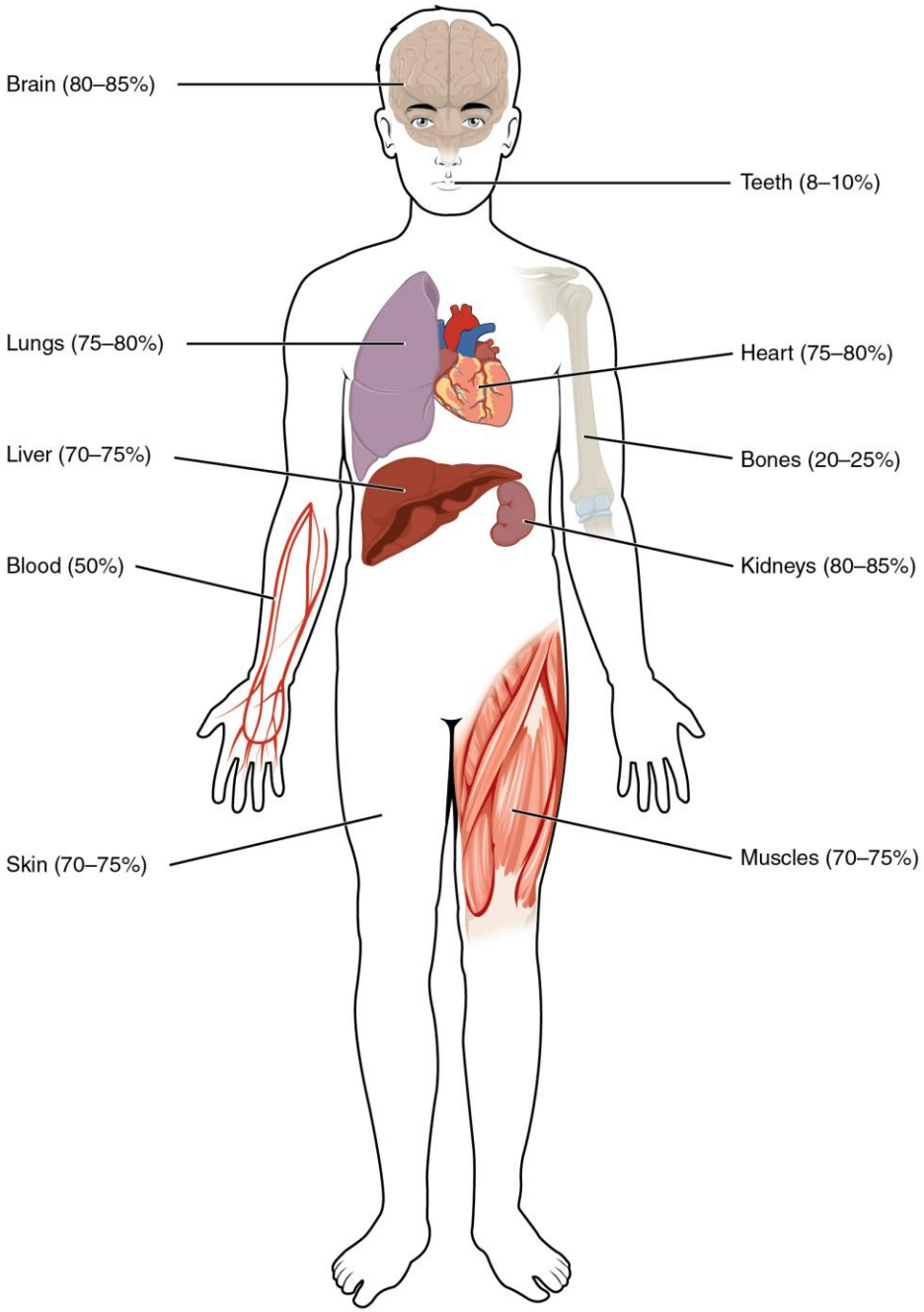
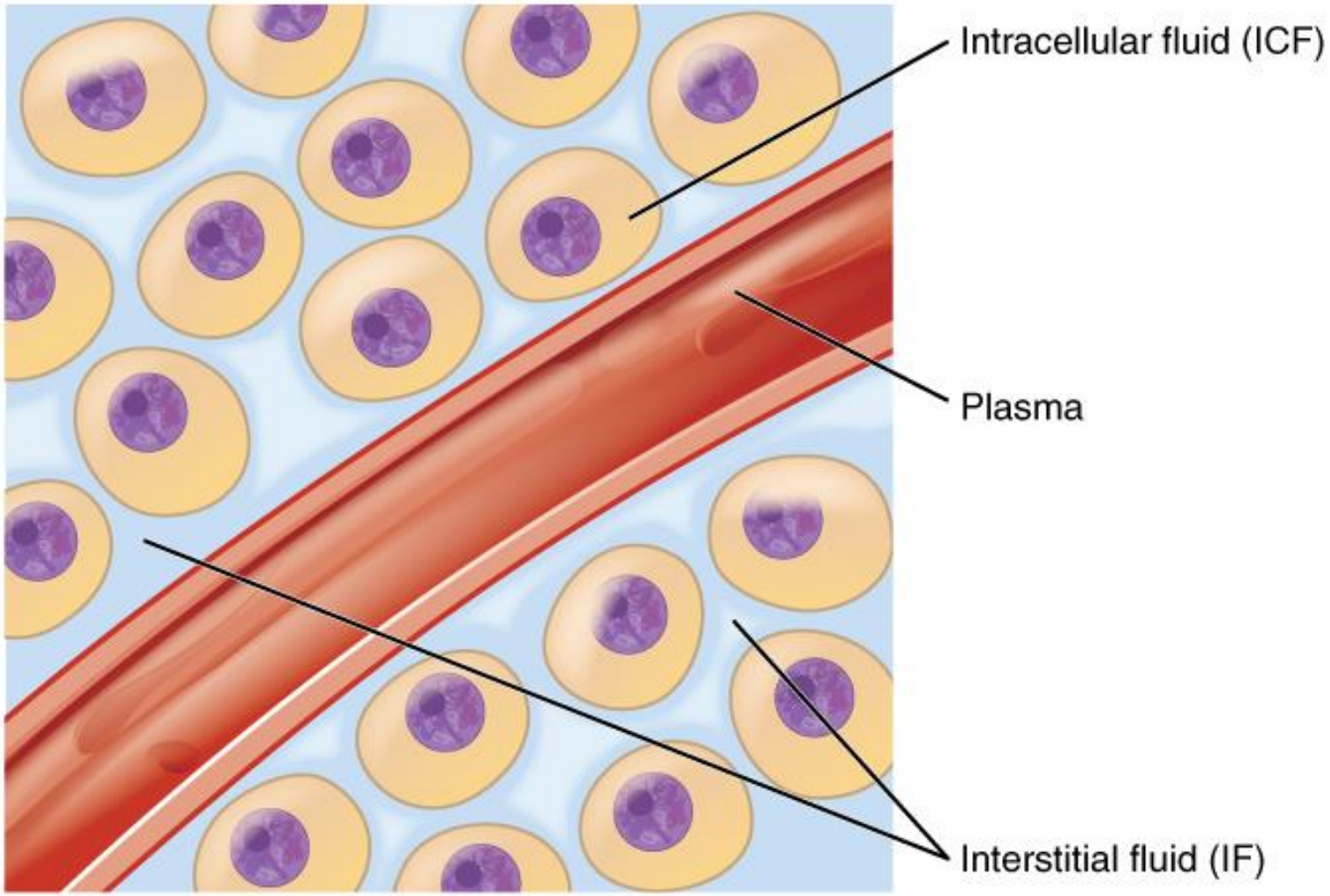
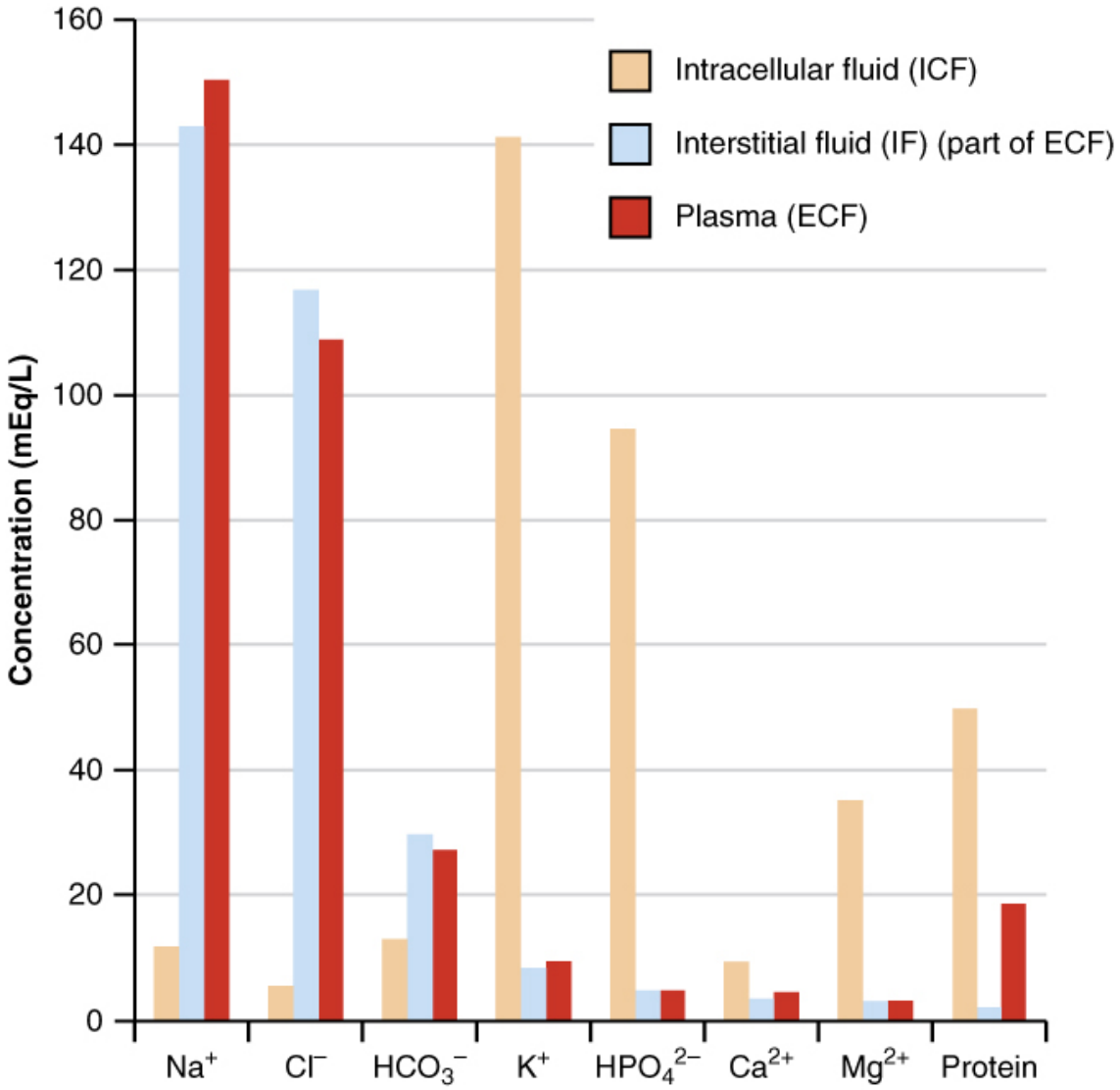
Body Fluids and Fluid Compartment

