Epihelial tissue

1

Human body:

1. Epithelial tissue
2. Connective tissue
3. Mascular tissue
4. Nervous tissue

TABLE 4–1 Main characteristics of the four basic types of tissues.

Tissue	Cells	Extracellular Matrix	Main Functions
Nervous	Elongated cells with extremely fine processes	Very small amount	Transmission of nerve impulses
Epithelial	Aggregated polyhedral cells	Small amount	Lining of surface or body cavities; glandular secretion
Muscle	Elongated contractile cells	Moderate amount	Strong contraction; body movements
Connective	Several types of fixed and wandering cells	Abundant amount	Support and protection of tissues/ organs

Organs:

- Parenchyma
- Stroma

Epihelial tissue

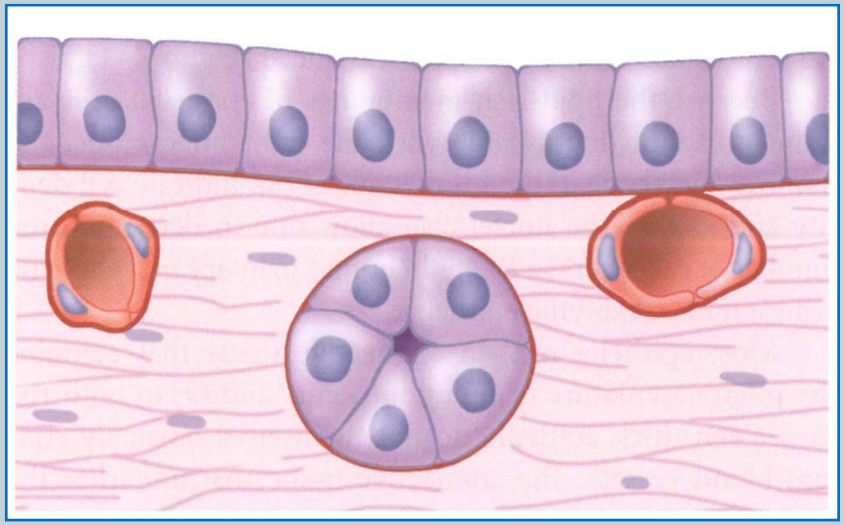
- Covering, lining & protecting surface (epidermis)
- Absorbtion (the intestinal lining)
- Secretion (parenchymal cell of glands)

Specific cells:

- Myoepithelial cells (contractile)
- Taste bubs or olfactory epithelium (specialized sensory cells)

Characteristic features of epithelial cells

- Columnar cell (elliptic or oval nucleus)
- Cuboidal cells (spherical nucleus)
- Squamous cell (flattened nucleus)



- No blood vessle

- Lamina propria in digestive, respiratory & urinary systems
- Papillae (in skin & tongue)

- Polarity

Basal pole
Apical pole
Lateral surface

Basement membrane

- Extra cellular materials
- Glycoprotein & ...

By TEM:

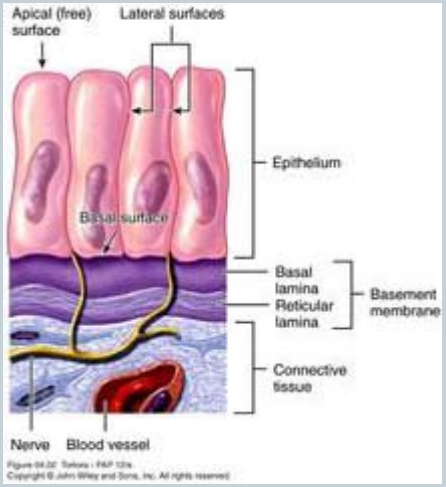
1. Basal lamina (electron dens 20-100 nm)
2. Reticular lamina (diffuse & fibrous)

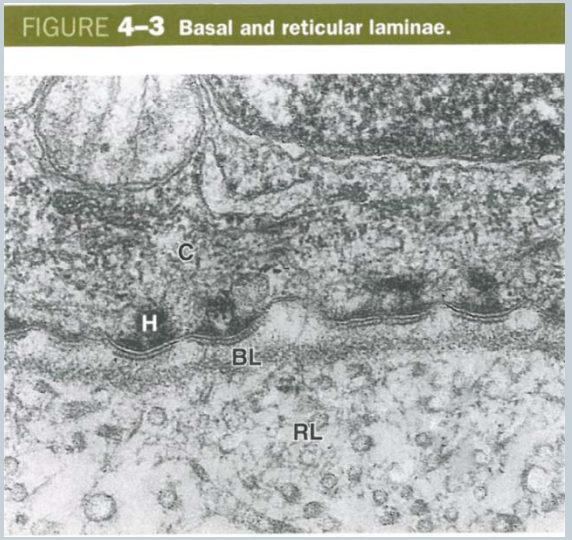
Basal lamina macromolecules

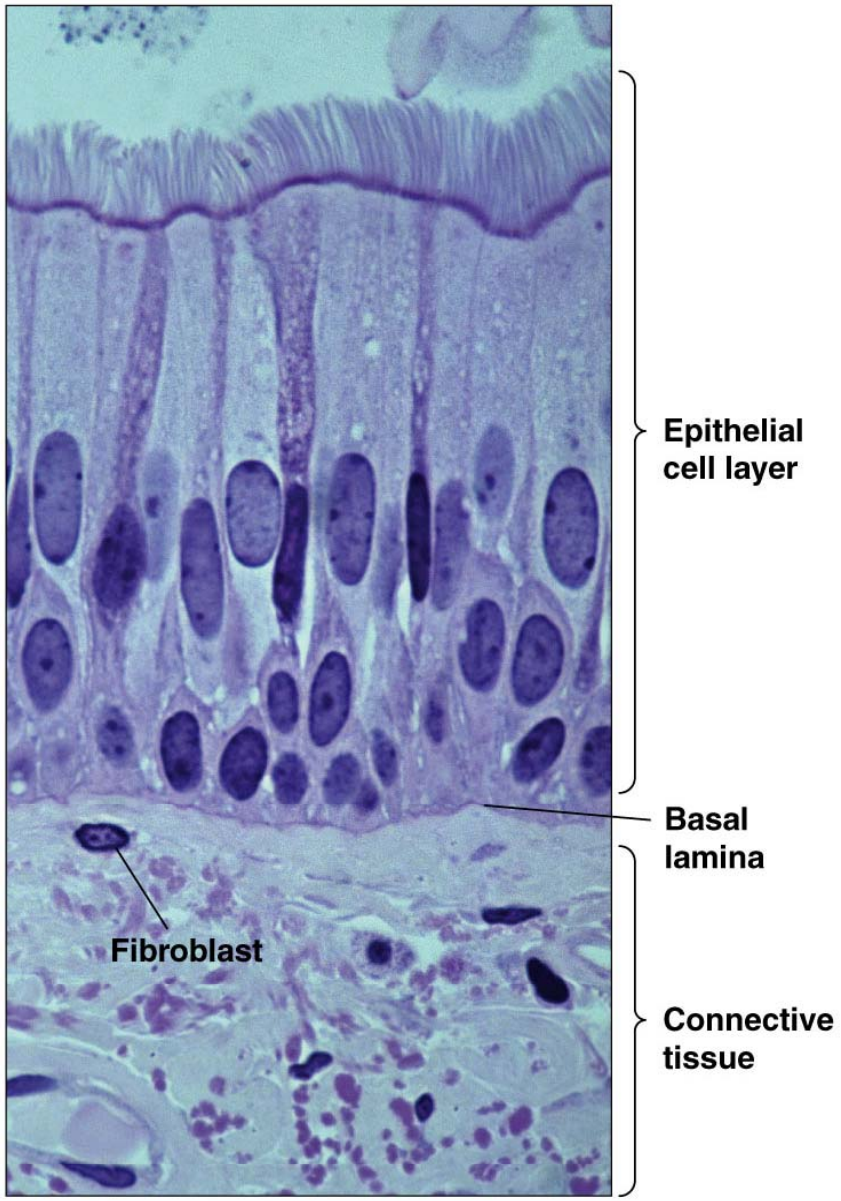
1. Laminin (glycoprotein)
2. type IV Collagen (3 chain poly peptide)
3. Entactin/nidogen(adhesive glycoprotein)
4. Perlecan (proteoglycan that bind collagen IV & laminin)

