Advanced Cell Biology. Lecture 30

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Minot State University

April 8th, 2011

Outline

Questions and answers

Membrane transport

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Membrane transport

Previous final question: the answer

What is the function of anchor protein?

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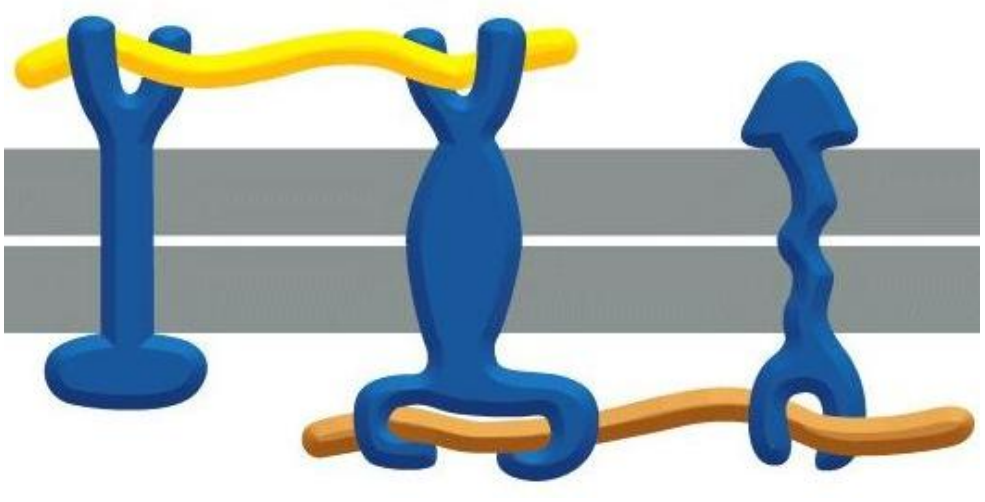
What is the function of anchor protein?

- To hold together internal and external molecules



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REPORT

A Virophage at the Origin of Large DNA Transposons

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ABSTRACT

DNA transposons are mobile genetic elements that have shaped the genomes of eukaryotes for millions of years, yet their origins remain obscure. We discovered a virophage that, on the basis of genetic homology, likely represents an evolutionary link between double-stranded DNA viruses and *Maverick/Polinton* eukaryotic DNA transposons. The Mavirus virophage parasitizes the giant *Cafeteria roenbergensis* virus and encodes 20 predicted proteins, including a retroviral integrase and a protein-primed DNA polymerase B. On the basis of our data, we conclude that *Maverick/Polinton* transposons may have originated from ancient relatives of Mavirus, and thereby influenced the evolution of eukaryotic genomes, although we cannot rule out alternative evolutionary scenarios.

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RESEARCH ARTICLE

Ribozyme-Catalyzed Transcription of an Active Ribozyme

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ABSTRACT

A critical event in the origin of life is thought to have been the emergence of an RNA molecule capable of replicating a primordial RNA "genome." Here we describe the evolution and engineering of an RNA polymerase ribozyme capable of synthesizing RNAs of up to 95 nucleotides in length. To overcome its sequence dependence, we recombined traits evolved separately in different ribozyme lineages. This yielded a more general polymerase ribozyme that was able to synthesize a wider spectrum of RNA sequences, as we demonstrate by the accurate synthesis of an enzymatically active RNA, a hammerhead endonuclease ribozyme. This recapitulates a central aspect of an RNA-based genetic system: the RNA-catalyzed synthesis of an active ribozyme from an RNA template.

Concentrations

- Unequal between outer and inner spaces
- Higher outside: Na^+, Ca^{2+}, Cl^-
- Higher inside: K^+, H^+

Diffusion

- Easy: small non-polar and uncharged polar
- Impossible: uncharged polar bigger than methanol; all ions

Transporters and channels

- Channels discriminate on the basis of charge and size: “trapdoors”
- Transporters discriminate by binding: “keyholes”