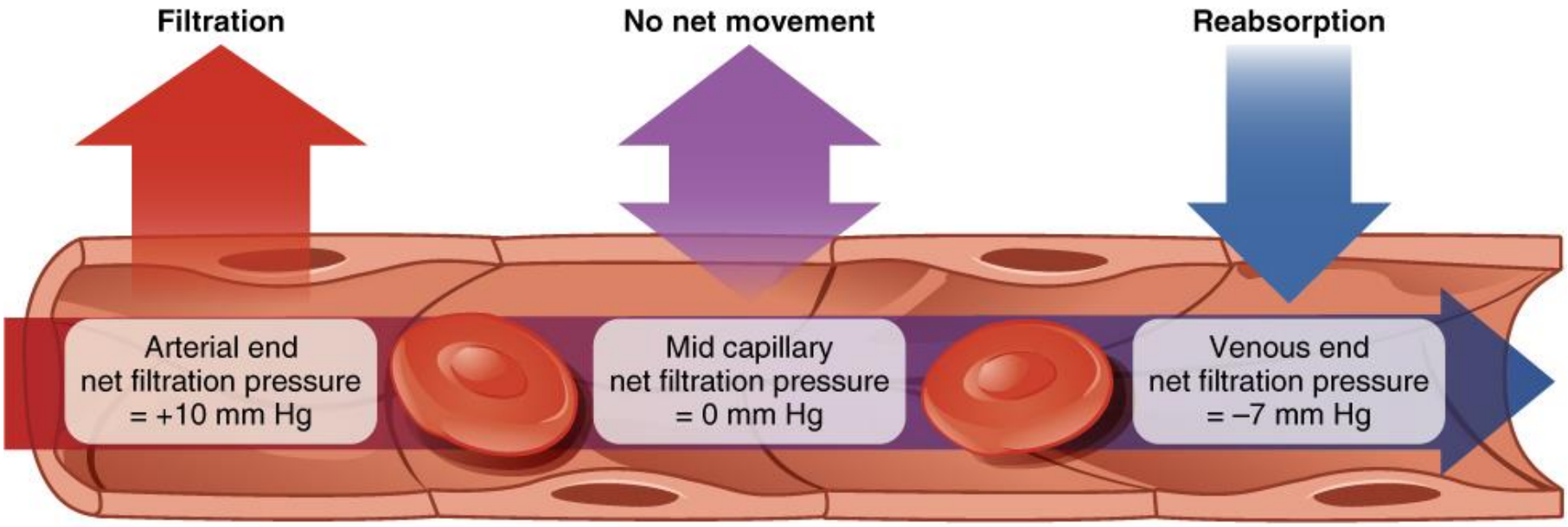

Brain (80–85%)
Teeth (8–10%)
Lungs (75–80%)
Heart (75–80%)
Liver (70–75%)
Bones (20–25%)
Blood (50%)
Kidneys (80–85%)
Skin (70–75%)
Muscles (70–75%)

Fluid Compartment in the Human Body



Composition of Body Fluid





Fluid exits capillary since capillary hydrostatic pressure (35 mm Hg) is greater than blood colloidal osmotic pressure (25 mm Hg)

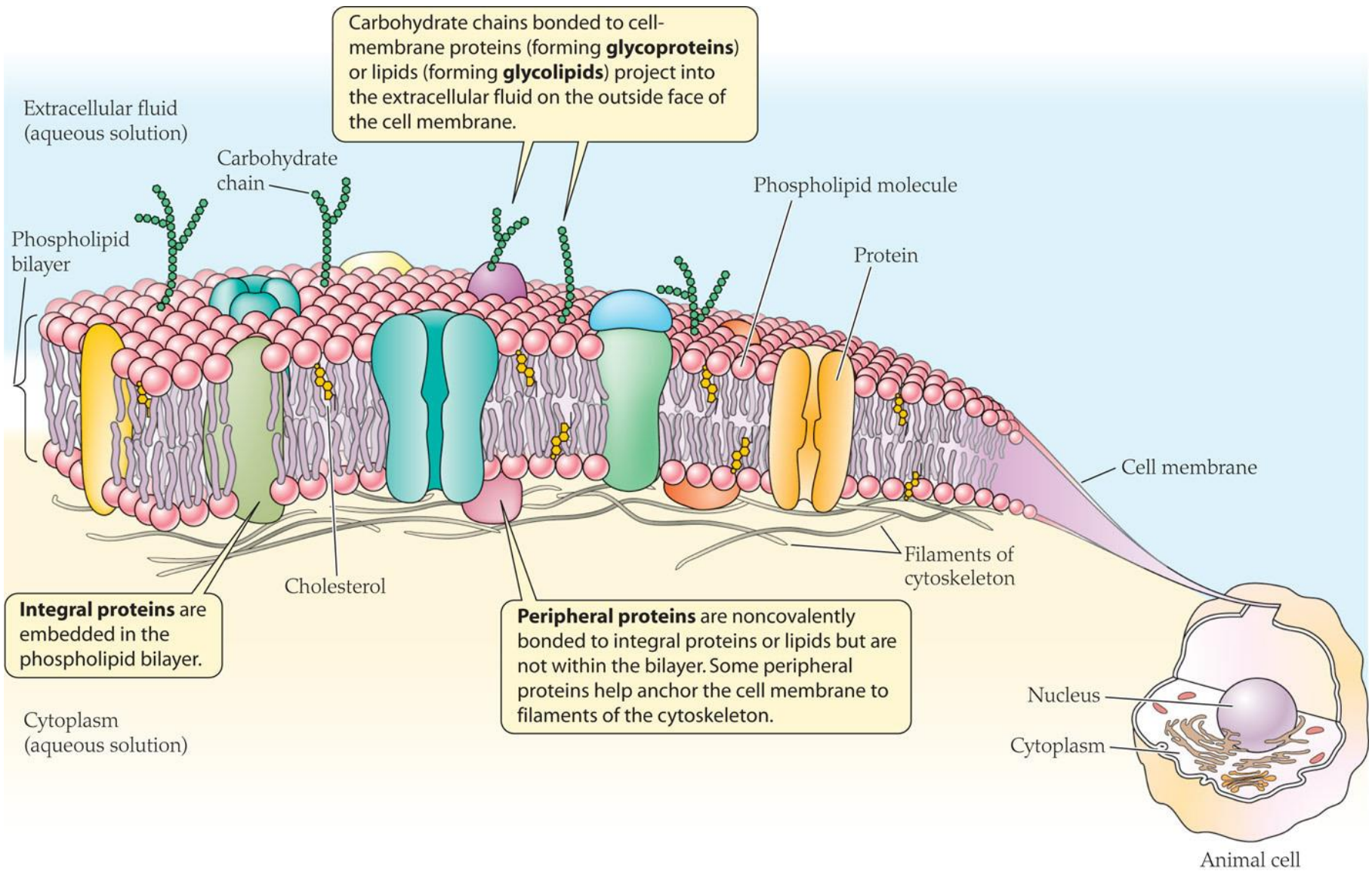
No net movement of fluid since capillary hydrostatic pressure (25 mm Hg) = blood colloidal osmotic pressure (25 mm Hg)

Fluid re-enters capillary since capillary hydrostatic pressure (18 mm Hg) is less than blood colloidal osmotic pressure (25 mm Hg)

Cell membranes and intracellular membranes

1. Cell membranes and intracellular membranes
2. Epithelia-the sheets of tissue that line body cavities and form the outer surfaces of organs

Figure 2.1 The structure of a cell membrane



Terminology

- **Polar** – electrons are unevenly distributed
- **Nonpolar** – electrons are evenly distributed, no charge imbalance
- **Amphipathic**-each molecule consists of a polar part and a nonpolar part (head group of phospholipid)
- **Leaflets** – two layers of the membrane