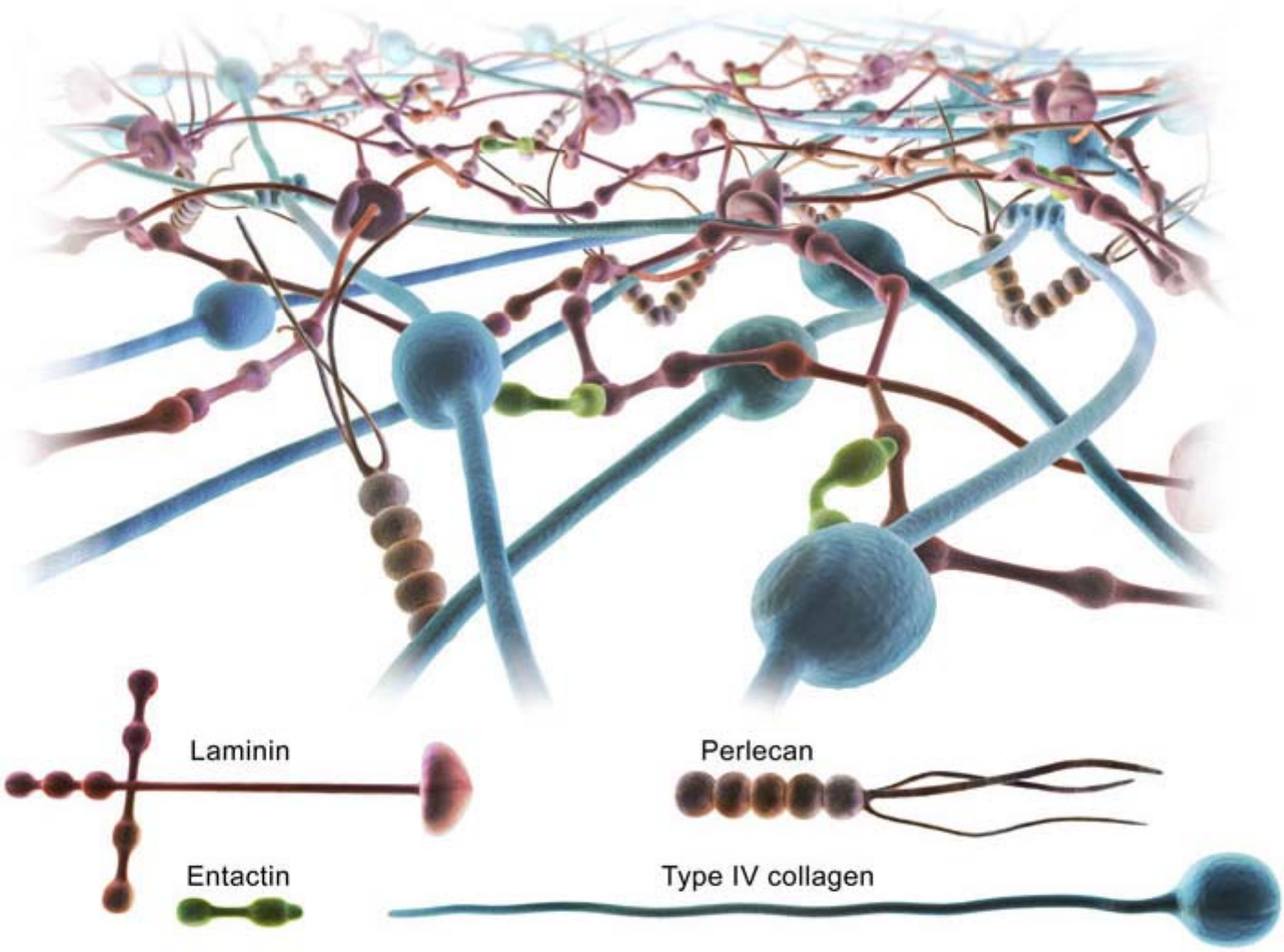
Reticular lamina macromolecules

1. Type III collagen
2. Type VII collagen (bind type III Col. To basal lamina)








Laminin
Perlecan
Entactin
Type IV collagen

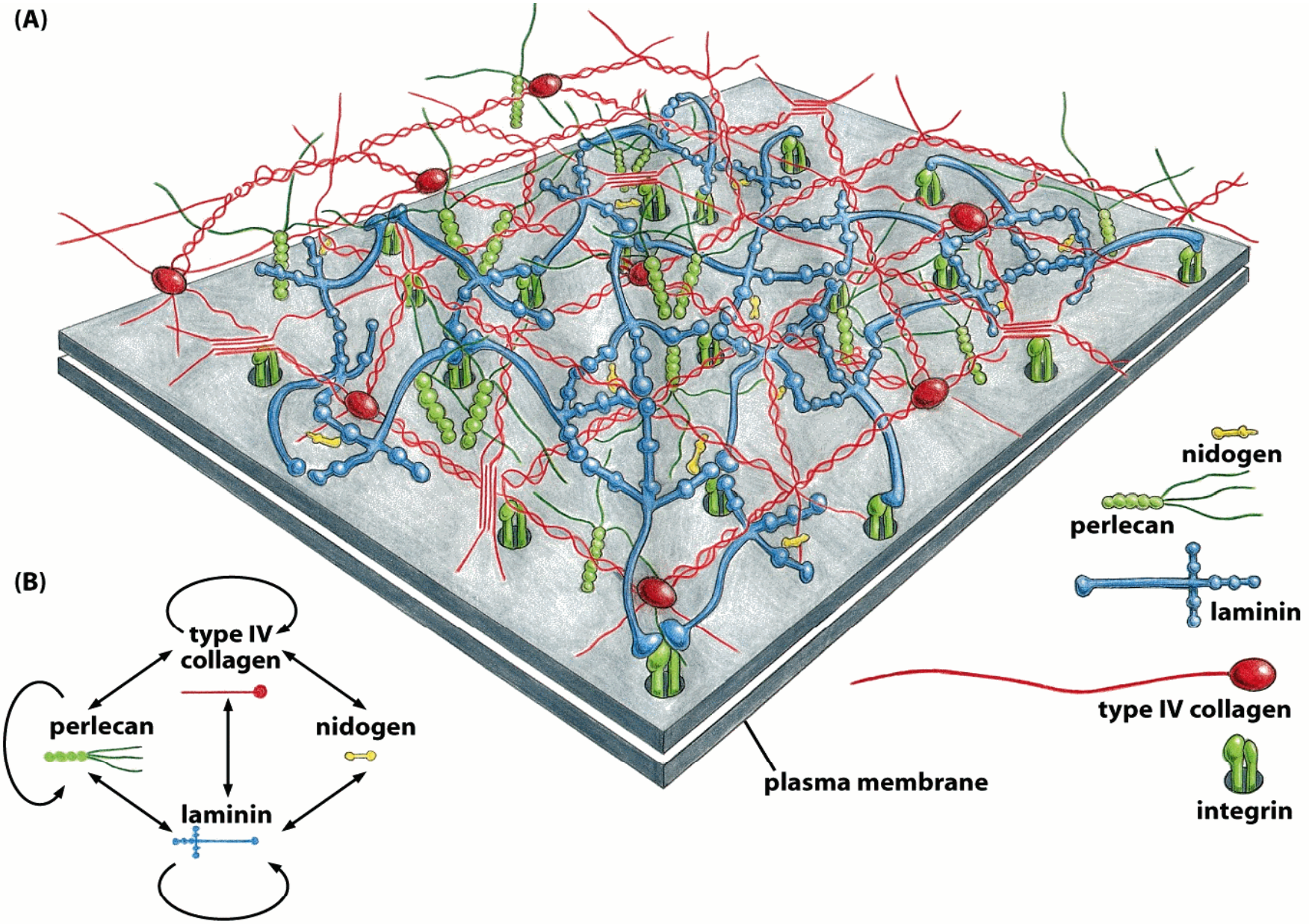
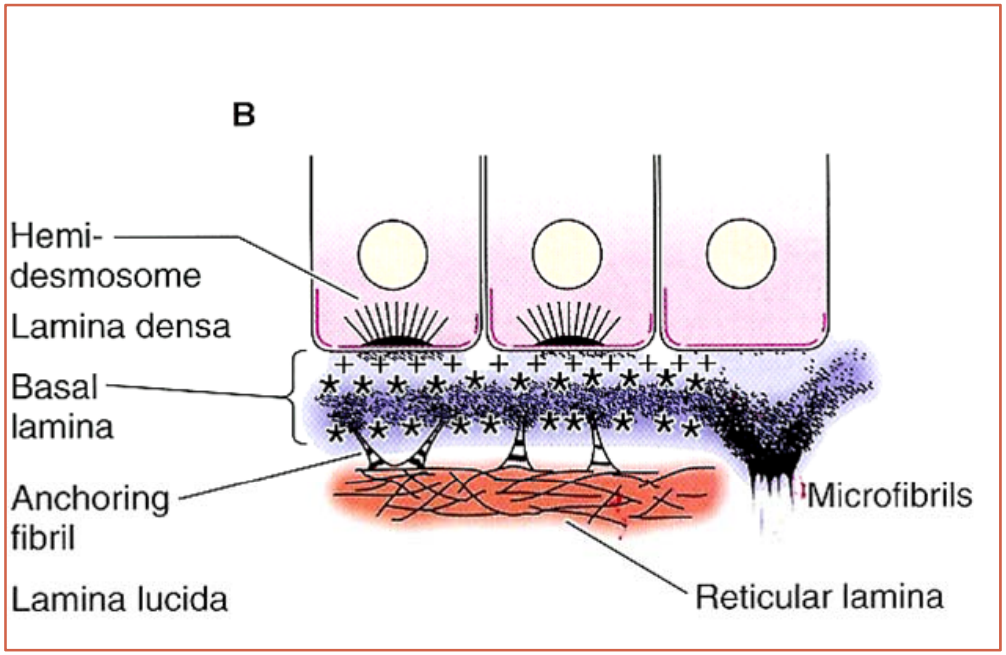
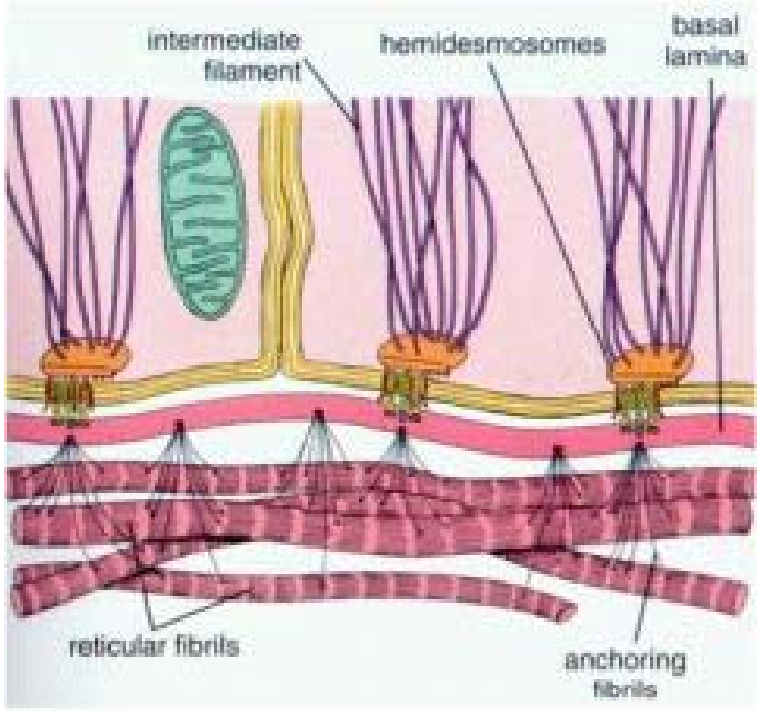


Figure 19-43 Molecular Biology of the Cell 5/e (© Garland Science 2008)

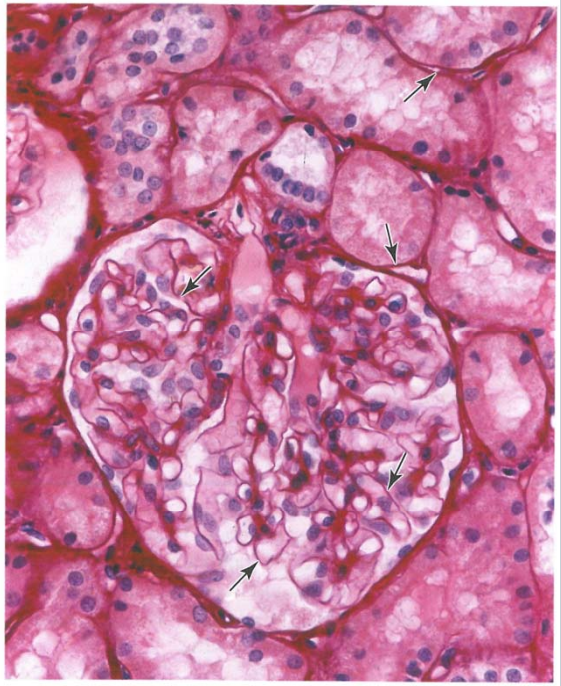

B
Hemi-
desmosome
Lamina densa
Basal
lamina
Anchoring
fibril
Lamina lucida
Microfibrils
Reticular lamina


intermediate
filament
hemidesmosomes
basal
lamina
reticular fibrils
anchoring
fibrils

Basement membrane function

- Structural support
- Polarity
- Attachment
- Filtration
- Mitogenic factor concentration
- Scaffold for repair & regeneration
- Protein organization in plasma membrane
- Cell-cell interaction (migration)

FIGURE 4–2 Basement membranes.