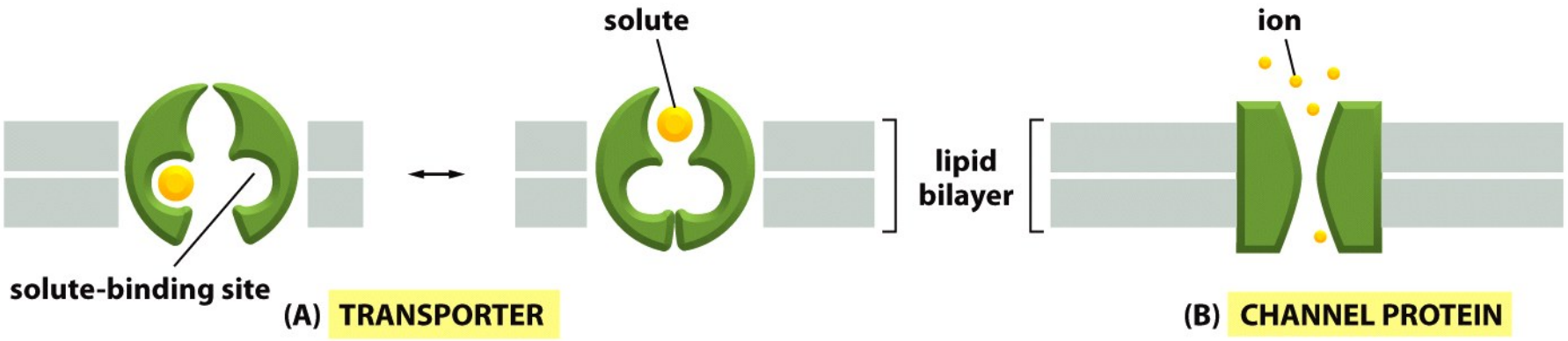
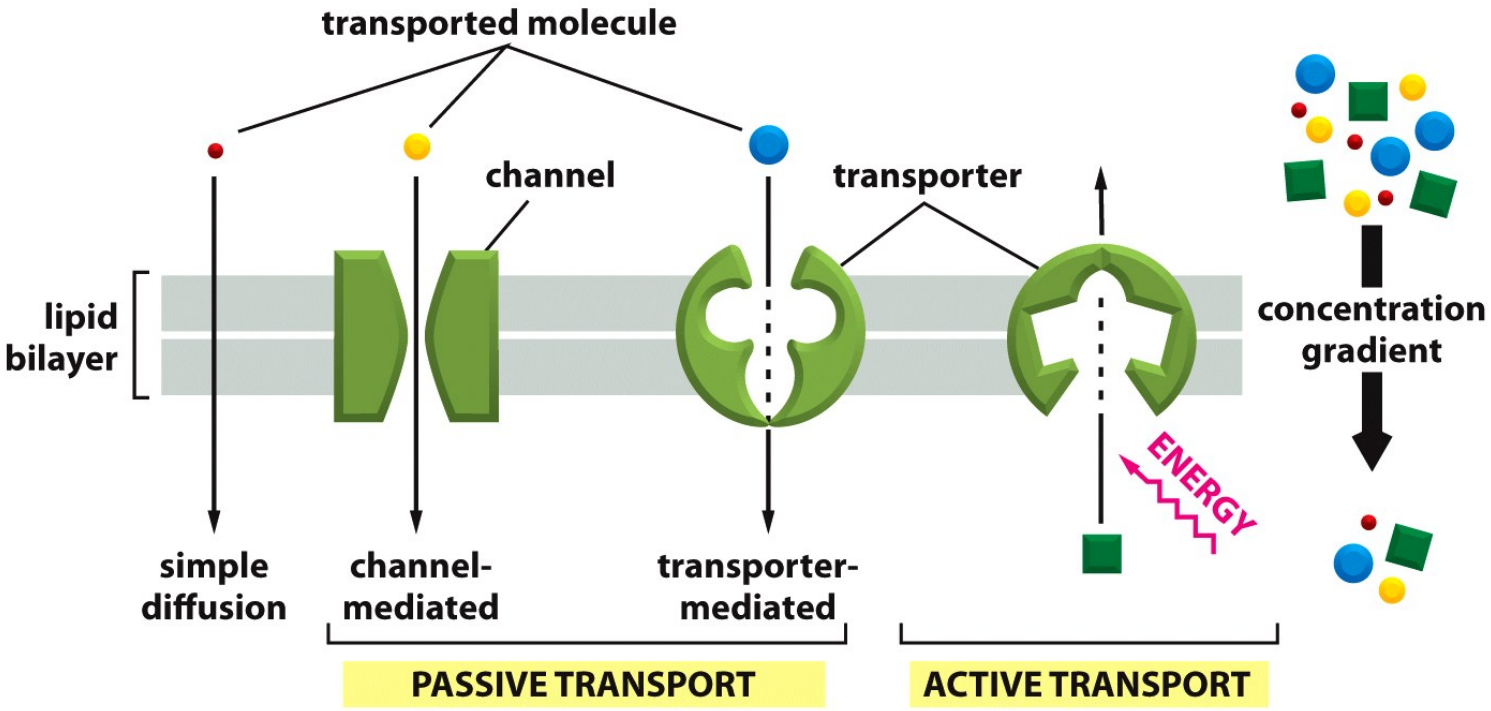


Figure 12-3 Essential Cell Biology 3/e (© Garland Science 2010)

Active and passive transport

- Active: energy spent, against concentration gradient—pumps
- Passive (facilitated diffusion): energy does not spent, along the concentration gradient



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Transporters: passive

- Glucose transporter: binds glucose and transfer it along the concentration gradient
- But only D-glucose
- Chemical + charging gradients = electrochemical gradient