Figure 2.2 The structure of membrane phospholipid molecules

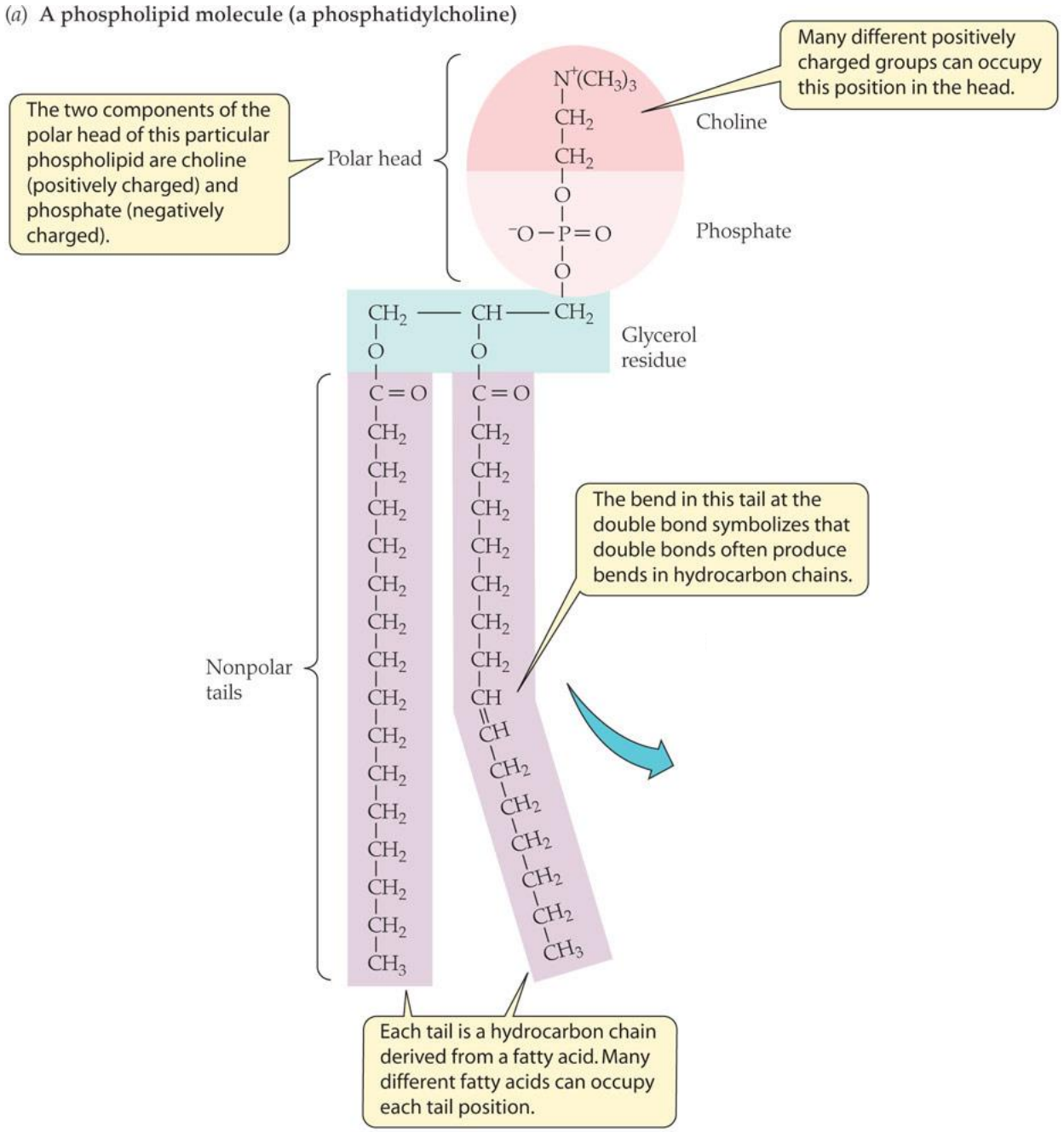
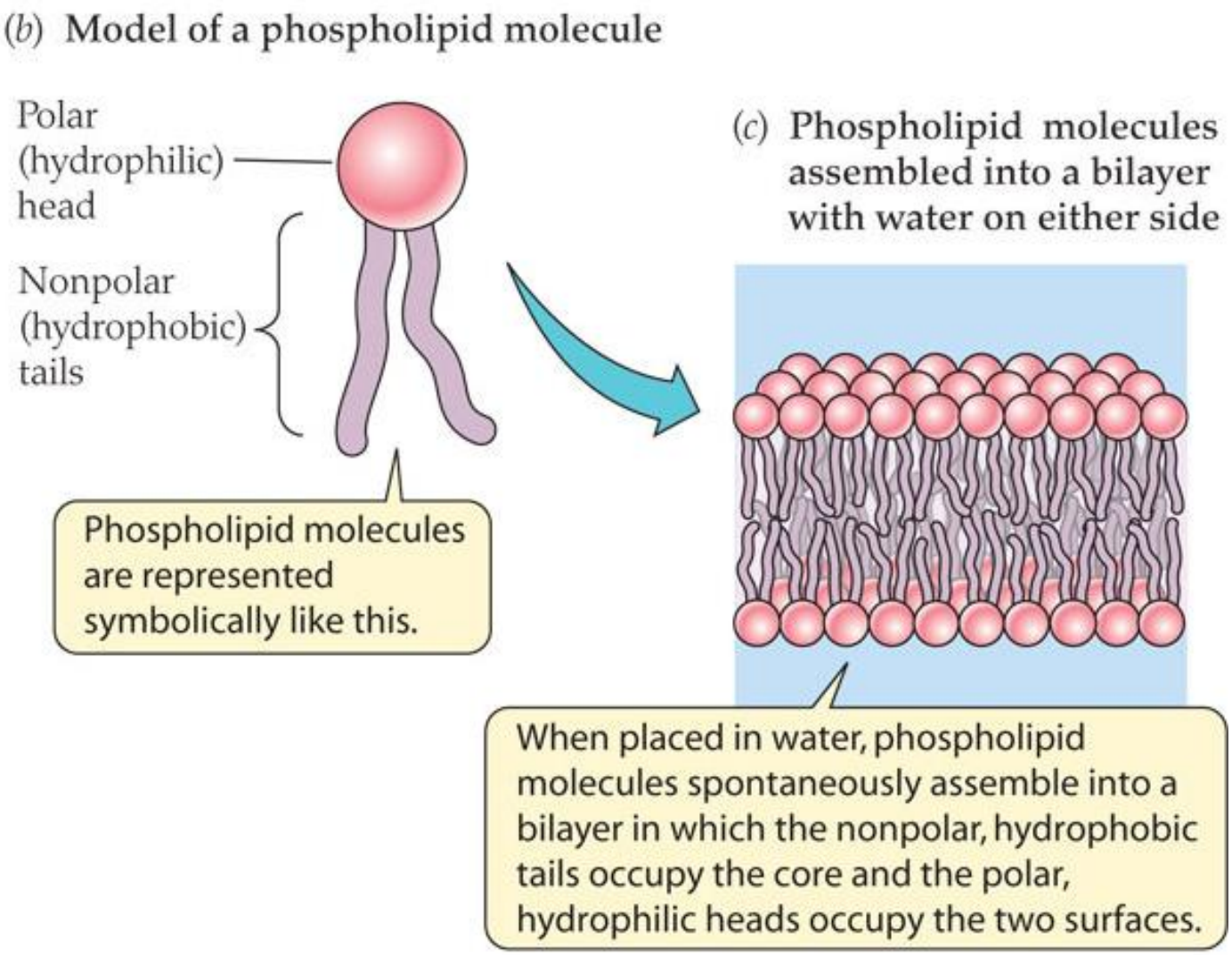


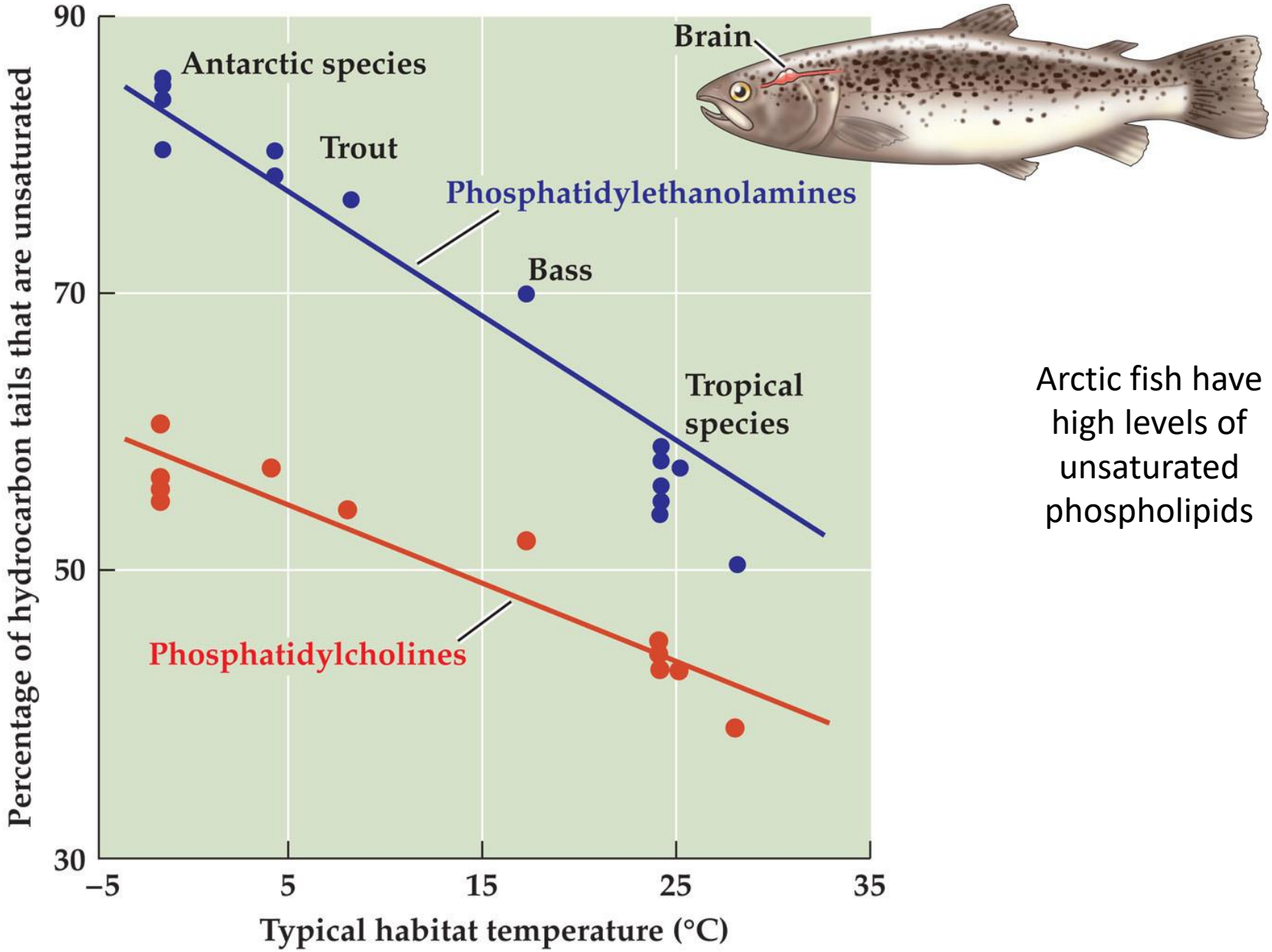
Figure 2.2 The structure of membrane phospholipid molecules



Membrane Fluidity

- RBC's have >150 kinds of phospholipids
- Phospholipids can travel (by diffusion) around the whole cell in a matter of minutes
- Temperature: lower→lower fluidity
- Fluidity depends on chemical saturation of the hydrocarbons in the tails
  - Saturated-non double bonds
  - Unsaturated – one or more double bonds, creates bends → higher fluidity

Figure 2.3 The degree of chemical unsaturation of the hydrocarbon tails of brain phospholipids in fish varies with habitat temperature