This section of kidney shows the well-stained basement membranes (arrows) of epithelia forming structures within the large, round renal glomerulus and its surrounding tubules. In kidney glomeruli the basement membrane, besides having a supporting function, has a highly developed role as a filter that is key to renal function. X100. Picrosirius-hematoxylin (PSH).

Intercellular adhesion & other junction

1. Tight junction(occluding j.)
2. Adherent junction (anchoring j.)
3. Gap junction (communicating j.)

- Zonula occludense (cloudin & occludin pr.)

- Zonula adherens (cadherin)

Catenin & actin (terminal web)

- Desmosome or macula adherens (anchoring j.)

Desmoglein & desmocollin (cadherin)
Desmoplakin & plakoglobin
Cytokeratin (desmin & vimentin)

- Gap junction (connexin make connexon)

- Hemidesmosome

integrin bind to laminin & col. IV

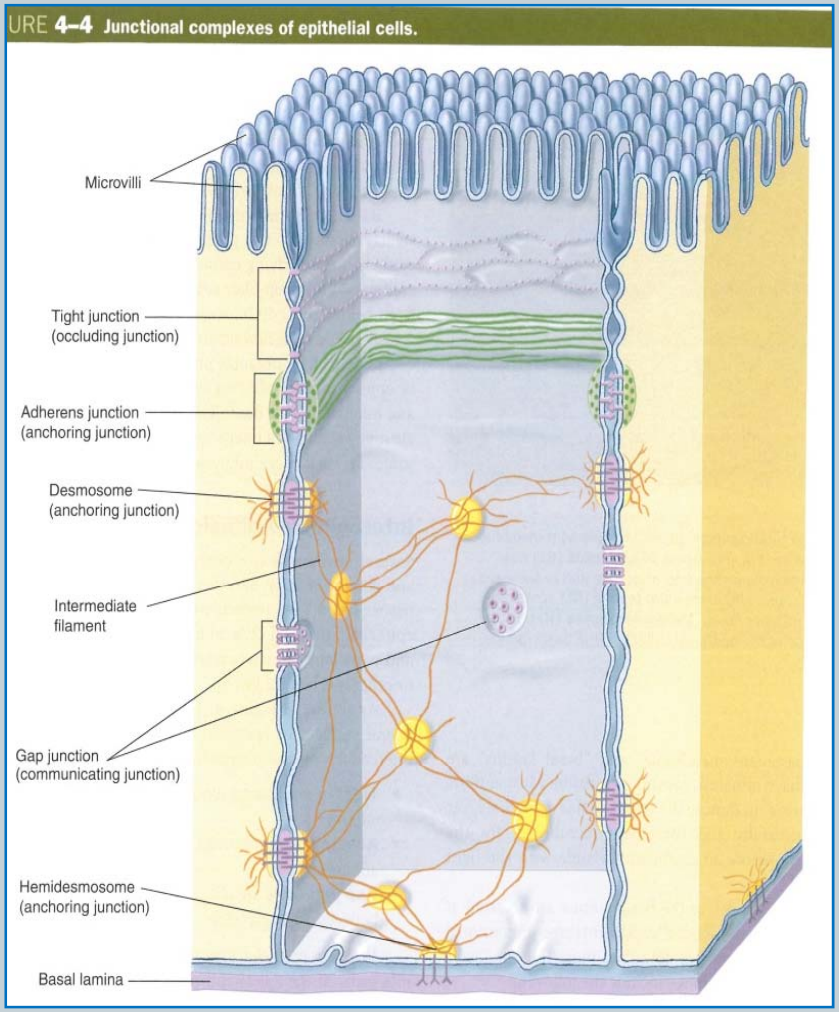
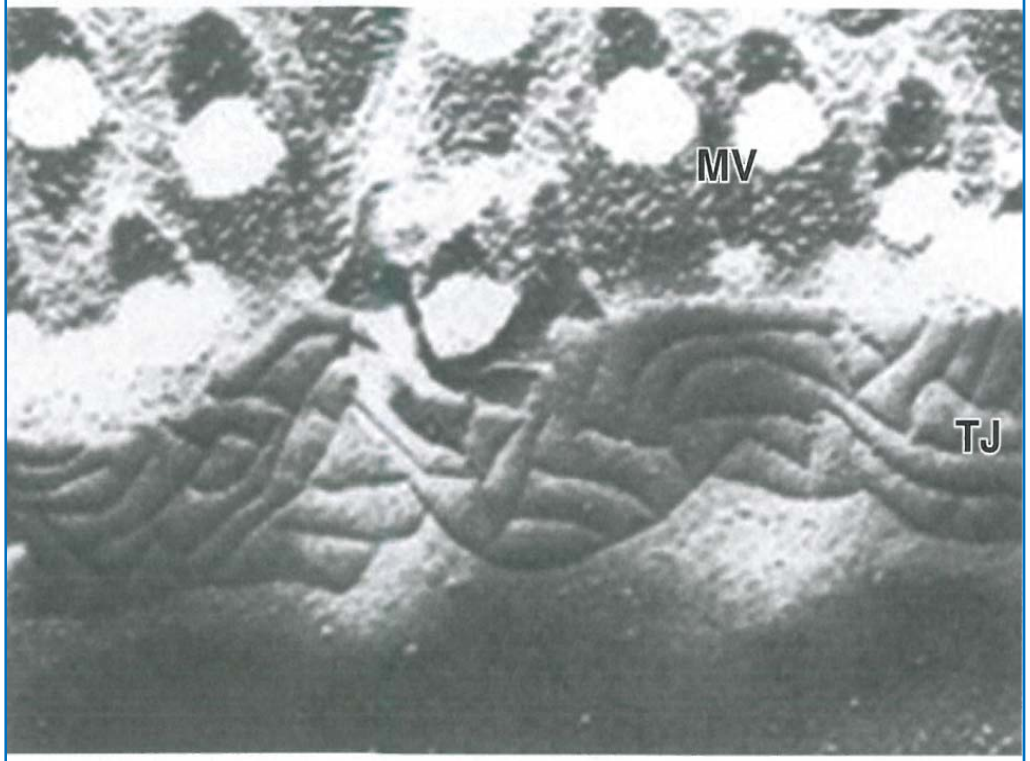


FIGURE **4–5** **Epithelial cell junctional complex.**

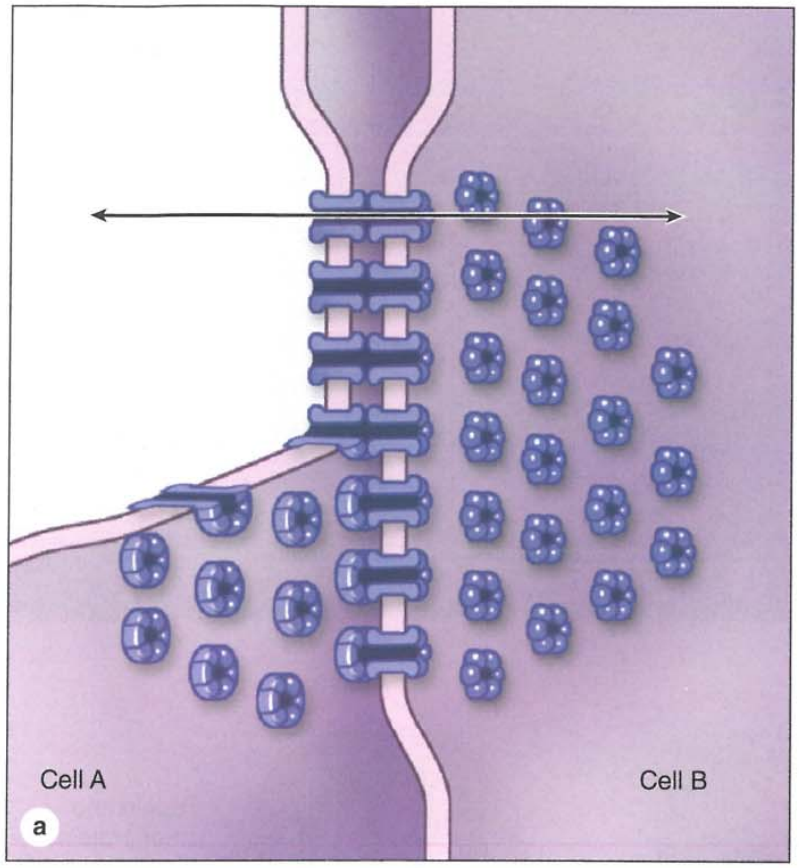
Ultrastructural view of the apical region near microvilli (**MV**) of two epithelial cells, revealing a junctional complex with a tight junction (**TJ**) or zonula occludens, an adherent junction (**AJ**) or zonula adherens, and a desmosome (**D**) associated with intermediate filaments (**IF**). The functions and major protein components of these junction types are summarized in Table 4–2. X195,000.

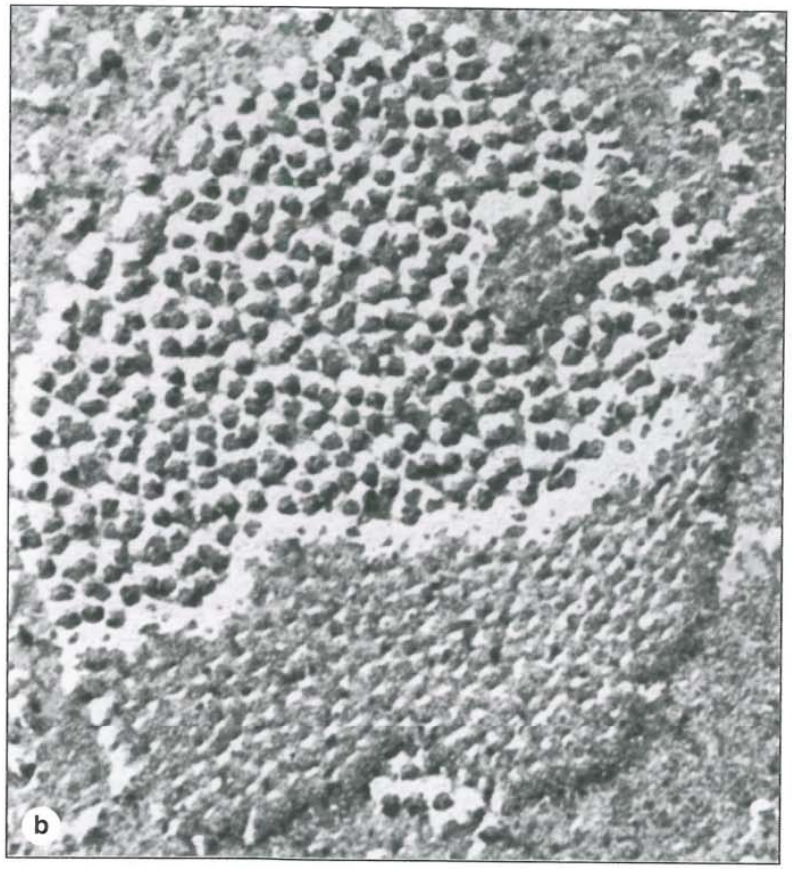
FIGURE **4–6** **View of a tight junction after cryofracture.**



Just below the apical microvilli (**MV**) of this epithelial cell, a cryofracture plane splitting fused cell membranes reveals the fused strands of transmembrane proteins forming the tight junction (zonula occludens). X100,000.