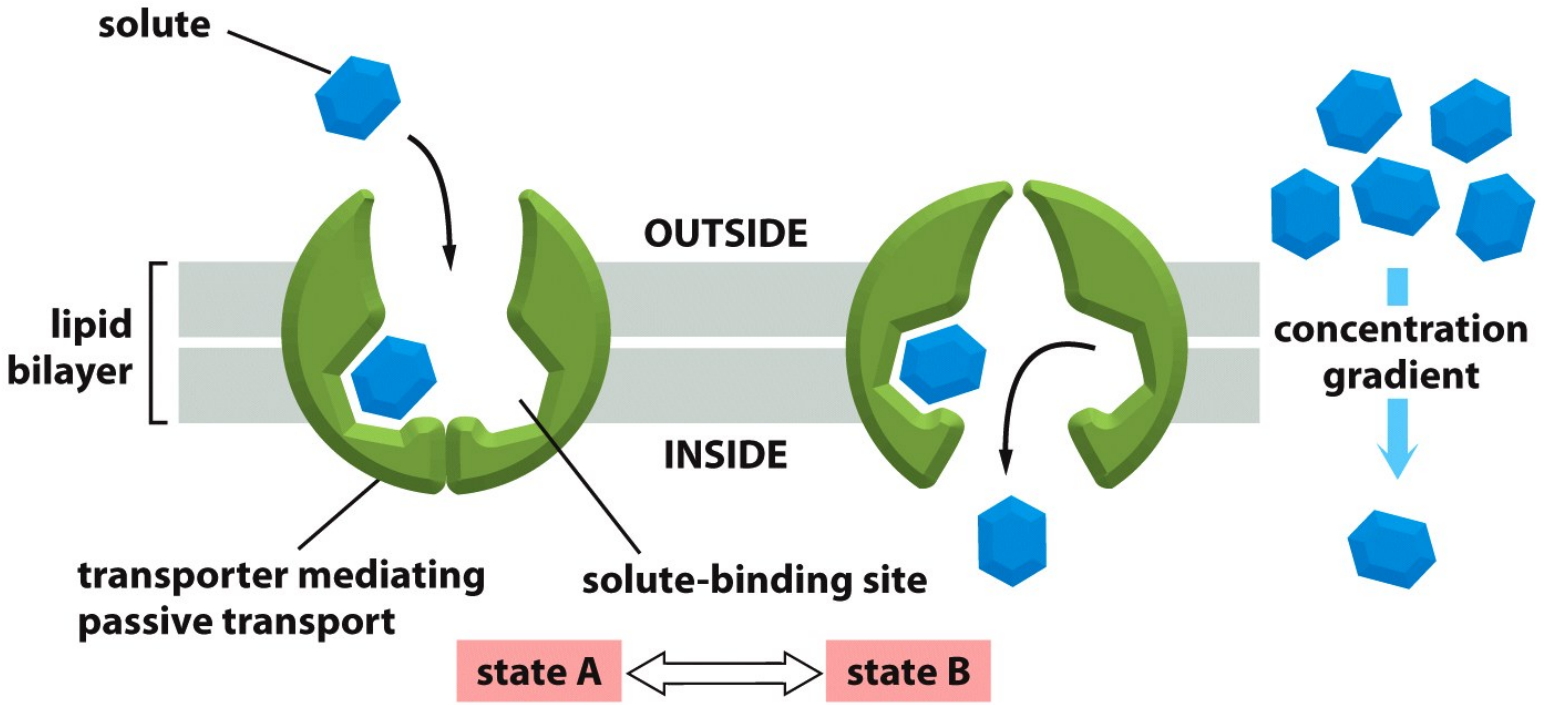

Figure 12-6 Essential Cell Biology 3/e (© Garland Science 2010)

Transporters: active

- Coupled (e.g., with gradient)
- ATP-driven
- Light-driven

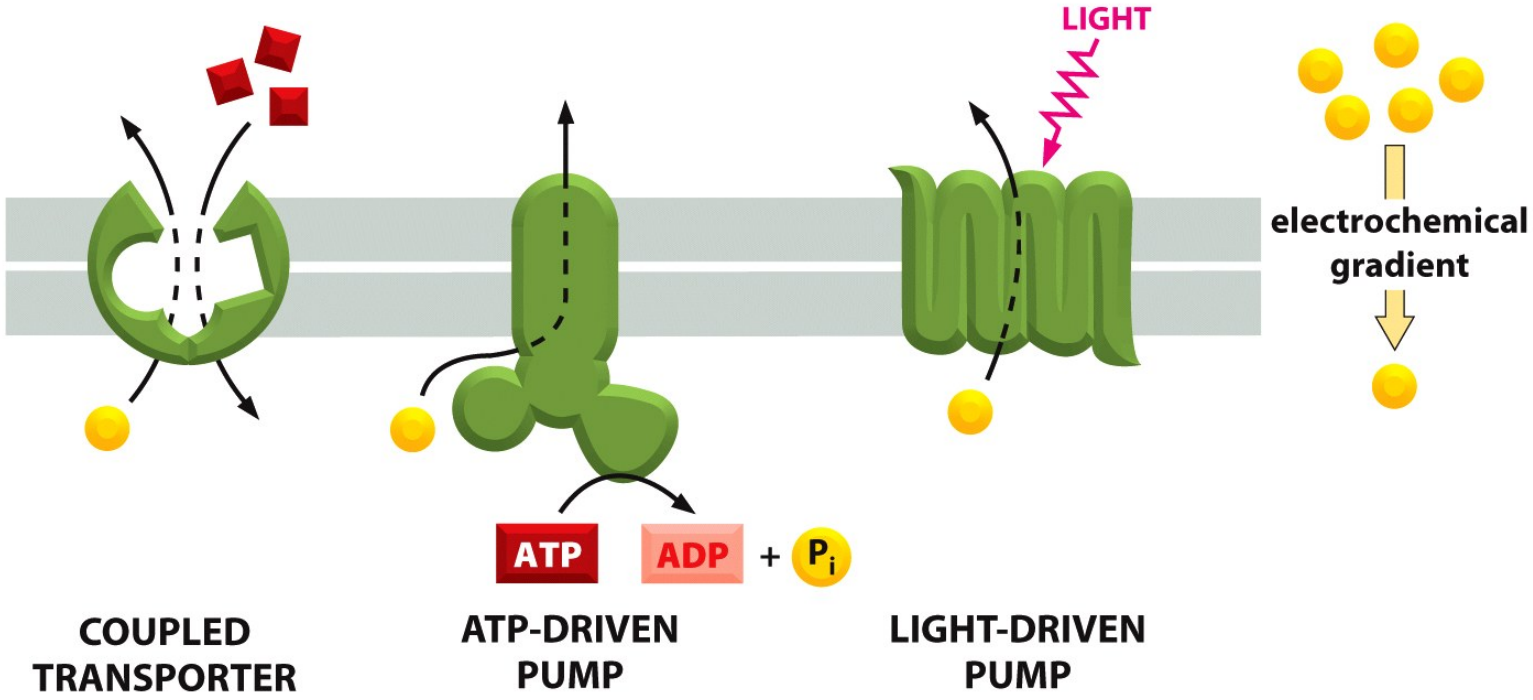

Figure 12-8 Essential Cell Biology 3/e (© Garland Science 2010)