Arctic fish have high levels of unsaturated phospholipids

ANIMAL PHYSIOLOGY 3E, Figure 2.3

Proteins Endow Membranes with Numerous Functional Capacities

Two *structural* designations for membrane proteins

1. **Integral** – parts of the membrane, can't be removed, usually transmembrane (span the whole membrane)
2. **Periperal** – can be removed, bonded noncovalently to membrane components, on one side of the membrane or the other

Five *functional* designations for membrane proteins

TABLE 2.1 The five functional types of membrane proteins and the functions they perform

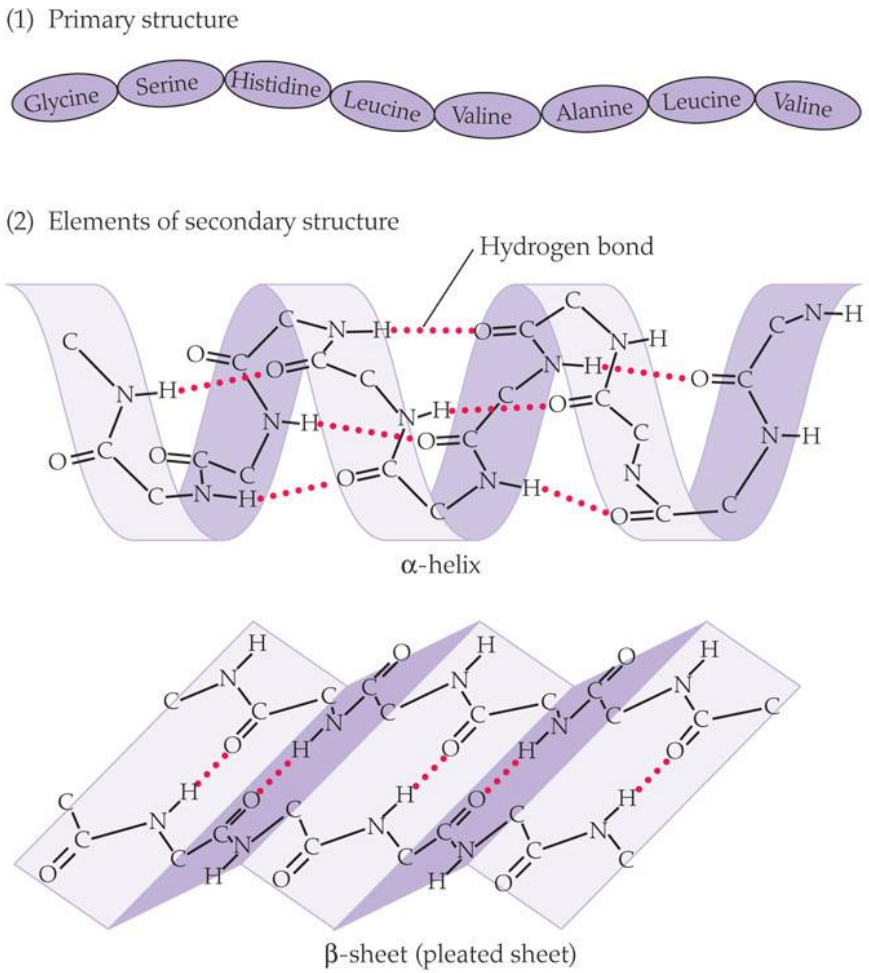
Functional type	Function performed (defining property)
Channel	Permits simple or quasi-simple *diffusion* of solutes in aqueous solution (see page 104)—or *osmosis* of water (see page 121)—through a membrane. A simplified view of a channel is that it creates a direct water path from one side to the other of a membrane (i.e., an aqueous pore) through which solutes in aqueous solution may diffuse or water may undergo osmosis.
Transporter (carrier)	Binds noncovalently and reversibly with specific molecules or ions to move them across a membrane intact. The transport through the membrane is *active transport* (see page 108) if it employs metabolic energy; it is *facilitated diffusion* (see page 108) if metabolic energy is not employed.
Enzyme	Catalyzes a chemical reaction in which covalent bonds are made or broken (see page 41).
Receptor	Binds noncovalently with specific molecules and, as a consequence of this binding, initiates a change in membrane permeability or cell metabolism. Receptor proteins mediate the responses of a cell to chemical messages (signals) arriving at the outside face of the cell membrane (see page 58).
Structural protein	Attaches to other molecules (e.g., other proteins) to anchor intracellular elements (e.g., cytoskeleton filaments) to the cell membrane, creates junctions between adjacent cells (see Figure 2.7), or establishes other structural relations.

ANIMAL PHYSIOLOGY 3E, Table 2.1

Fluid Mosaic Model of Membranes

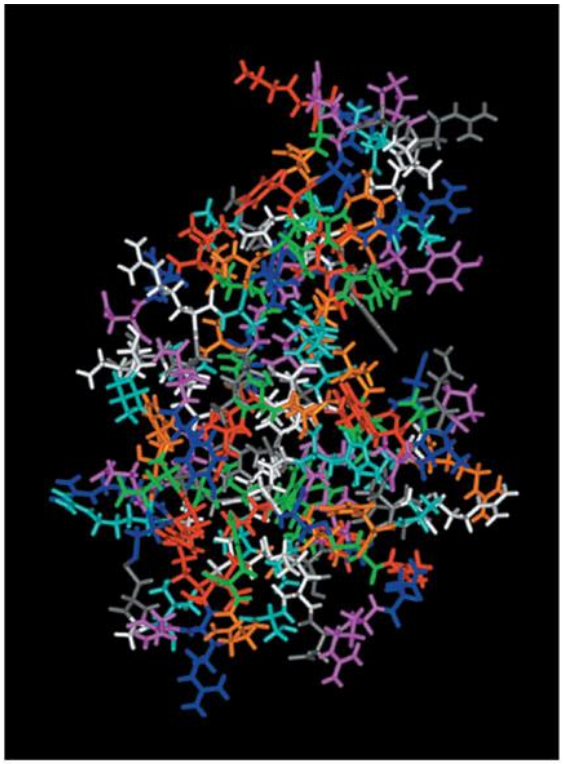
A membrane consists of a mosaic of protein and lipid molecules, all of which move about in directions parallel to the membrane faces because of the fluid state of the lipid matrix

Box Extension 2.1 Figure A The structural hierarchy of proteins



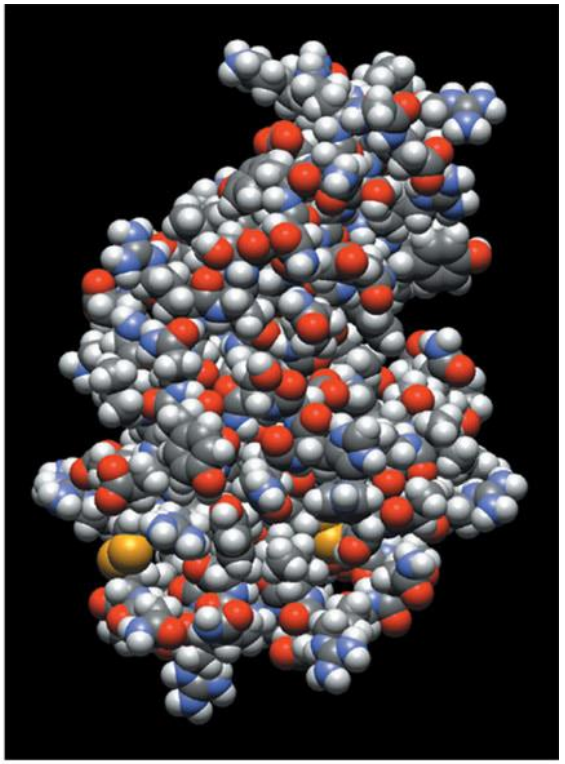
***ANIMAL PHYSIOLOGY 3E*, Box Extension 2.1 Figure A**

Box Extension 2.1 Figure B Three ways to diagram the tertiary structure of one protein. All three diagrams represent lysozyme