FIGURE **4–7** **Gap junctions.**





(a) A diagram of a gap junction shows the structural elements that allow the exchange of nutrients and signal molecules between cells without loss of material into the intercellular space. The communicating channels are formed by pairs of abutting particles **(connexons)**, which are in turn each composed of six protein subunits (connexins) that span the lipid bilayer of each cell membrane. The channel formed by paired connexons (arrow) is about 1.5 nm in diameter, limiting the size of transmitted molecules. **(b)** A cryofracture preparation of a gap junction, showing the patch of aggregated transmembrane protein complexes, the connexons. X150,000.

TABLE 4–2 Epithelial cell junctions, their major structural features and functions, and medical significance.

Junction	Tight Junction (Zonula Occludens)	Adherent Junction (Zonula Adherens)	Desmosome (Macula Adherens)	Hemidesmosome	Gap Junction (Nexus)
Major transmembrane link proteins	Occludins, claudins, ZO proteins	E-cadherin, catenin complexes	Cadherin family proteins (desmogleins, desmocollin)	Integrins	Connexin
Cytoskeletal components	Actin filaments	Actin filaments	Intermediate filaments (keratins)	Intermediate filaments	None
Major functions	Seals adjacent cells to one another, controlling passage of molecules between them; separates apical and basolateral membrane domains	Provides points linking the cytoskeletons of adjacent cells; strengthens and stabilizes nearby tight junctions	Provides points of strong intermediate filament coupling between adjacent cells, strengthening the tissue	Anchors cytoskeleton to the basal lamina	Allows direct transfer of small molecules and ions from one cell to another
Medical significance	Defects in occludins may compromise the fetal blood-brain barrier, leading to severe neurologic disorders	Loss of E-cadherin in epithelial cell tumors (carcinomas) promotes tumor invasion and the shift to malignancy	Autoimmunity against desmoglein I leads to dyshesive skin disorders characterized by reduced cohesion of epidermal cells	Mutations in the integrin-β4 gene are linked to some types of epidermolysis bullosa, a skin blistering disorder	Mutations in various connexin genes have been linked to certain types of deafness and peripheral neuropathy

>> MEDICAL APPLICATION

Various **blistering (bullous) diseases**, such as pemphigus vulgaris, involving the epidermis or stratified squamous epithelia of the oral mucosa, are due to abnormal desmosome function caused by autoimmune reactions against specific desmogleins that reduce cell-to-cell adhesion. Similar disorders arise with genetic mutations for various junctional proteins.

>> MEDICAL APPLICATION

Proteins of the **zonula occludens** provide the targets for certain common bacteria of medical importance. The enterotoxin secreted by *Clostridium perfringens*, which causes "food poisoning," binds claudin molecules of intestinal cells, prevents insertion of these proteins during maintenance of tight junctions, and causes loss of tissue fluid into the intestinal lumen via the paracellular pathway.

Similarly, *Helicobacter pylori*, which is important in the etiology of **gastric ulcers**, binds the extracellular domains of tight-junction proteins in cells of the stomach and inserts a protein into these cells, which targets ZO-1 and disrupts signaling from the junction.

Specializations of the apical cell surface

Microvilli

- Brush or striated border
- 1 µ length & 0.1 µ
- Enhance surface (20-30)
- Thick glycolalix (enzymes)

>> MEDICAL APPLICATION

Celiac disease, also called **gluten-sensitive enteropathy** or **sprue**, is a disorder of the small intestine in which one of the first pathologic changes is loss of the microvilli brush border of the absorptive cells. This is caused by an immune reaction against the wheat protein gluten during its digestion, which produces diffuse enteritis (intestinal inflammation), changes to the epithelial cells leading to malabsorption, and eventually to pathologic changes in the intestinal wall. The malabsorption problems and structural changes are reversible when gluten is removed from the diet.

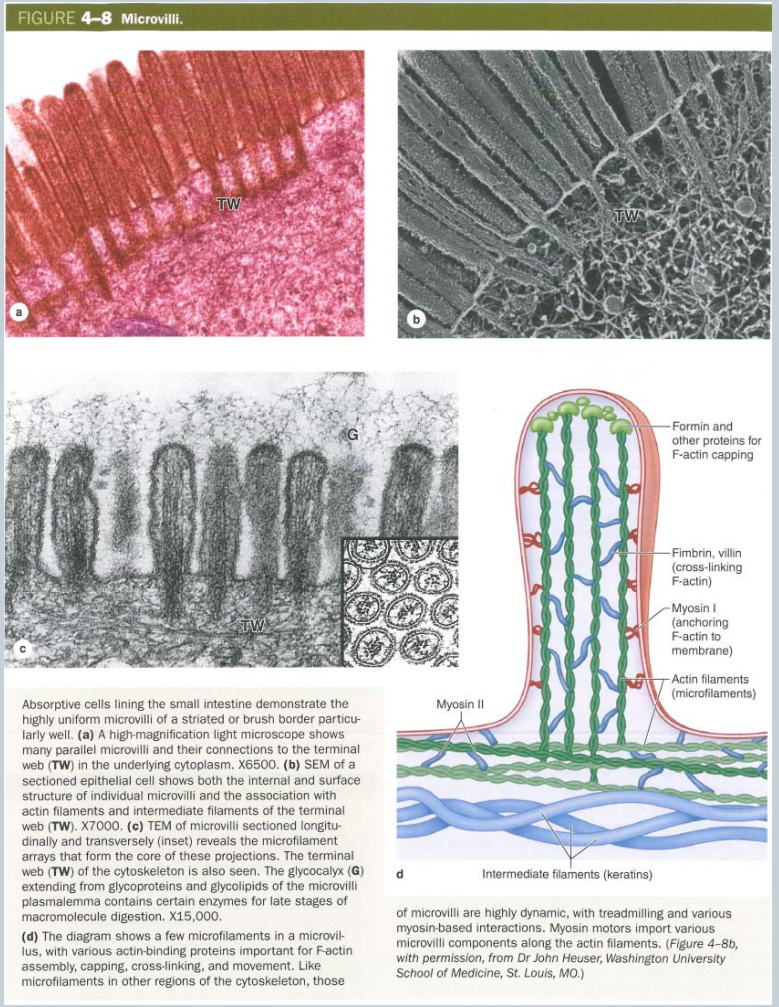


FIGURE 4–8 Microvilli.

Absorptive cells lining the small intestine demonstrate the highly uniform microvilli of a striated or brush border particularly well. **(a)** A high-magnification light microscope shows many parallel microvilli and their connections to the terminal web (**TW**) in the underlying cytoplasm. X6500. **(b)** SEM of a sectioned epithelial cell shows both the internal and surface structure of individual microvilli and the association with actin filaments and intermediate filaments of the terminal web (**TW**). X7000. **(c)** TEM of microvilli sectioned longitudinally and transversely (inset) reveals the microfilament arrays that form the core of these projections. The terminal web (**TW**) of the cytoskeleton is also seen. The glycocalyx (**G**) extending from glycoproteins and glycolipids of the microvilli plasmalemma contains certain enzymes for late stages of macromolecule digestion. X15,000.

(d) The diagram shows a few microfilaments in a microvillus, with various actin-binding proteins important for F-actin assembly, capping, cross-linking, and movement. Like microfilaments in other regions of the cytoskeleton, those of microvilli are highly dynamic, with treadmilling and various myosin-based interactions. Myosin motors import various microvilli components along the actin filaments. (*Figure 4–8b, with permission, from Dr John Heuser, Washington University School of Medicine, St. Louis, MO.*)

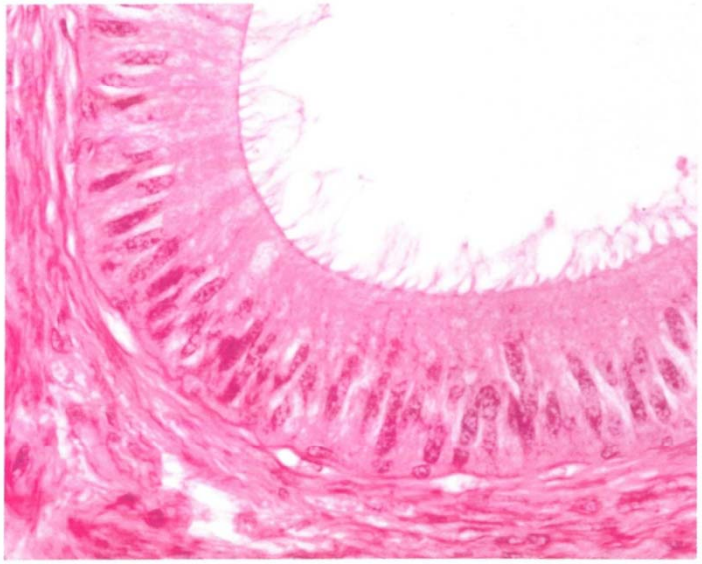
Stereocilia

- Epididymis
- Proximal ductus deferens
- Increase cell surface area
- Increse absorption

- Inner ear sensory cells
- motion detecting function
- Longer than microvilli & less motile

In terminal web

FIGURE 4–9 Stereocilia.



At the apical ends of the tall epithelial cells lining organs such as the epididymis (shown here) are numerous very long stereocilia, which increase the surface area available for absorption. Stereocilia are much longer than microvilli and often have distal branching. X400. H&E.