Sodium-potassium pump I

- The other name is Na^+–K^+ ATPase
- ≈30% of ATP consumption in animal cells

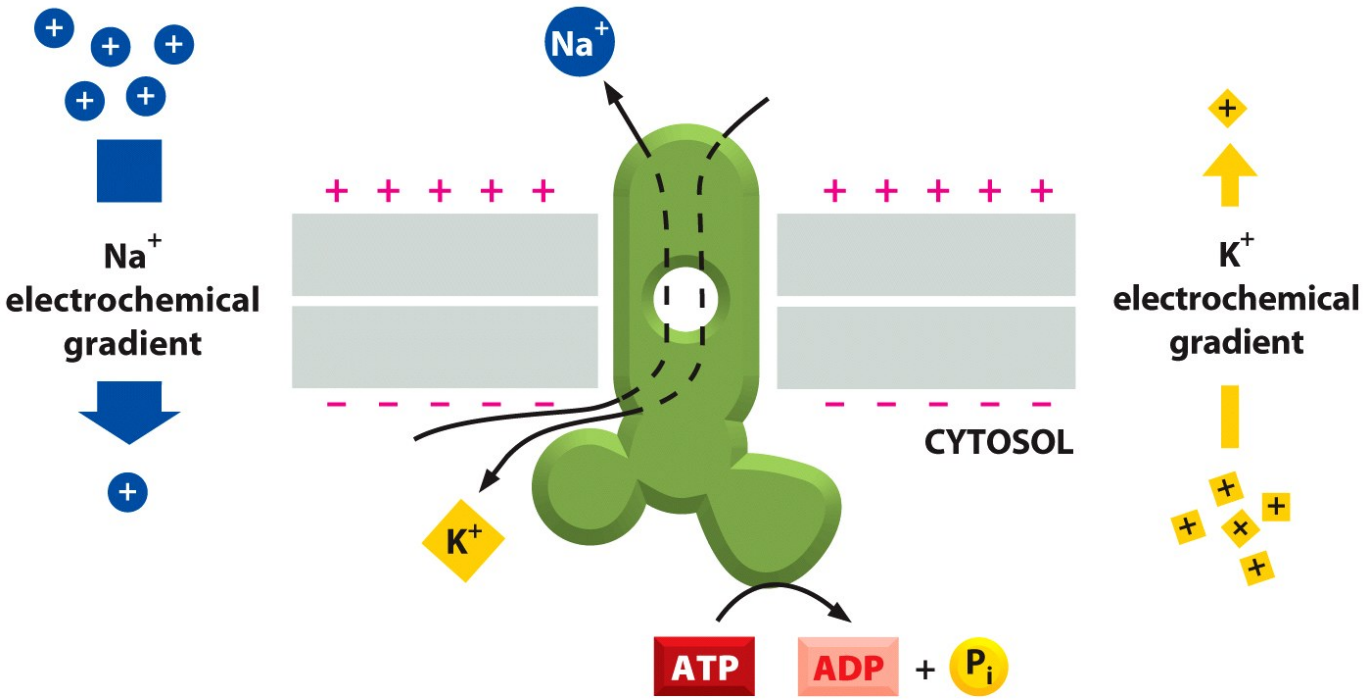

Figure 12-9 Essential Cell Biology 3/e (© Garland Science 2010)

Sodium-potassium pump II

- Sodium-potassium is actually a cycle
- P group is added and released

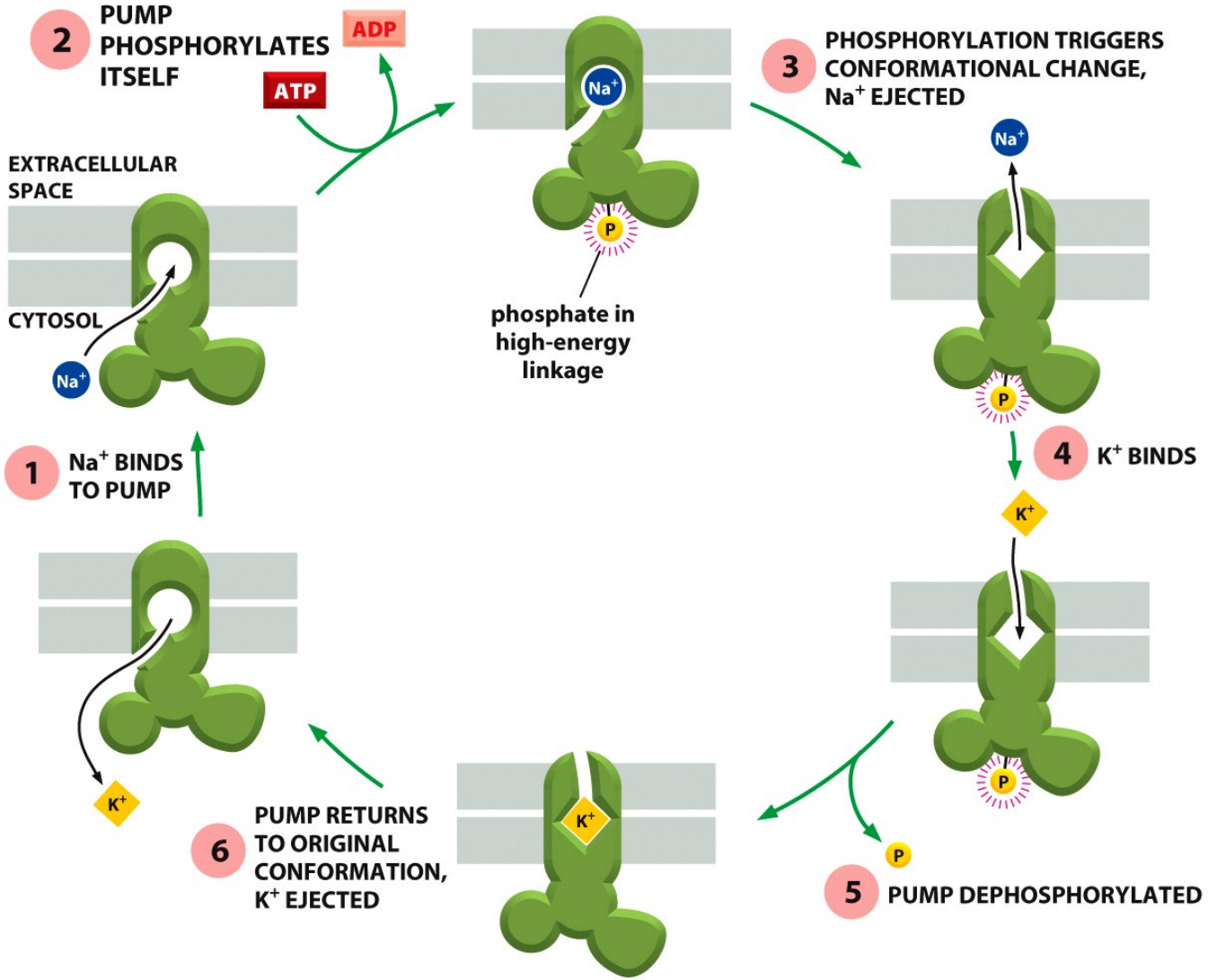

Figure 12-11 Essential Cell Biology 3/e (© Garland Science 2010)