Stick model

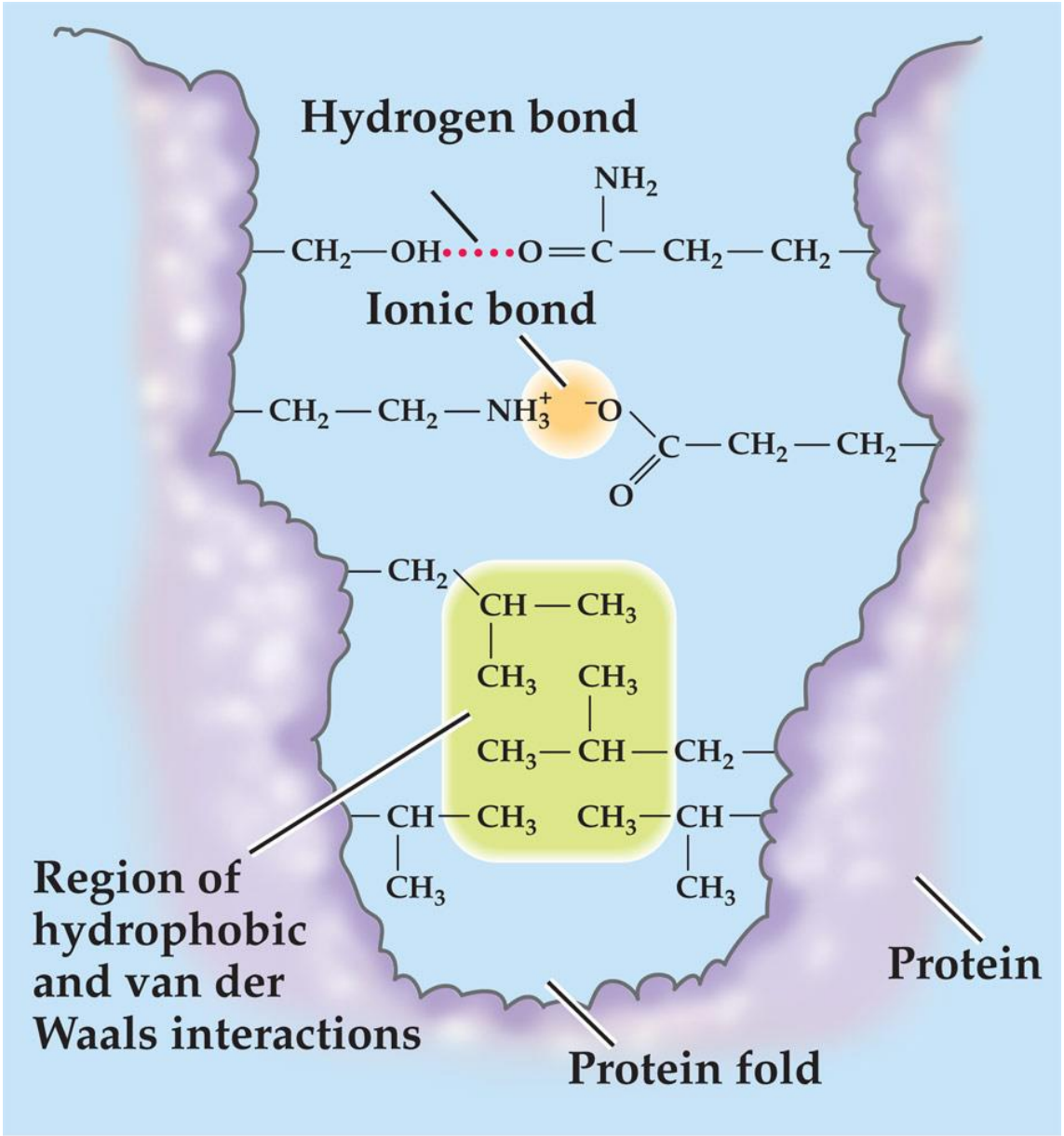
Ribbon model



Space-filling model

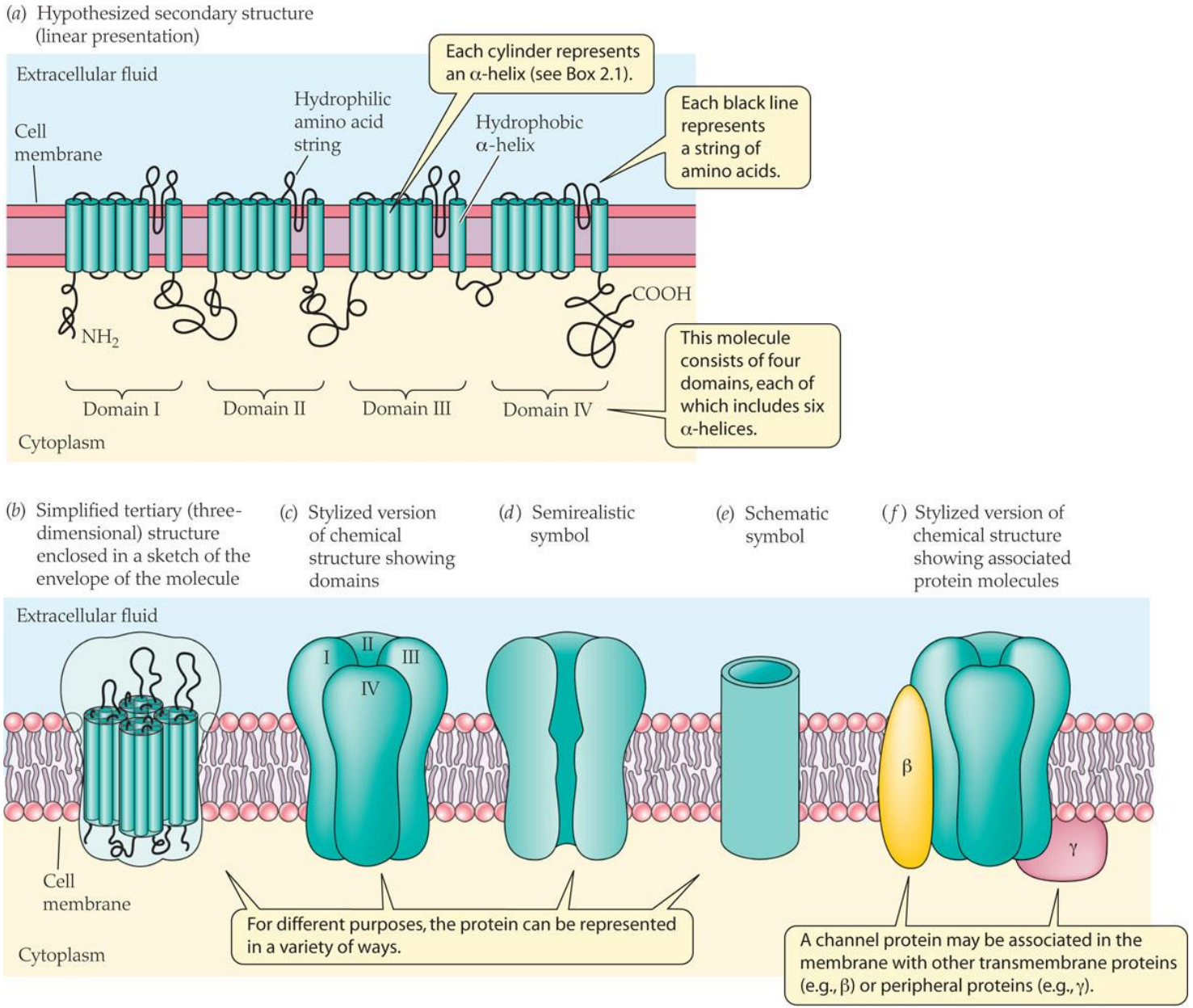
***ANIMAL PHYSIOLOGY 3E,* Box Extension 2.1 Figure B**

Box Extension 2.1 Figure C Types of weak, noncovalent bonds that are important in protein structure



***ANIMAL PHYSIOLOGY 3E,* Box Extension 2.1 Figure C**

Figure 2.4 The structure of a transmembrane protein—a voltage-gated Na^+ channel—illustrating several modes of presentation



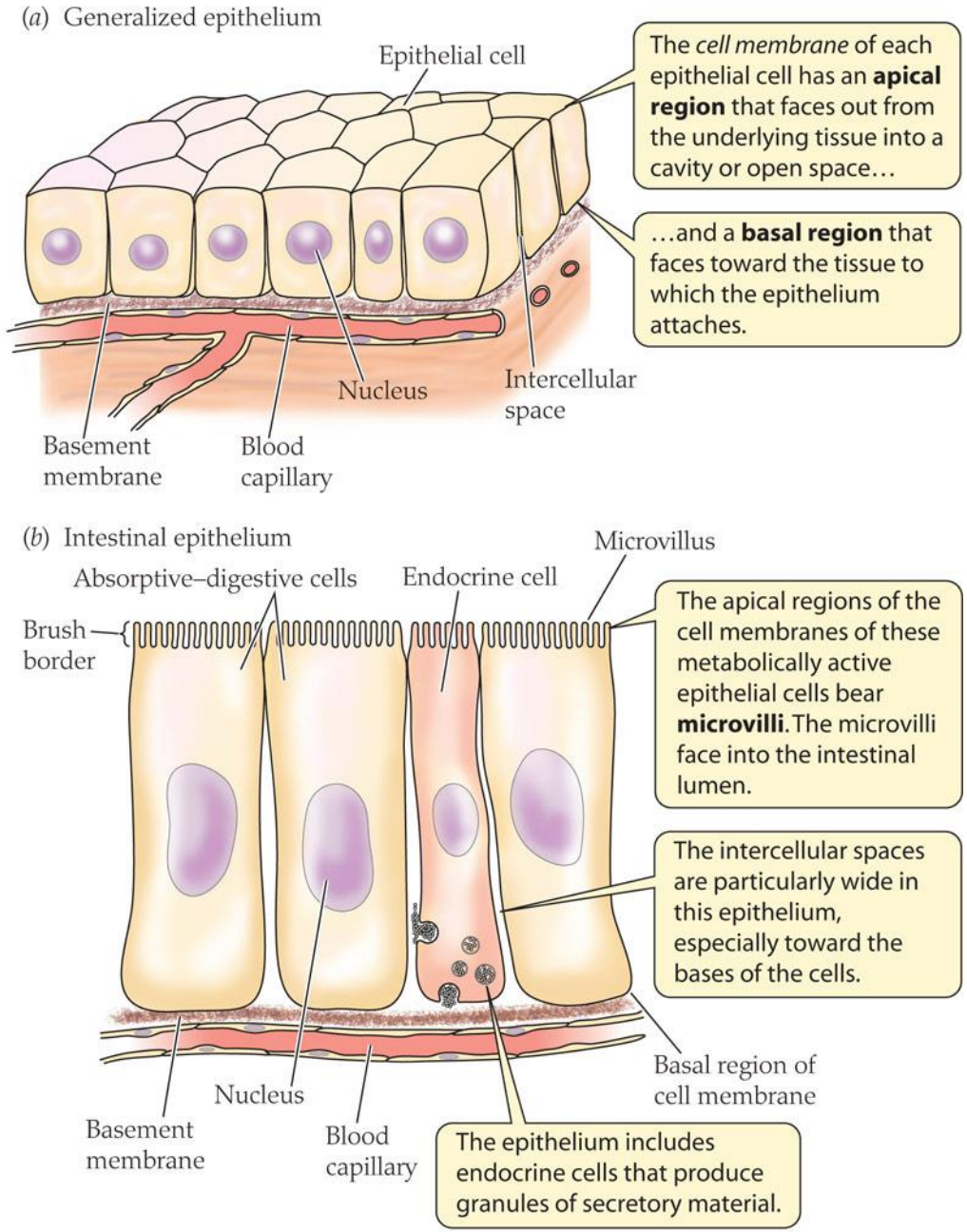
***ANIMAL PHYSIOLOGY 3E*, Figure 2.4**

Four Topics in Chapter 2

1. Cell membranes and intracellular membranes
2. **Epithelia-the sheets of tissue that line body cavities and form the outer surfaces of organs**
3. Enzyme function, diversity and evolution
4. Mechanisms by which cells receive and act on signals