Cilia

- Longer than microvilli
- Microtubule
- Primary cilia
- Motile cilia (epithelial cells)
- 9+2 doublet structure
- 9 triplets in basal body
- Dynein & kinesin
- ATP
- Flagellum

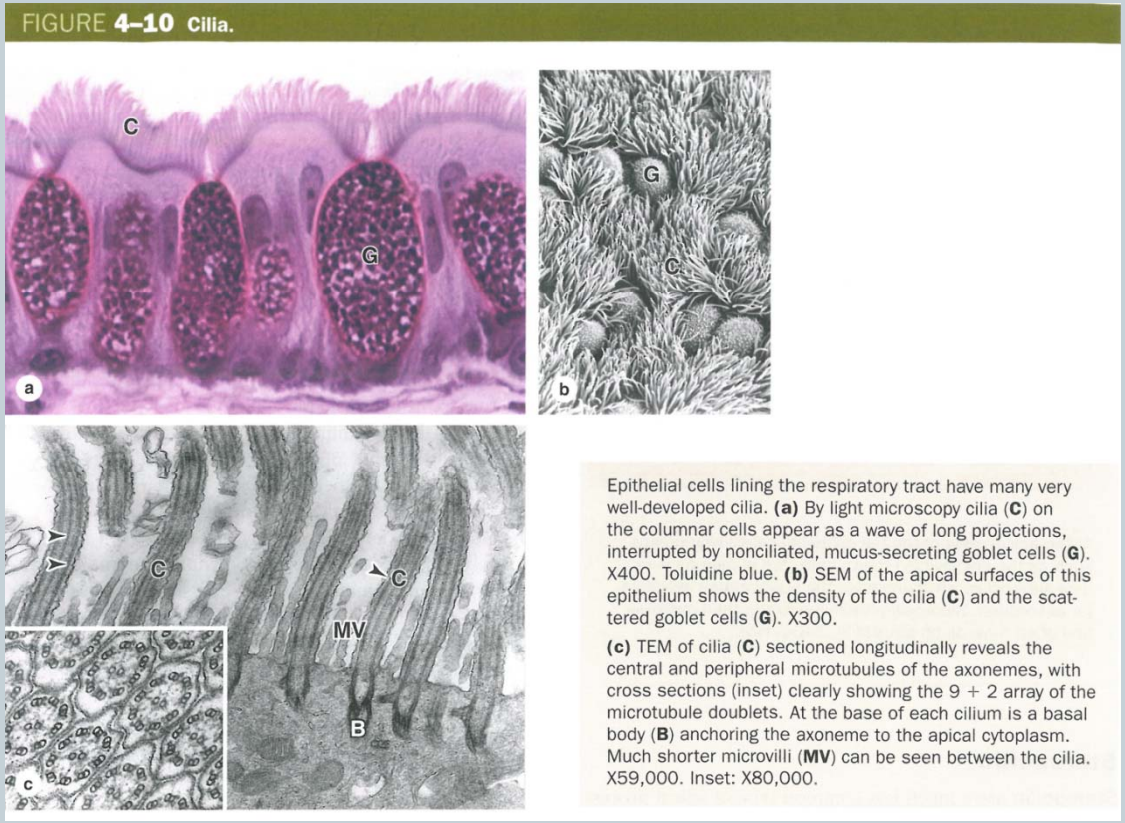


FIGURE **4–10** Cilia.

Epithelial cells lining the respiratory tract have many very well-developed cilia. **(a)** By light microscopy cilia (**C**) on the columnar cells appear as a wave of long projections, interrupted by nonciliated, mucus-secreting goblet cells (**G**). X400. Toluidine blue. **(b)** SEM of the apical surfaces of this epithelium shows the density of the cilia (**C**) and the scattered goblet cells (**G**). X300.

(c) TEM of cilia (**C**) sectioned longitudinally reveals the central and peripheral microtubules of the axonemes, with cross sections (inset) clearly showing the 9 + 2 array of the microtubule doublets. At the base of each cilium is a basal body (**B**) anchoring the axoneme to the apical cytoplasm. Much shorter microvilli (**MV**) can be seen between the cilia. X59,000. Inset: X80,000.

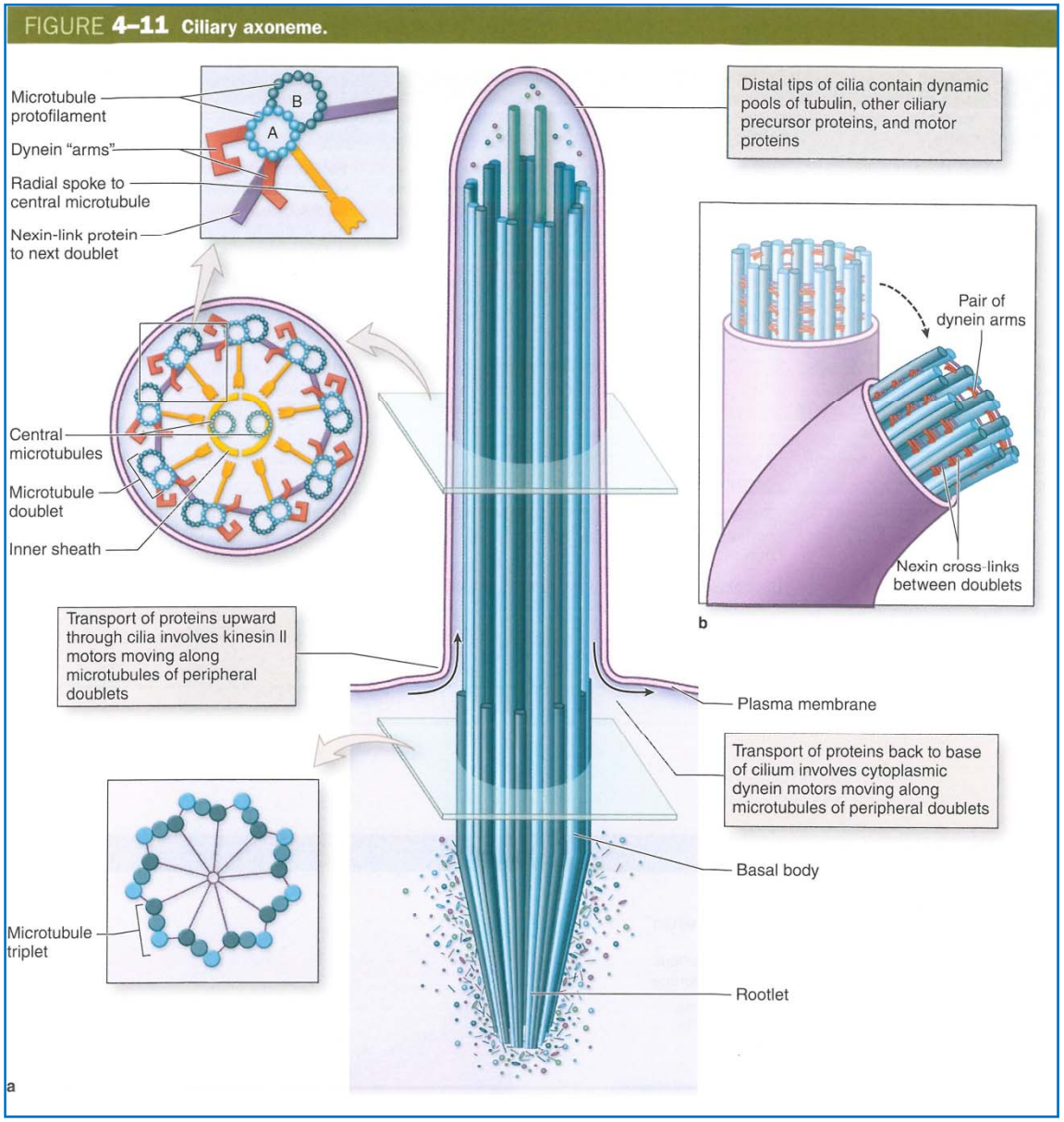


FIGURE 4–11 Ciliary axoneme.
Microtubule protofilament
Dynein "arms"
Radial spoke to central microtubule
Nexin-link protein to next doublet
B
A
Central microtubules
Microtubule doublet
Inner sheath
Microtubule triplet
a
Distal tips of cilia contain dynamic pools of tubulin, other ciliary precursor proteins, and motor proteins
Pair of dynein arms
Nexin cross-links between doublets
b
Transport of proteins upward through cilia involves kinesin II motors moving along microtubules of peripheral doublets
Plasma membrane
Transport of proteins back to base of cilium involves cytoplasmic dynein motors moving along microtubules of peripheral doublets
Basal body
Rootlet

Epithelia types

- **Covering or lining epithelium**
- **Secretory or glandular epithelium**

Covering or lining epithelium

- Simple epithelia
- Stratified epithelia
- Pseudostratified columnar epithelium

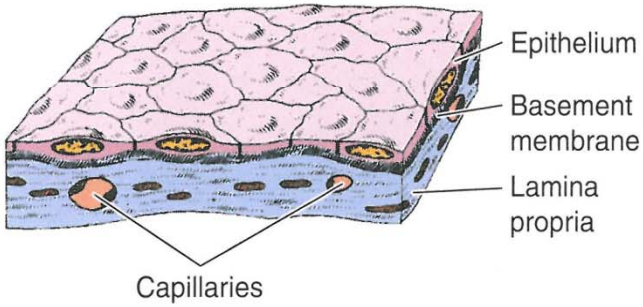
- **Simple epithelia**

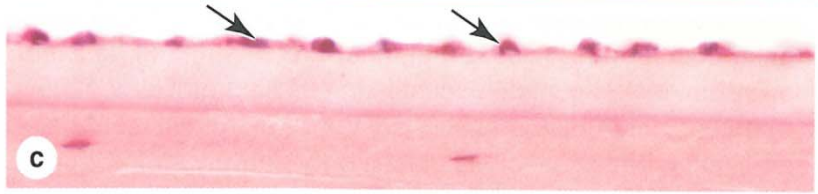
Squamous

Cuboidal

Columnar

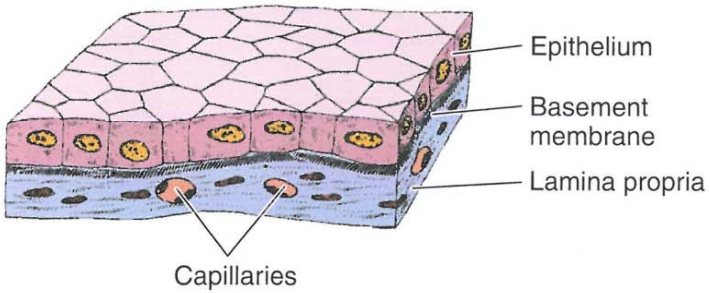
FIGURE 4–12 Simple squamous epithelium.

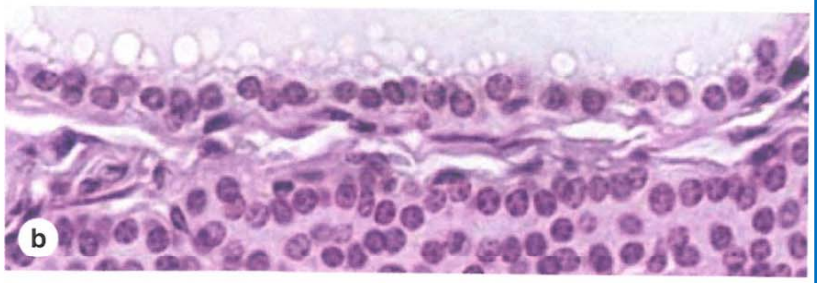


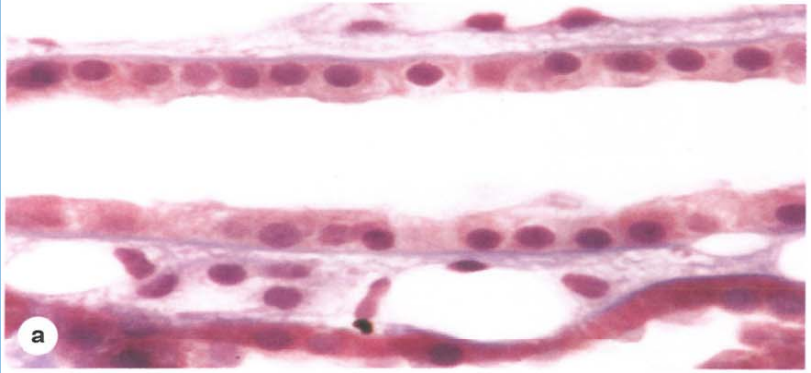


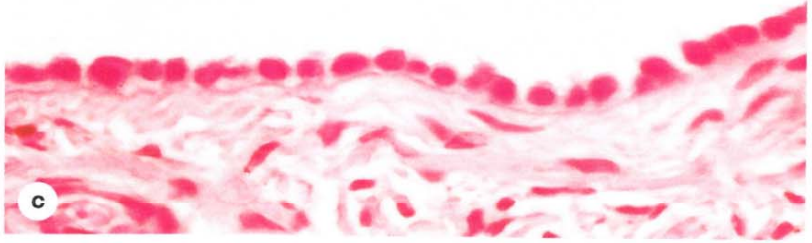
This is a single layer of thin cells, in which the **cell nuclei** (arrows) are the thickest and most visible structures. Simple epithelia are typically specialized as lining of vessels and cavities, where they regulate passage of substances into the underlying tissue. The thin cells often exhibit transcytosis. Examples shown here are those lining the thin renal loops of Henle **(a)**, covering the outer wall of the intestine **(b)**, and lining the inner surface of the cornea **(c)**. a, c X400; b X600. H&E.

