytosis in Animal Cells

Phagocytosis

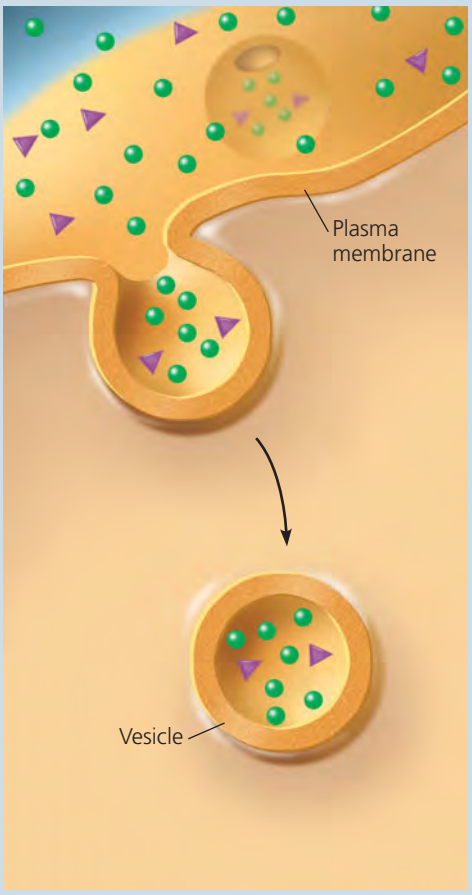


In **phagocytosis,** a cell engulfs a particle by wrapping pseudopodia (singular, *pseudopodium*) around it and packaging it within a membranous sac called a food vacuole. The particle will be digested after the food vacuole fuses with a lysosome containing hydrolytic enzymes (see Figure 6.13a).

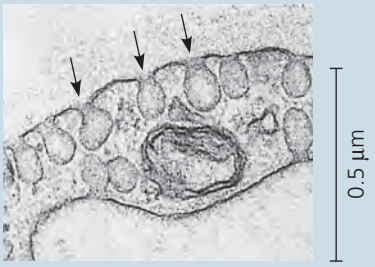


An amoeba engulfing a bacterium via phagocytosis (TEM).

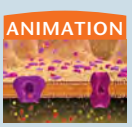
Pinocytosis



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 (indicated by arrows) in a cell lining a small blood vessel (TEM).



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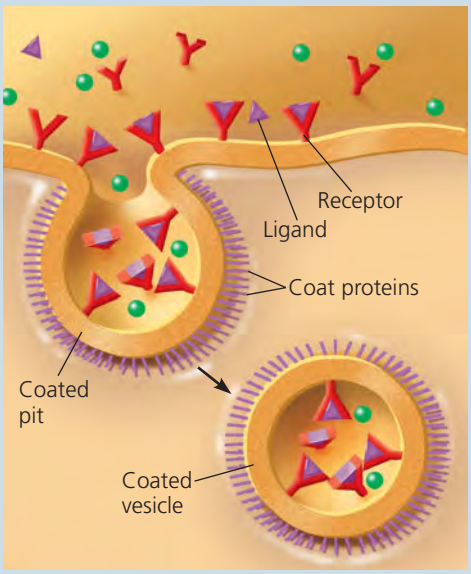
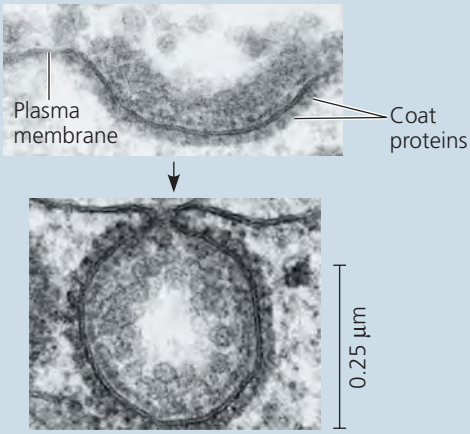
Receptor-Mediated Endocytosis



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, to which specific substances (ligands) bind. The receptor proteins then cluster in regions of the membrane called coated pits, which are lined on their cytoplasmic side by a fuzzy layer of coat proteins. Next, each 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 the ingested material is liberated from the vesicle, the emptied receptors are recycled to the plasma membrane by the same vesicle.



Top: A coated pit. *Bottom:* A coated vesicle forming during receptor-mediated endocytosis (TEMs).