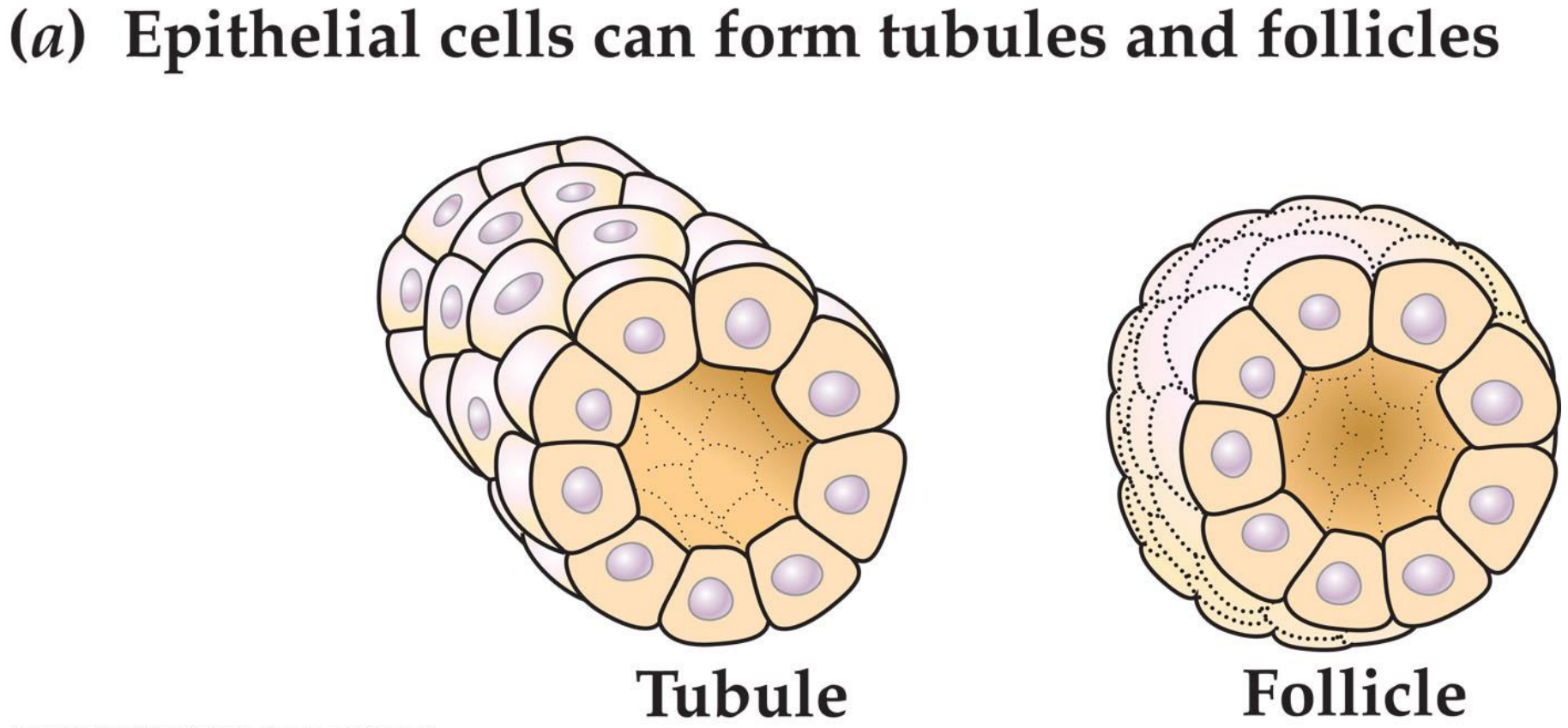
- Epithelia compartmentalize the body by forming boundaries between body regions
- Also form a boundary between an animal and its external environment

Figure 2.5 Simple epithelia-single layer of cells (squamous, cuboidal, columnar)



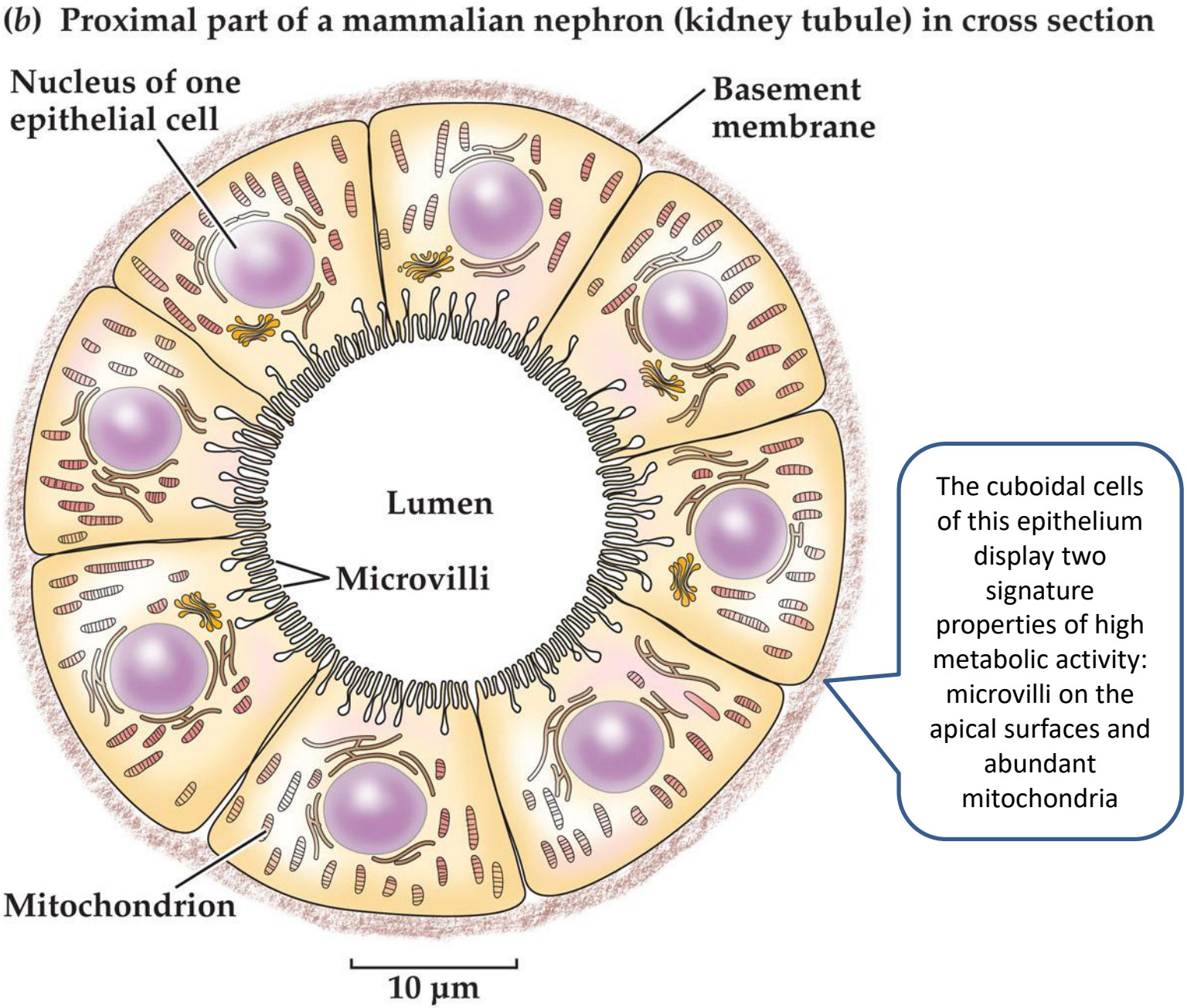
***ANIMAL PHYSIOLOGY 3E*, Figure 2.5**

Figure 2.6 Tubules and follicles formed by simple epithelia (Part 1)



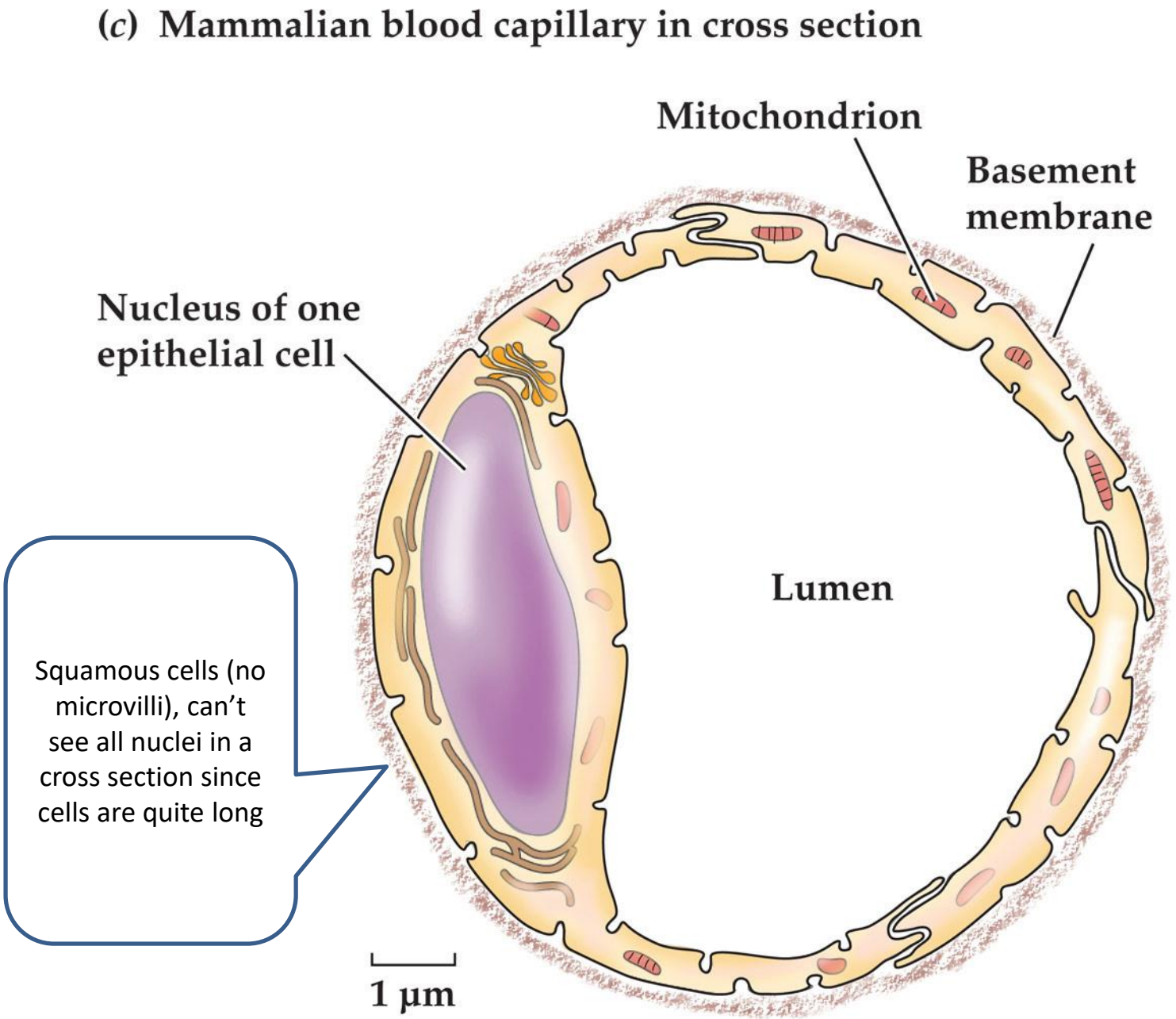
ANIMAL PHYSIOLOGY 3E, **Figure 2.6 (Part 1)**