FIGURE **4–13** **Simple cuboidal epithelium.**



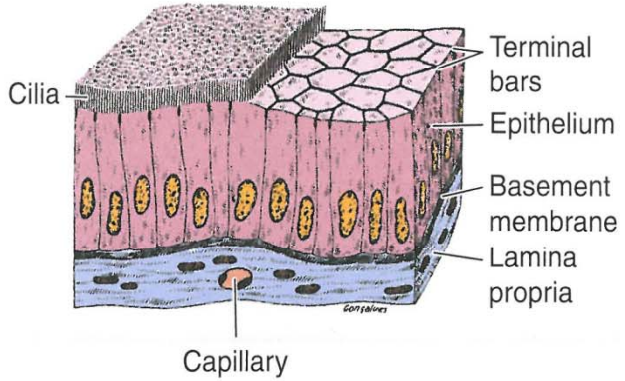


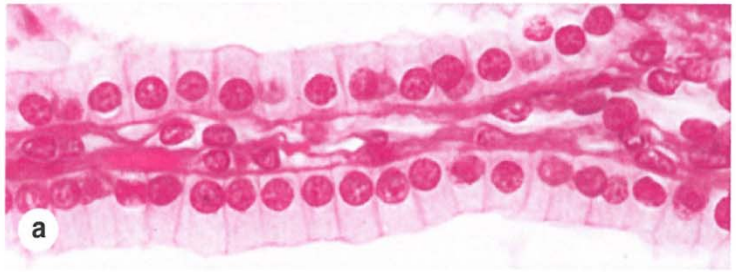


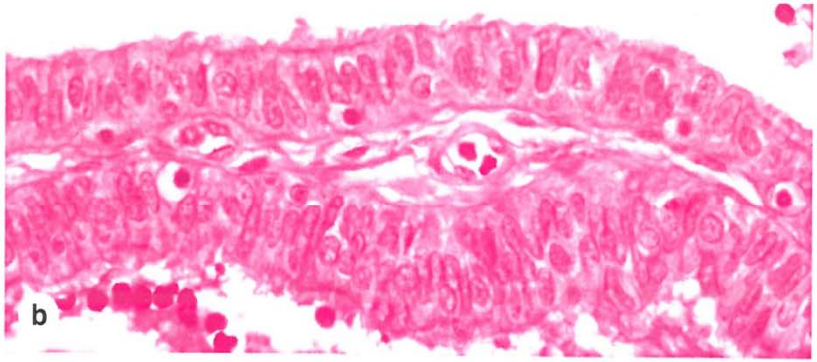


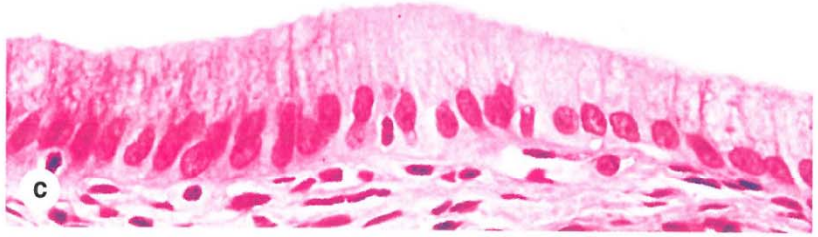
Cells here are roughly as tall as they are wide. Their greater thickness allows cytoplasm to be rich in mitochondria and other organelles for a high level of active transport across the epithelium and other functions. Examples shown here are from a renal collecting tubule **(a)**, a large thyroid follicle **(b)**, and the thick mesothelium covering an ovary **(c)**. All X400. H&E.

FIGURE 4–14 Simple columnar epithelium.









Cells here are always taller than they are wide, with apical cilia or microvilli, and are often specialized for absorption. Complexes of tight and adherent junctions, sometimes called "terminal bars" in light microscopic images, are present at the apical ends of cells. The examples shown here are from a renal collecting duct **(a)**, the oviduct lining, with both secretory and ciliated cells **(b)**, and the lining of the gall bladder **(c)**. All X400. H&E.

- **Stratified epithelia**

Squamous

1. Keratinized (skin)
2. Nonkeratinized (mouth, esophagus, vagina)

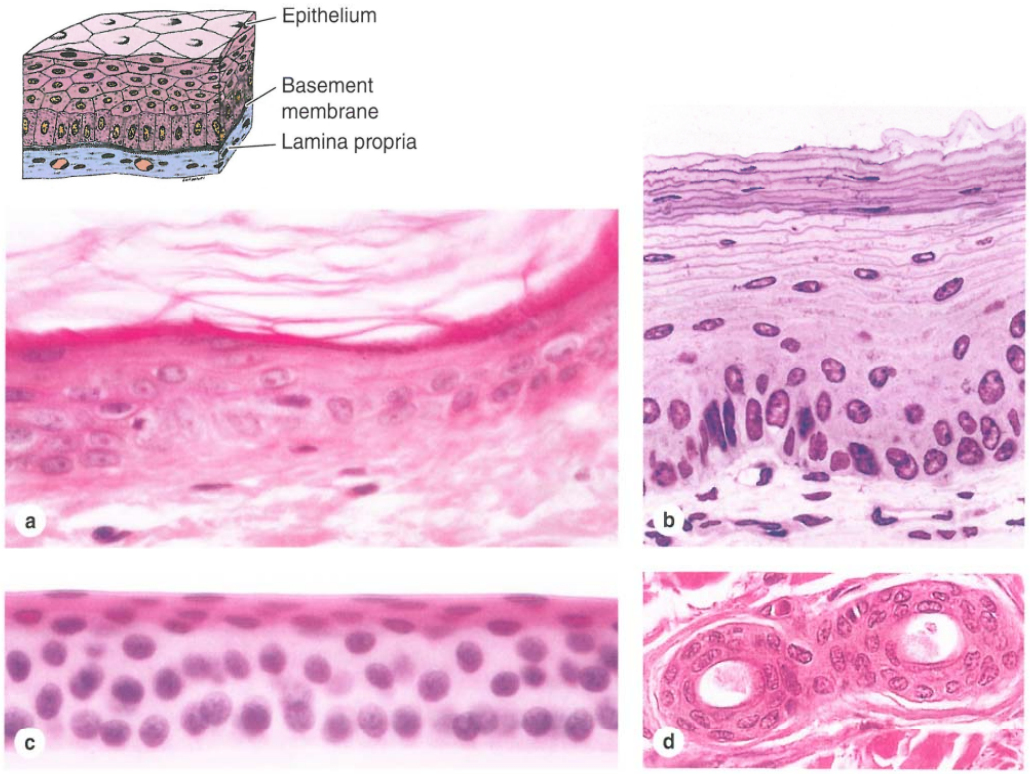
Cuboidal (exceretory ducts of salivary & sweet glands)

Columnar (conjunctiva lining eyelids, protective & mucos secretion)

Transitional or urothelium (umbrella cells)

- Pseudostratified columnar epithelium

FIGURE **4–15** **Stratified epithelium.**

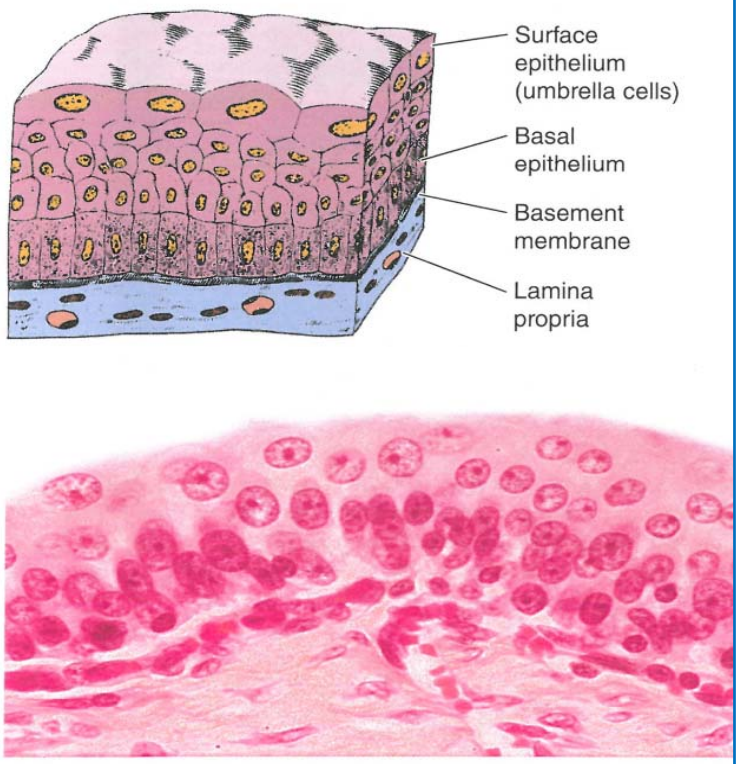


Stratified squamous epithelia usually have protective functions: protection against easy invasion of underlying tissue by microorganisms and protection against water loss. These functions are particularly important in the epidermis **(a)** in which differentiating cells become **keratinized**, ie, filled with keratin and other substances, eventually lose their nuclei and organelles, and form superficial layers flattened squames that impede water loss. Keratinized cells are sloughed off and replaced by new cells from more basal layers, which are discussed fully with the skin in Chapter 18.

Nonkeratinized epithelia occur in many organs, such as the esophageal lining **(b)** or outer covering of the cornea **(c)**. Here cells accumulate much less keratin and retain their nuclei but still provide protection against microorganisms.

Stratified cuboidal or columnar epithelia are fairly rare but occur in excretory ducts of certain glands, such as sweat glands **(d)** where the double layer of cells allows additional functions. All X400; (b) PT, (a, c, and d) H&E.