Sodium-potassium movie

Osmotic balance

- Osmosis is the default diffusion of ions in a water across semi-permeable membrane
- Aquaporin channels facilitate the water movement
- Cell walls and contractile vacuoles are used to maintain osmotic pressure, but in animals there is only a sodium-potassium pump (and some other pumps)

Calcium pumps

- The goal is to keep calcium concentration low
- Calcium pump is also an ATPase

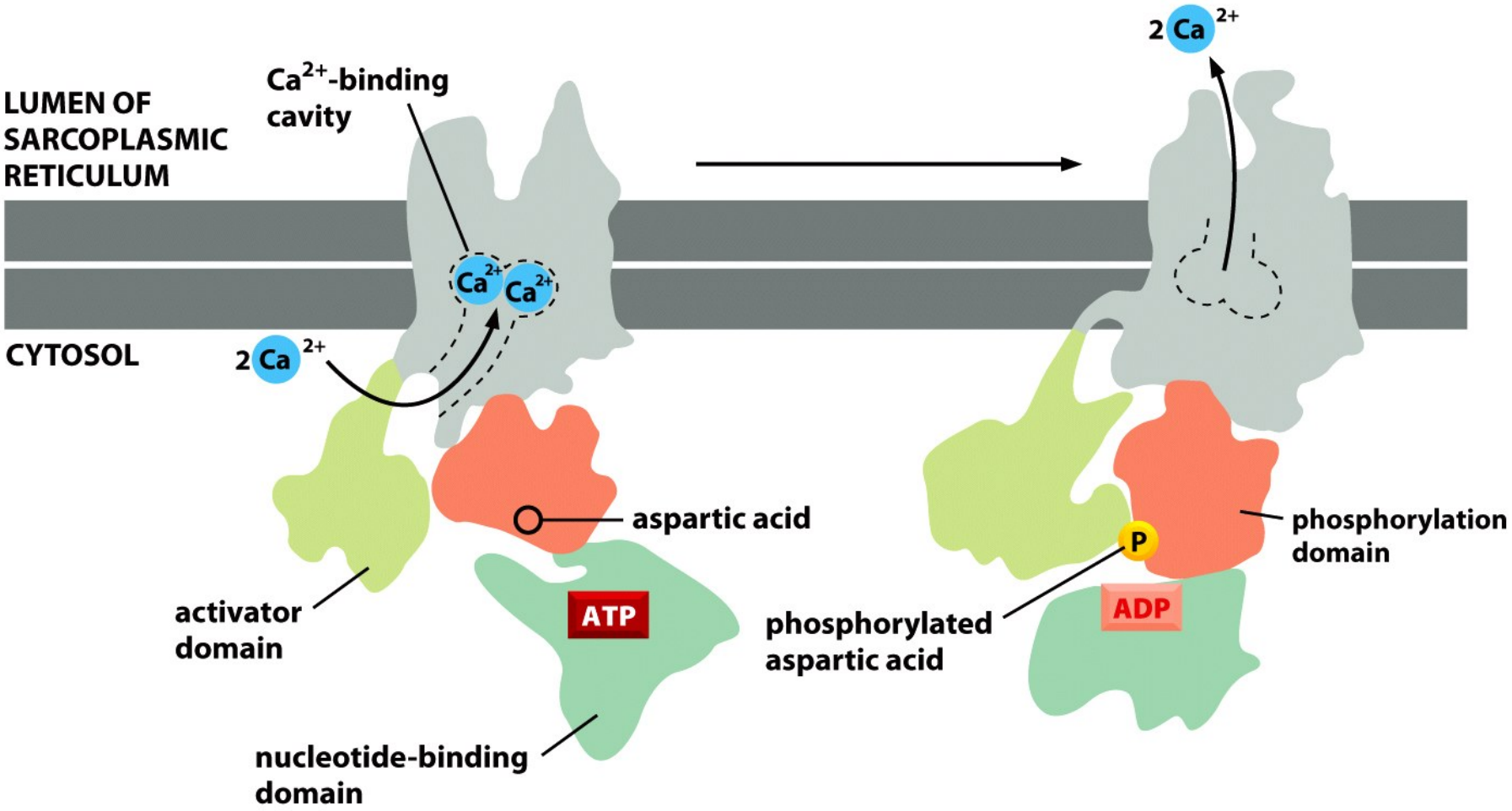

Figure 12-15 Essential Cell Biology 3/e (© Garland Science 2010)

Coupled transporters

- Symports: glucose–Na^+ symport (there is also non-coupled glucose uniport)
- Antiports: Na^+–H^+ exchanger