Figure 2.6 Tubules and follicles formed by simple epithelia (Part 2)



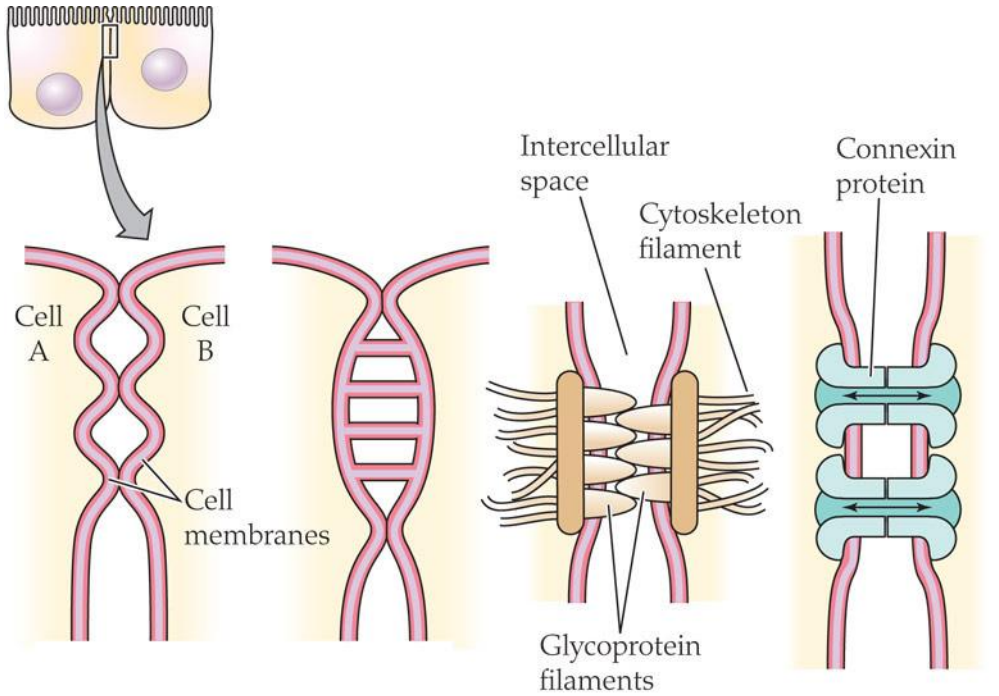
ANIMAL PHYSIOLOGY 3E, Figure 2.6 (Part 2)

Figure 2.6 Tubules and follicles formed by simple epithelia (Part 3)



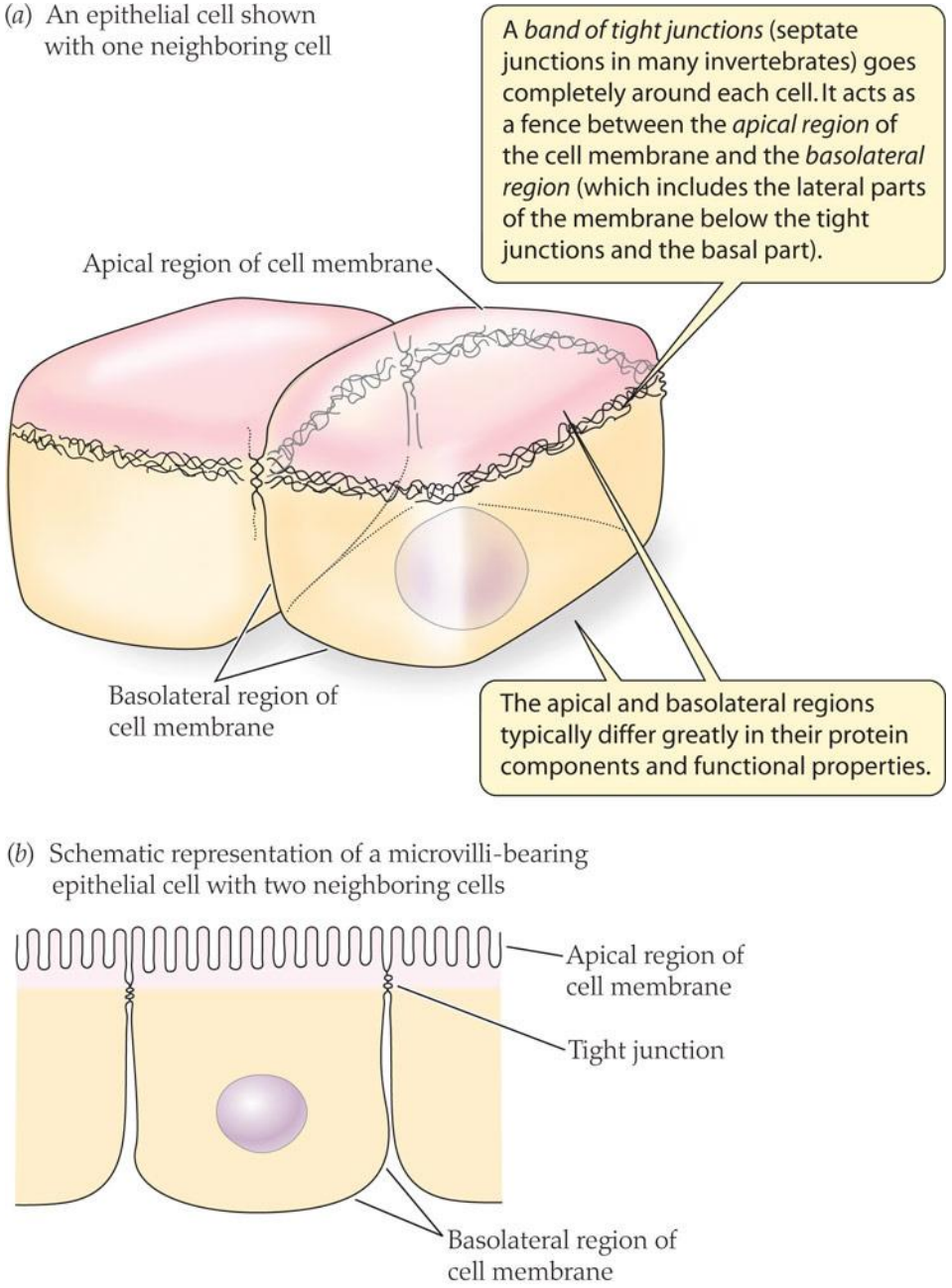
ANIMAL PHYSIOLOGY 3E, Figure 2.6 (Part 3)

Figure 2.7 Types of junctions between cells



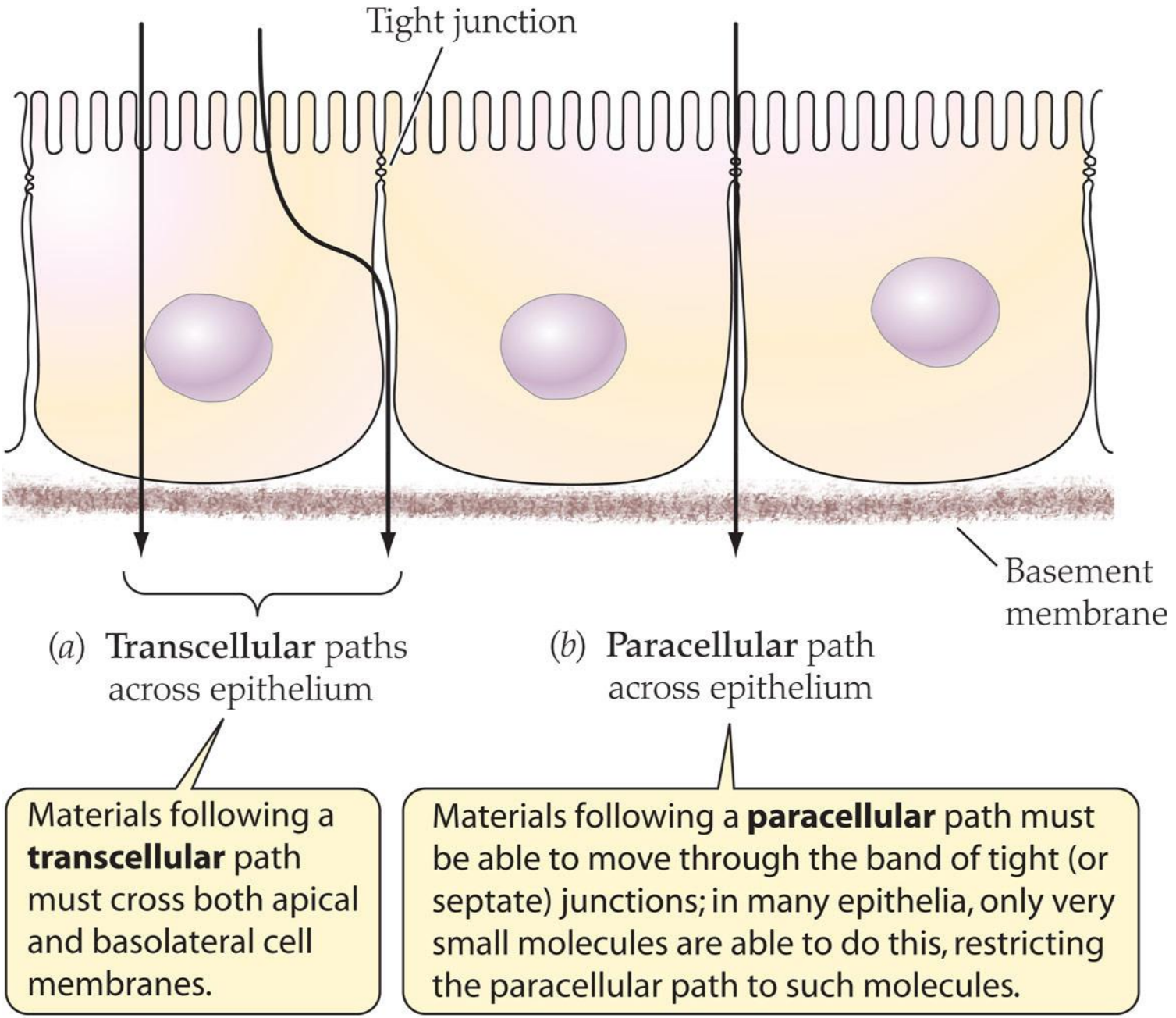
***ANIMAL PHYSIOLOGY 3E*, Figure 2.7**

Figure 2.8 The organization of epithelial cells into apical and basolateral regions