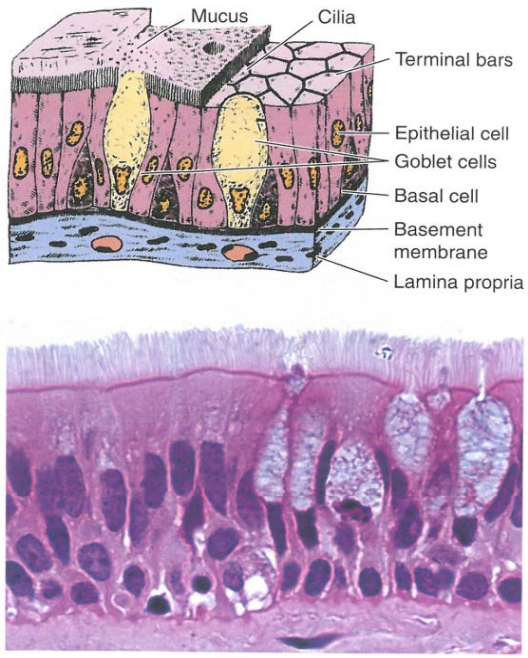
FIGURE **4–16** **Transitional epithelium or urothelium.**



Urothelium is stratified and lines much of the urinary tract. The superficial cells are rounded or dome-shaped, and have specialized membrane features enabling them to withstand the hypertonic effects of urine and protect underlying cells from this toxic solution. Cells of this epithelium are also able to adjust their relationships with one another and undergo a transition in their appearance as the urinary bladder fills and the wall is distended. These unique features of transitional epithelium are discussed more extensively in Chapter 19. X400. H&E.

Pseudostratified columnar epithelium

FIGURE **4–17** **Pseudostratified epithelium.**



Cells of pseudostratified epithelia appear to be in several layers, but their basal ends all rest on the basement membrane. The pseudostratified columnar epithelium of the upper respiratory tract shown here contains many ciliated cells, as well as other cells with their nuclei at different levels. X400. H&E.

>> MEDICAL APPLICATION

In **chronic bronchitis**, common among habitual smokers, the number of goblet cells in the lining of airways in the lungs often increases greatly. This leads to excessive mucus production in areas where there are too few ciliated cells for its rapid removal and contributes to obstruction of the airways. The ciliated pseudostratified epithelium lining the bronchi of smokers can also be transformed into stratified squamous epithelium by metaplasia.

TABLE 4–3 Common types of covering epithelia.

Major Feature	Cell Form	Examples of Distribution	Main Function
Simple (one layer of cells)	Squamous	Lining of vessels (endothelium); Serous lining of cavities: pericardium, pleura, peritoneum (mesothelium)	Facilitates the movement of the viscera (mesothelium), active transport by pinocytosis (mesothelium and endothelium), secretion of biologically active molecules (mesothelium)
	Cuboidal	Covering the ovary, thyroid	Covering, secretion
	Columnar	Lining of intestine, gallbladder	Protection, lubrication, absorption, secretion
Pseudostratified (layers of cells with nuclei at different levels; not all cells reach surface but all adhere to basal lamina)		Lining of trachea, bronchi, nasal cavity	Protection, secretion; cilia-mediated transport of particles trapped in mucus out of the air passages
Stratified (two or more layers of cells)	Squamous keratinized (dry)	Epidermis	Protection; prevents water loss
	Squamous nonkeratinized (moist)	Mouth, esophagus, larynx, vagina, anal canal	Protection, secretion; prevents water loss
	Cuboidal	Sweat glands, developing ovarian follicles	Protection, secretion
	Transitional	Bladder, ureters, renal calyces	Protection, distensibility
	Columnar	Conjunctiva	Protection

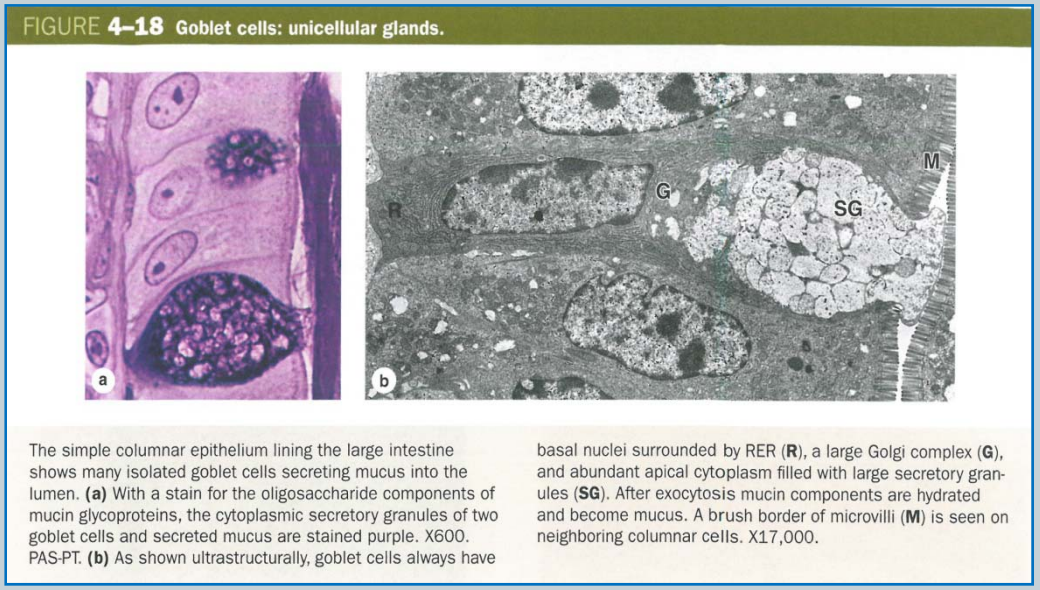
Secretory epithelia & glands

Secretory vesicle

- Protein (pancreas)
- Lipid (adrenal & sebaceous glands)
- Carbohydrate and pr. Complex (salivary glands)
- All of mentioned (mammary glands)
- Water & electrolyte (sweet glands)

- Unicellular glands

Goblet cell



Gland formation

- Exocrine glands
- Endocrine glands

Secretory portions & ducts

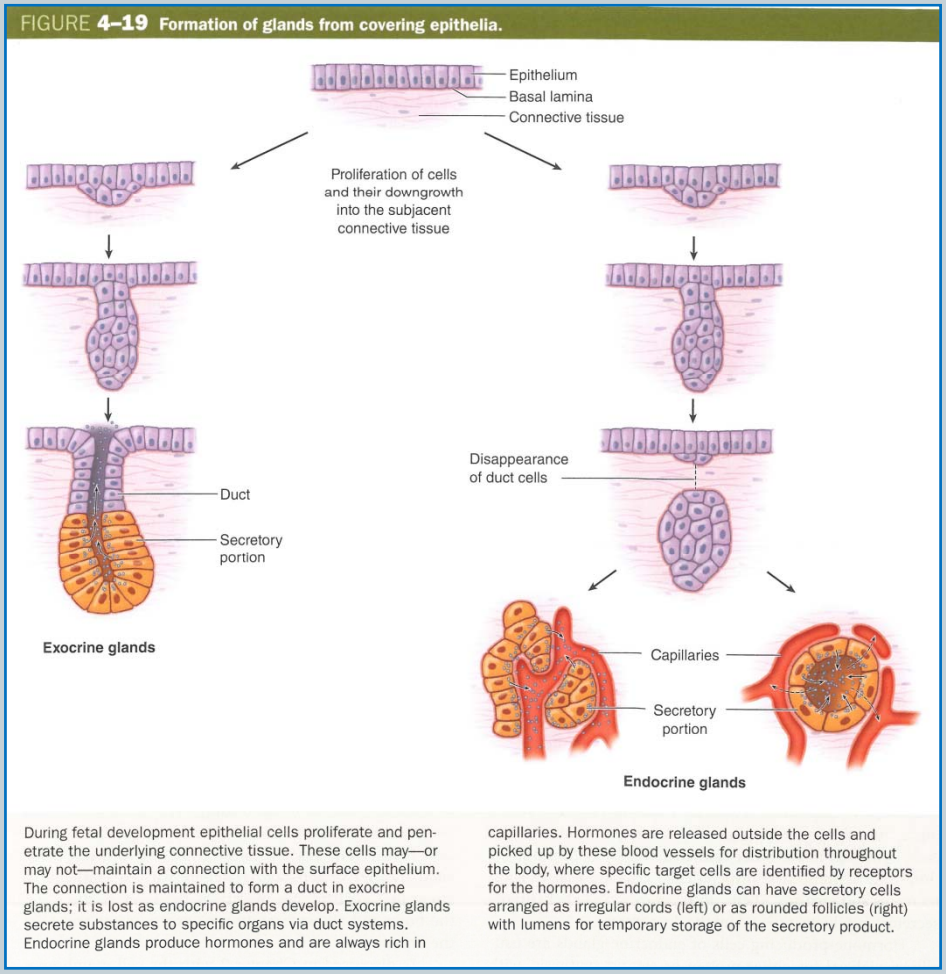


FIGURE **4–19** **Formation of glands from covering epithelia.**

During fetal development epithelial cells proliferate and penetrate the underlying connective tissue. These cells may—or may not—maintain a connection with the surface epithelium. The connection is maintained to form a duct in exocrine glands; it is lost as endocrine glands develop. Exocrine glands secrete substances to specific organs via duct systems. Endocrine glands produce hormones and are always rich in capillaries. Hormones are released outside the cells and picked up by these blood vessels for distribution throughout the body, where specific target cells are identified by receptors for the hormones. Endocrine glands can have secretory cells arranged as irregular cords (left) or as rounded follicles (right) with lumens for temporary storage of the secretory product.