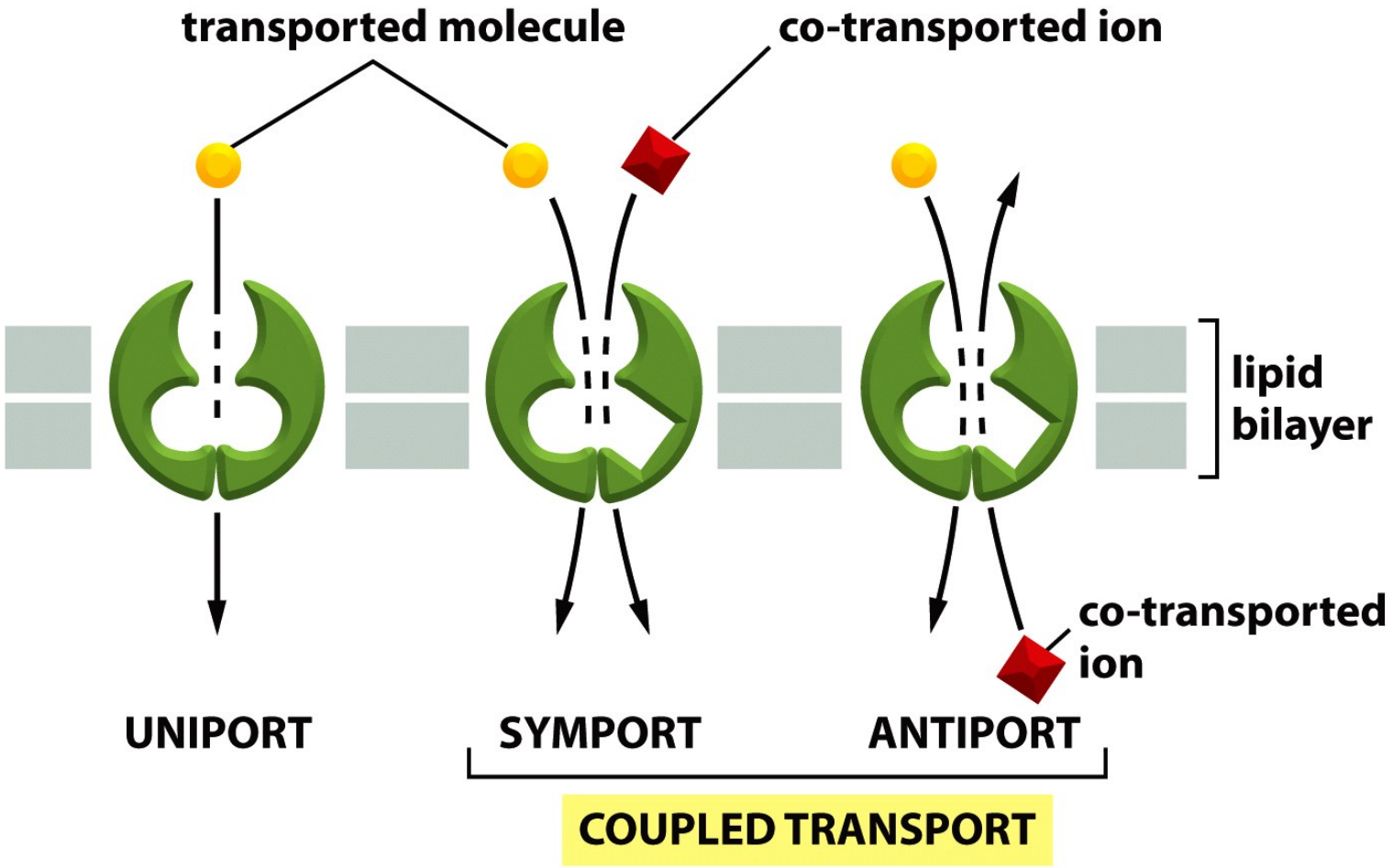

Figure 12-16 Essential Cell Biology 3/e (© Garland Science 2010)

Carrier proteins movie

Glucose–Na^+ symport

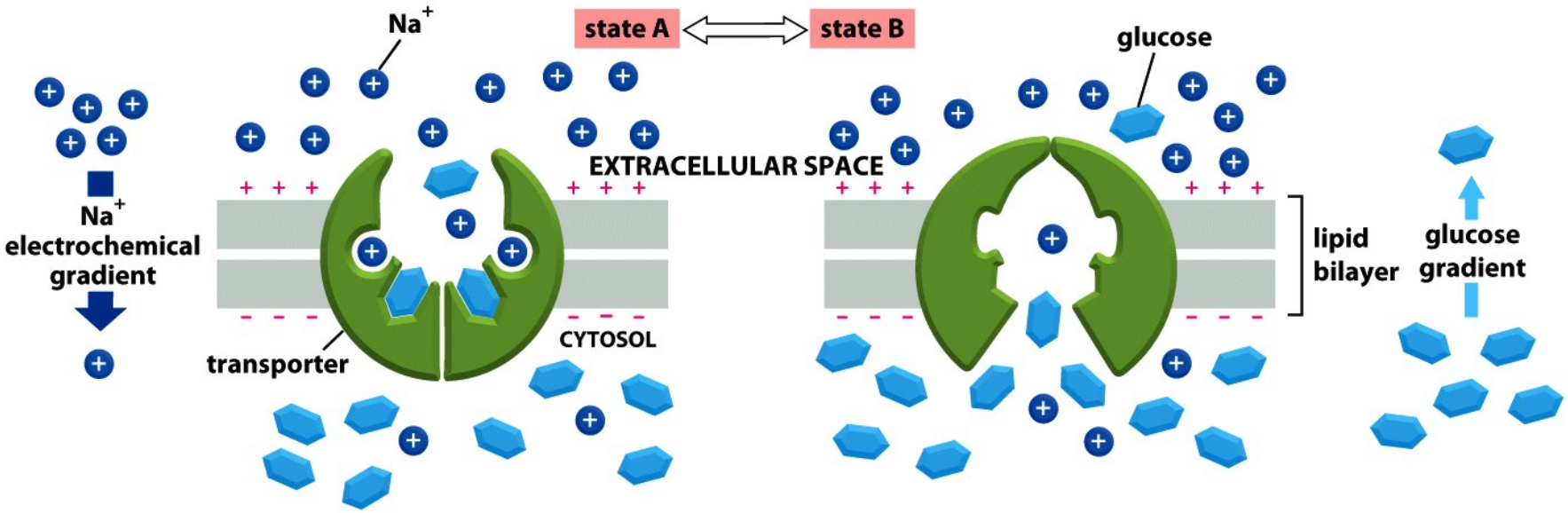

Figure 12-17 Essential Cell Biology 3/e (© Garland Science 2010)

Glucose uptake movie

Proton gradients

- Non-animals maintain the osmotic pressure through proton pumps
- Bacteriorodopsin is a light-driven proton pump