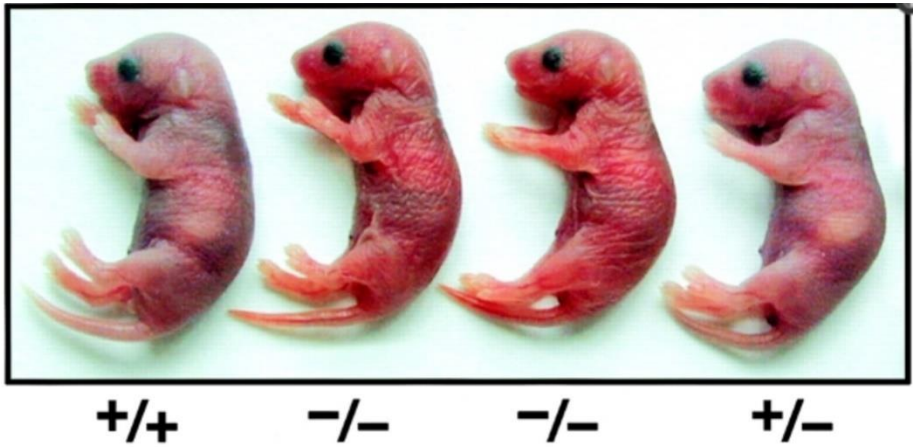
***ANIMAL PHYSIOLOGY 3E*, Figure 2.8**

Figure 2.9 Transcellular and paracellular paths across an epithelium



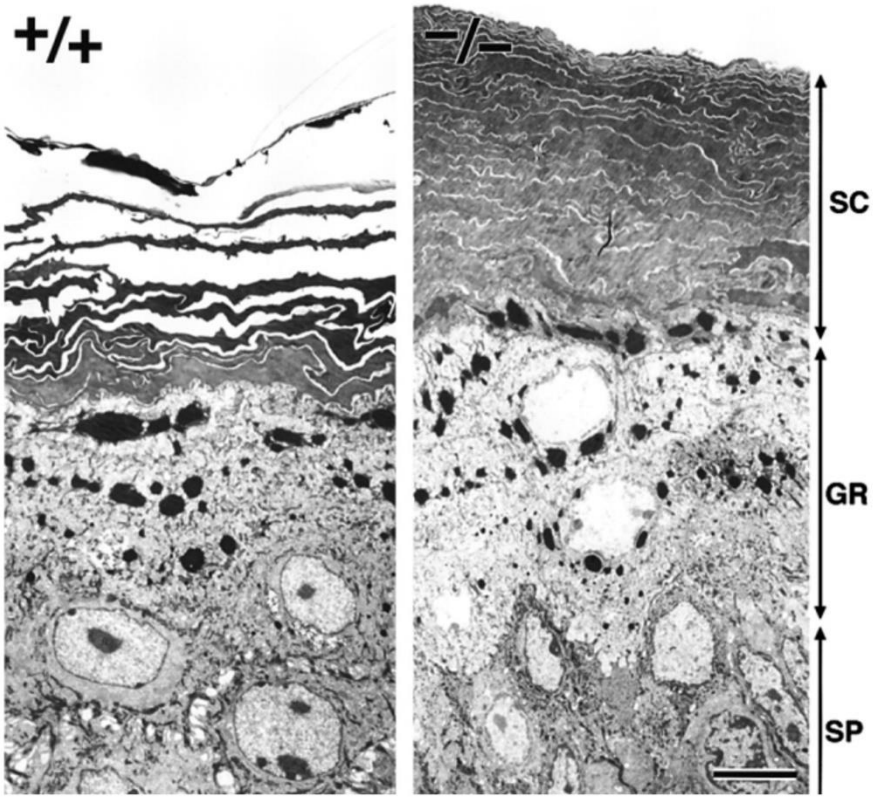
ANIMAL PHYSIOLOGY 3E, Figure 2.9

Impairment of epidermal barrier in Claudin 1 deficient mice



Wild type

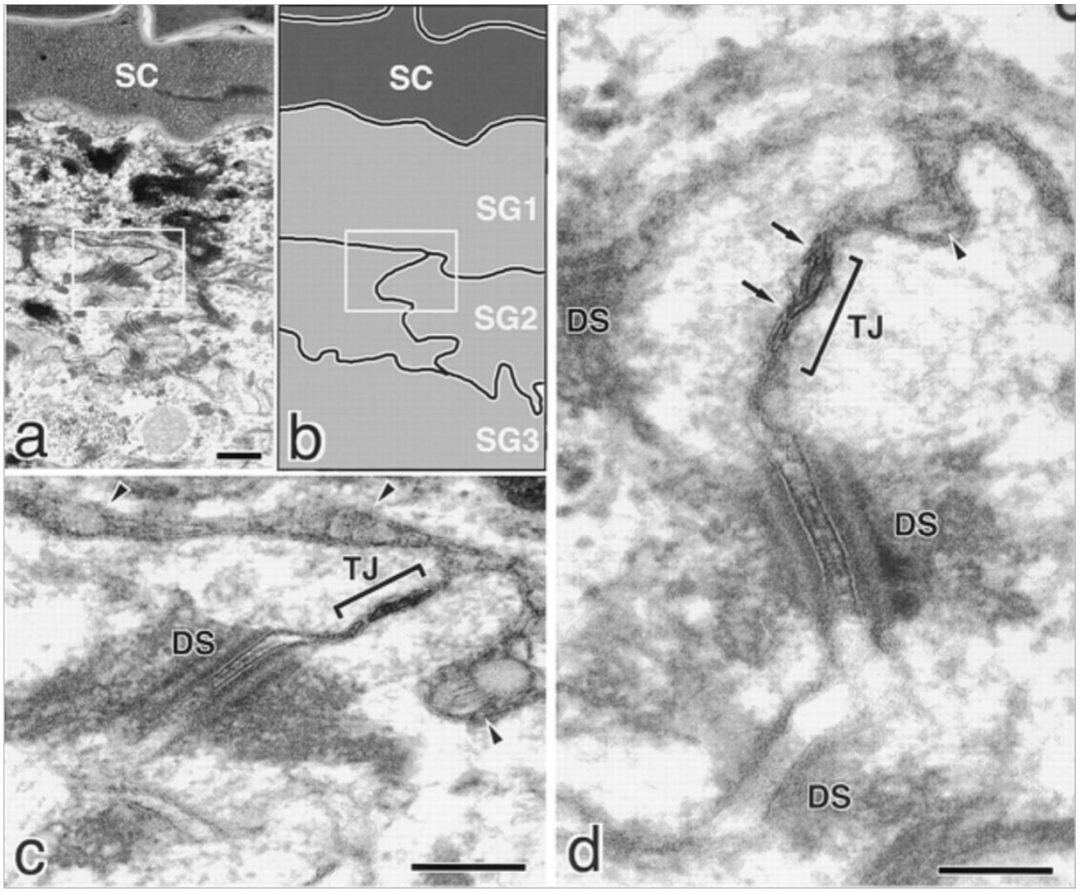
Claudin 1-knock out



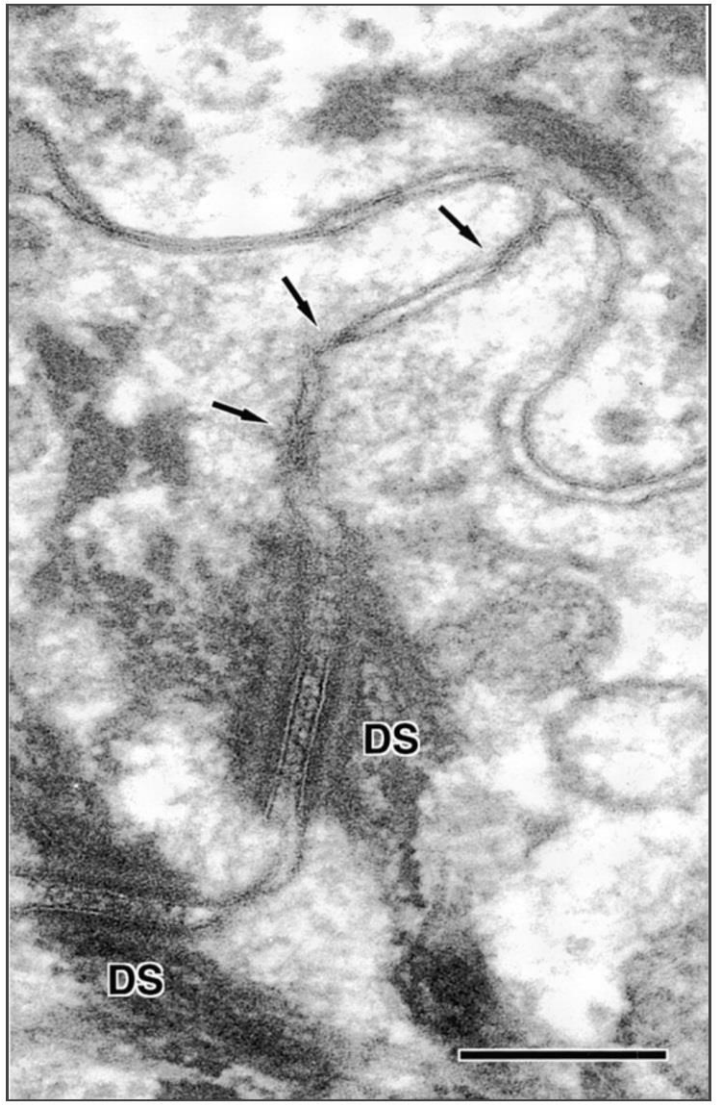
SC: stratum corneum; SG: stratum granulosum; SP: stratum spinosum

Claudin-based tight junctions are crucial for the mammalian epidermal barrier.
J Cell Biol. 2002 Mar 18; 156(6): 1099–1111.

Wild type



Claudin 1-knock out



TJ: tight junction; DS: desmosome

Chapter 2 Opener Two slow-moving predators that use molecular weapons to capture fast-moving prey