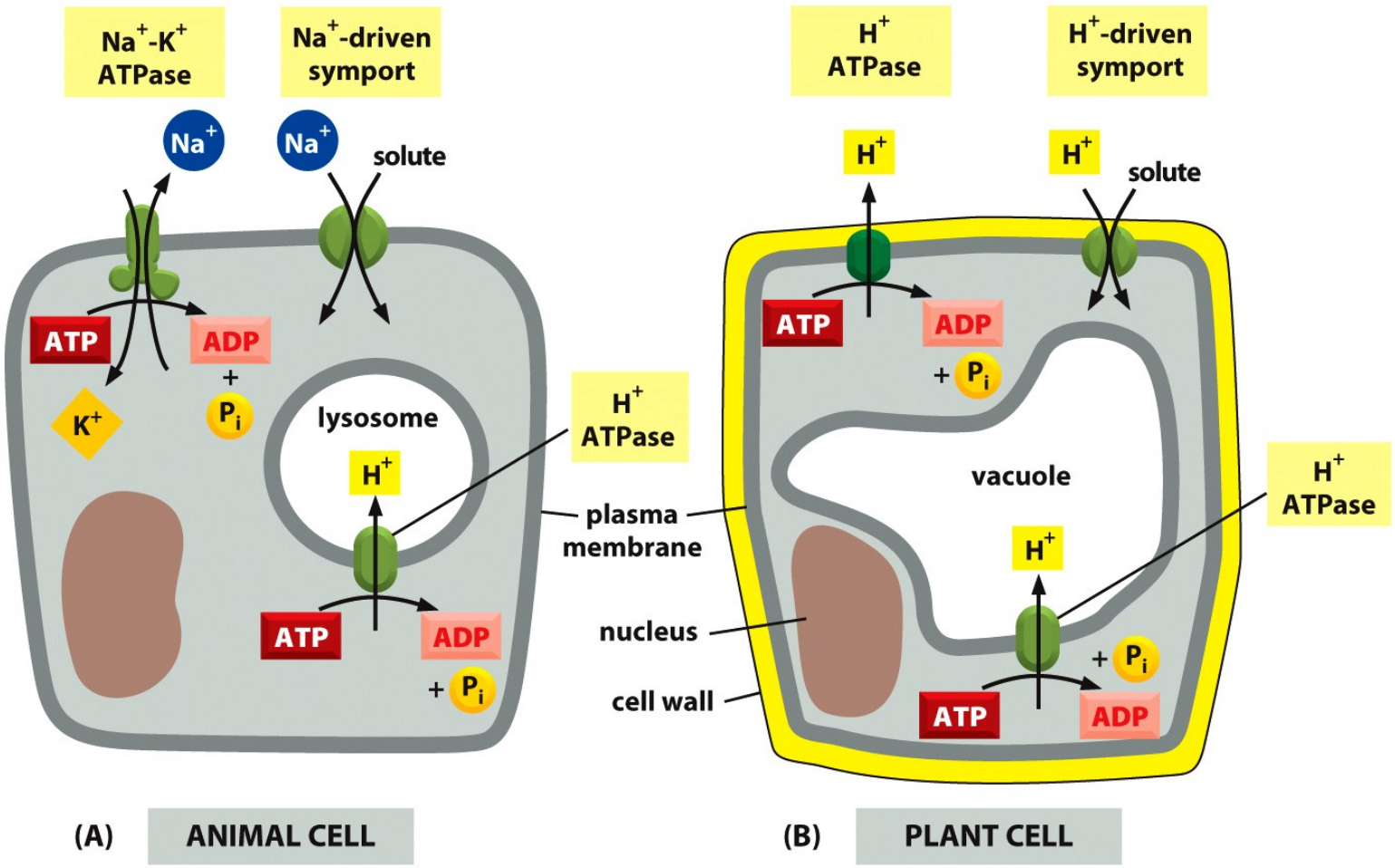

Figure 12-19ab Essential Cell Biology 3/e (© Garland Science 2010)

TABLE 12–2 SOME EXAMPLES OF TRANSPORTERS

TRANSPORTER	LOCATION	ENERGY SOURCE	FUNCTION
Glucose transporter	plasma membrane of most animal cells	none	passive import of glucose
Na^+-driven glucose pump	apical plasma membrane of kidney and intestinal cells	Na^+ gradient	active import of glucose
Na^+-H^+ exchanger	plasma membrane of animal cells	Na^+ gradient	active export of H^+ ions, pH regulation
Na^+-K^+ pump (Na^+-K^+ ATPase)	plasma membrane of most animal cells	ATP hydrolysis	active export of Na^+ and import of K^+
Ca^{2+} pump (Ca^{2+} ATPase)	plasma membrane of eucaryotic cells	ATP hydrolysis	active export of Ca^{2+}
H^+ pump (H^+ ATPase)	plasma membrane of plant cells, fungi, and some bacteria	ATP hydrolysis	active export of H^+
H^+ pump (H^+ ATPase)	membranes of lysosomes in animal cells and of vacuoles in plant and fungal cells	ATP hydrolysis	active export of H^+ from cytosol into vacuole
Bacteriorhodopsin	plasma membrane of some bacteria	light	active export of H^+

Table 12-2 Essential Cell Biology 3/e (© Garland Science 2010)

Ion channels

- Narrow
- Some are wide like gap junction channels, porin channels

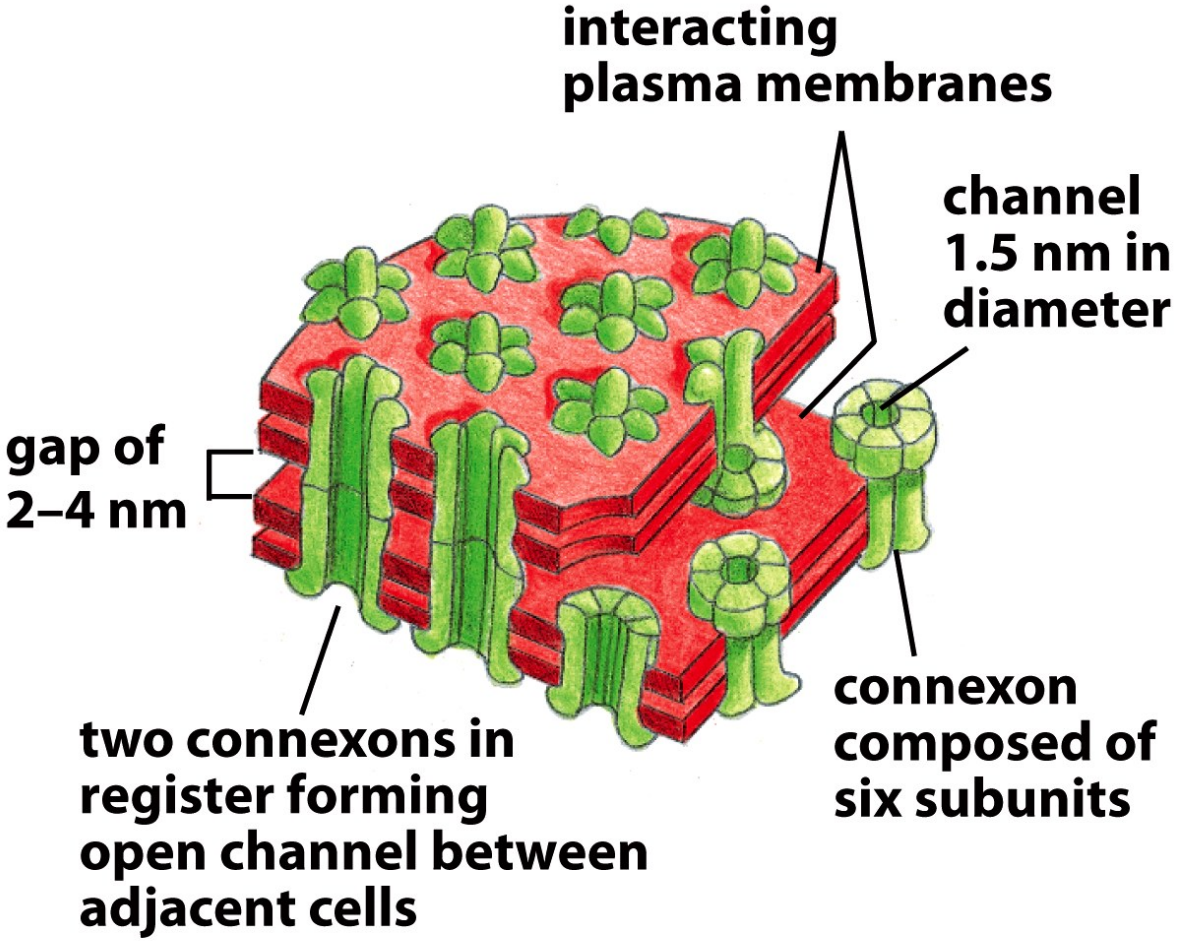

Figure 20-29b Essential Cell Biology 3/e (© Garland Science 2010)

Ion channels: selectivity

- Select ions on the basis of size and charge
- Ion filers facilitate the selectivity of ions
- Differ from simple pores also because channels have two states, open and closed

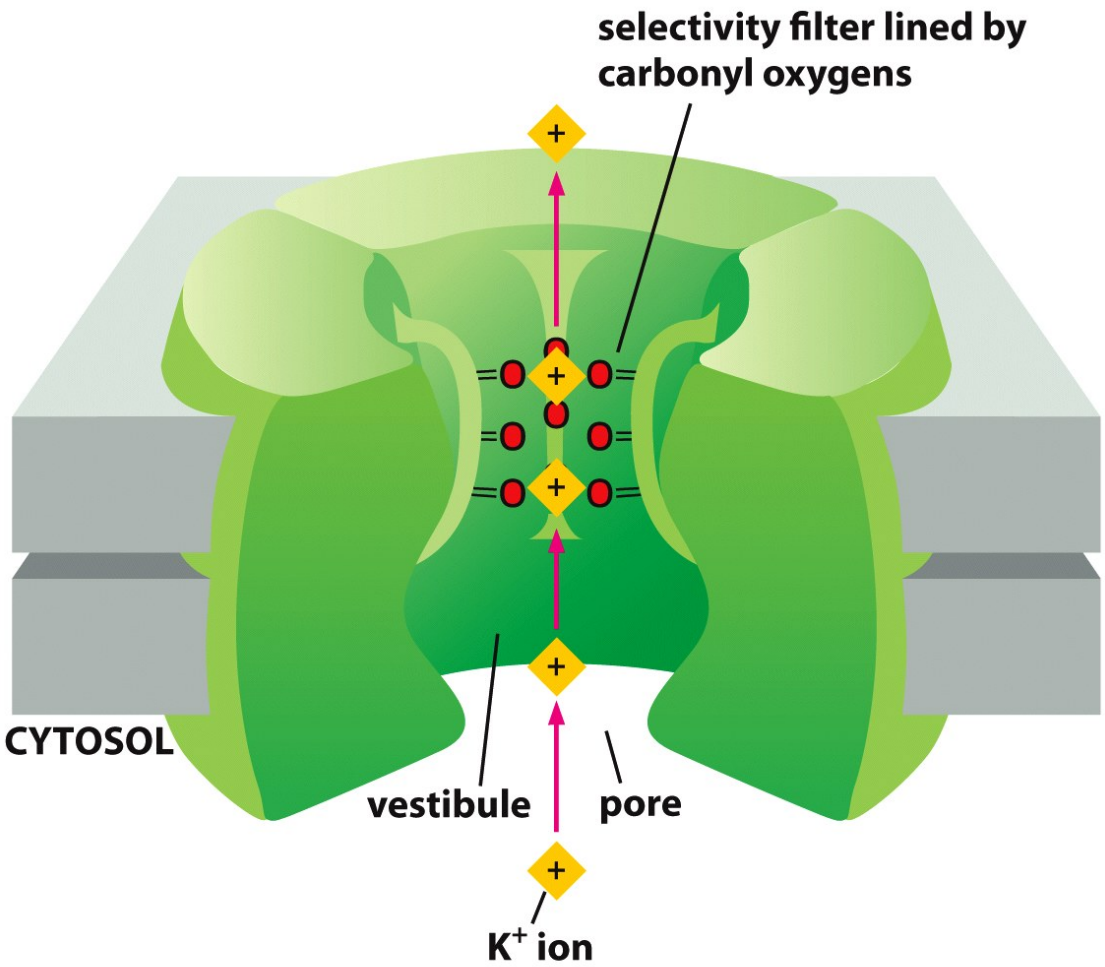

Figure 12-20 Essential Cell Biology 3/e (© Garland Science 2010)

Potassium channel movie

Final question (1 point)

Final question (1 point)

Are transporters selective?

Summary

- Both transporters and channels are selective
- Only transporters may be active

For Further Reading

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B. Alberts et al.
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Chapter 12: 387–403.