Exocrine Glands

- Glands & ducts:

Ducts

1. Simple
2. Compound

Tubular

Acinar

Tubuloacinar

Secretory portion

- Tubular (short or long & coiled)
- coiled
- Acinar

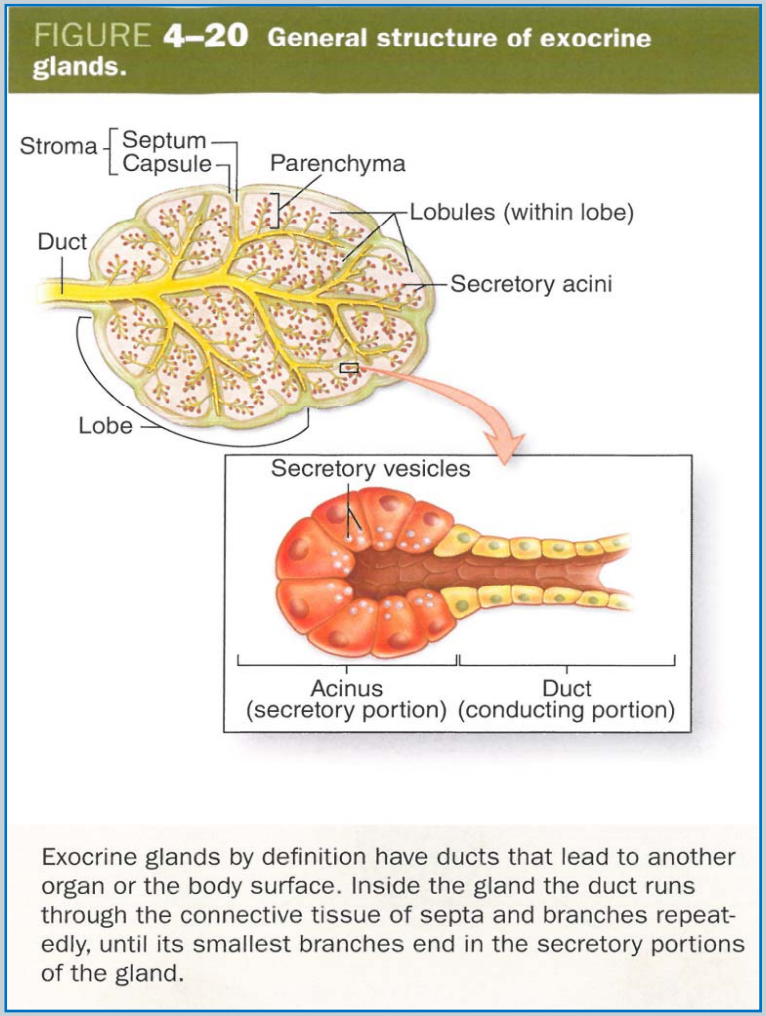
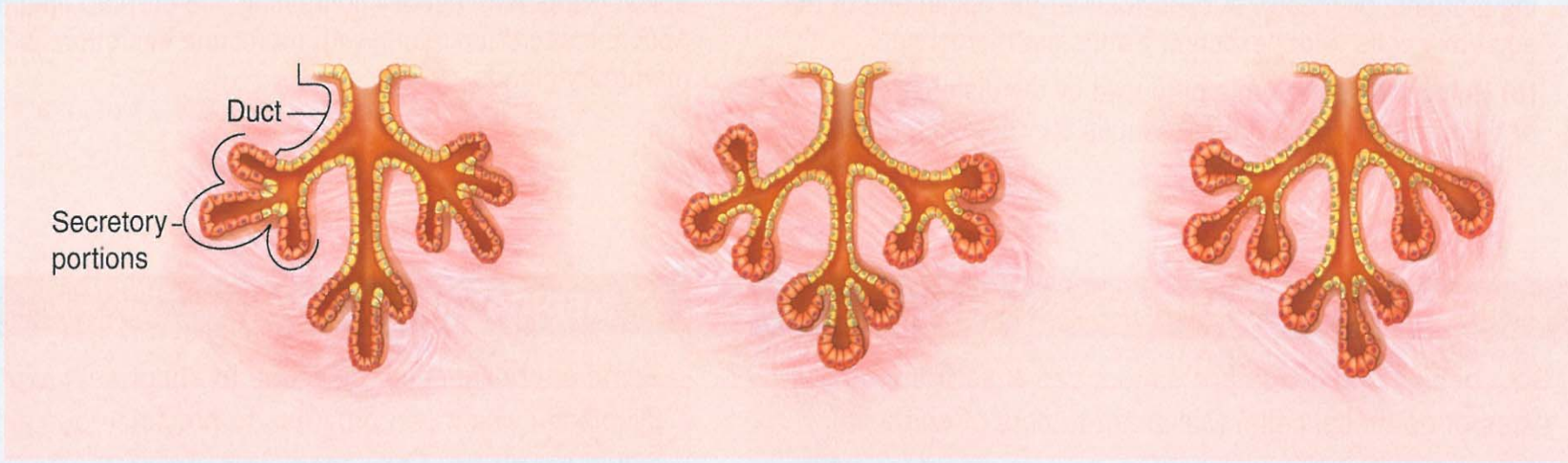


TABLE 4–4 Structural classes of exocrine glands, features of each class, and examples.

SIMPLE Glands **(Ducts Do Not Branch)**

Class	Simple Tubular	Branched Tubular	Coiled Tubular	Acinar (or Alveolar)	Branched Acinar
					
Features	Elongated secretory portion; duct usually short or absent	Several long secretory parts joining to drain into 1 duct	Secretory portion is very long and coiled	Rounded, saclike secretory portion	Multiple saclike secretory parts entering the same duct
Examples	Mucous glands of colon; intestinal glands or crypts (of Lieberkühn)	Glands in the uterus and stomach	Sweat glands	Small mucous glands along the urethra	Sebaceous glands of the skin

COMPOUND Glands (Ducts from Several Secretory Units Converge into Larger Ducts)

Class	Tubular	Acinar (Alveolar)	Tubuloacinar
			
Features	Several *elongated*, coiled secretory units and their ducts converge to form larger ducts	Several *saclike* secretory units with small ducts converge at a larger duct	Ducts of both tubular and acinar secretory units converge at larger ducts
Examples	Submucosal mucous glands (of Brunner) in the duodenum	Exocrine pancreas	Salivary glands

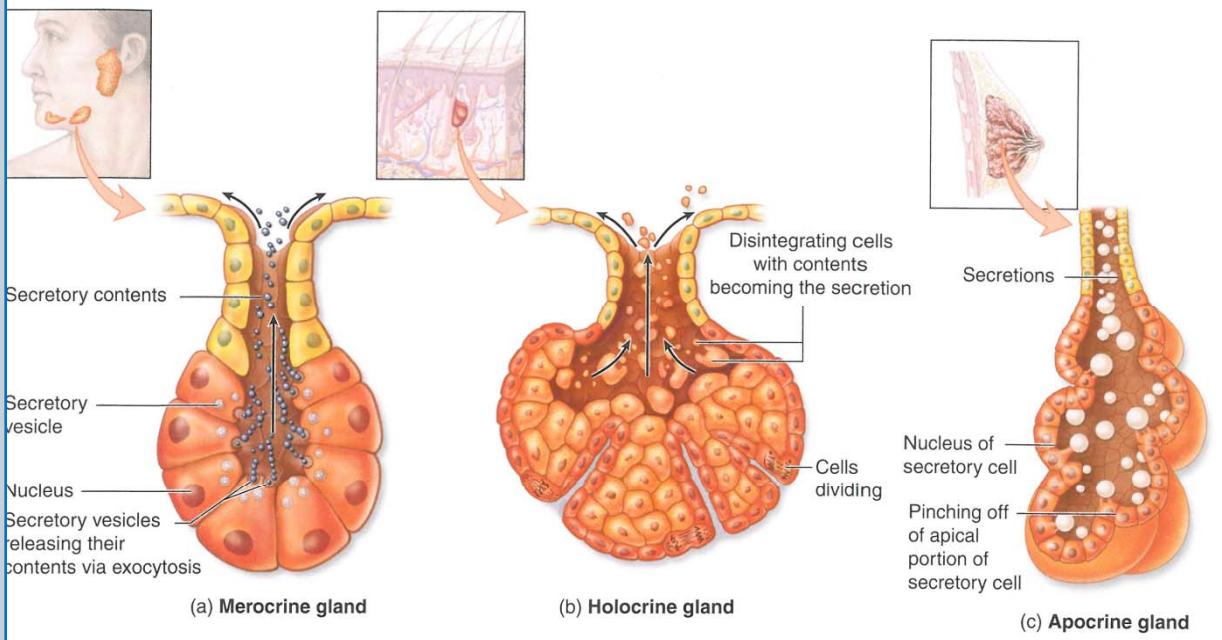
Secretion mechanism

- Merocrine secretion
- Apocrine secretion
- Holocrine secretion

>> MEDICAL APPLICATION

The holocrine sebaceous glands are the primary structure involved in the common form of **acne**, acne vulgaris. Excessive holocrine secretion of sebum and keratin triggered by the surge of the steroid hormone testosterone that occurs in both genders at puberty frequently leads to blocked ducts within the gland. Activity of the normal commensal skin bacterium *Propionibacterium acnes* within the blocked duct commonly produces localized inflammation.

FIGURE **4–21** **Mechanisms of exocrine gland secretion.**

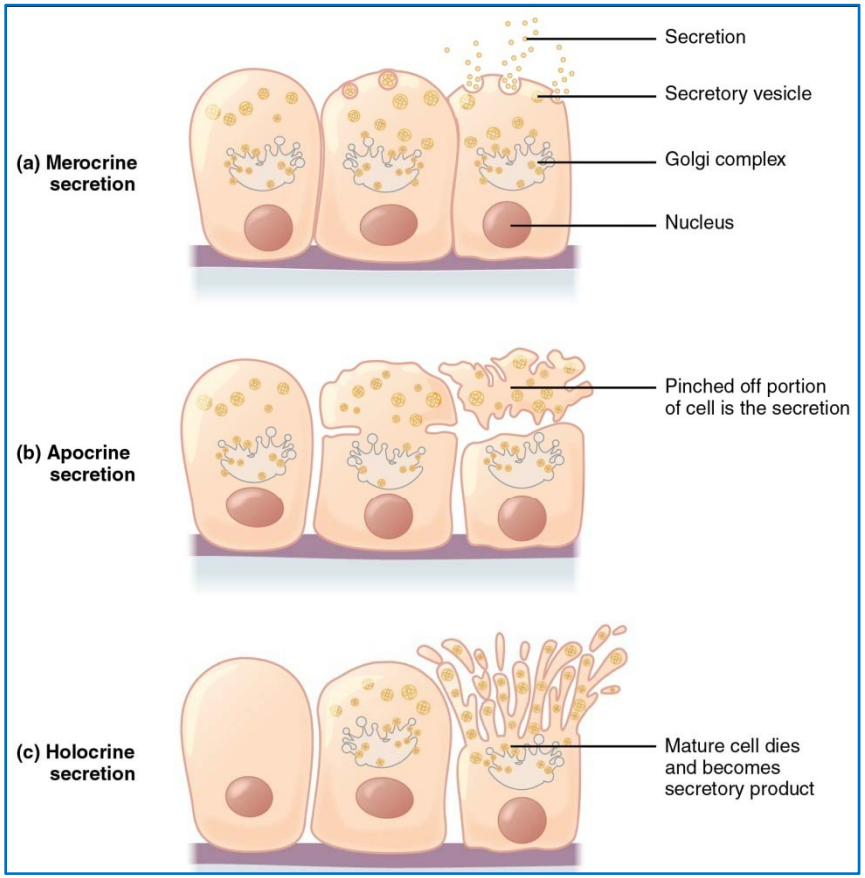


Three basic types of secretion are used by cells of exocrine glands, depending on what substance is being secreted.

(a) Merocrine secretion releases products, usually containing proteins, by means of exocytosis at the apical end of the secretory cells. Most exocrine glands are merocrine.

(b) Holocrine secretion is produced by the disintegration of the secretory cells themselves as they complete their terminal differentiation, which involves becoming filled with product. Sebaceous glands of hair follicles are the best examples of holocrine glands.

(c) Apocrine secretion involves loss of membrane-enclosed apical cytoplasm, usually containing one or more lipid droplets. Apocrine secretion, along with merocrine secretion, is seen in mammary glands.


(a) Merocrine secretion
Secretion
Secretory vesicle
Golgi complex
Nucleus
(b) Apocrine secretion
Pinched off portion of cell is the secretion
(c) Holocrine secretion
Mature cell dies and becomes secretory product

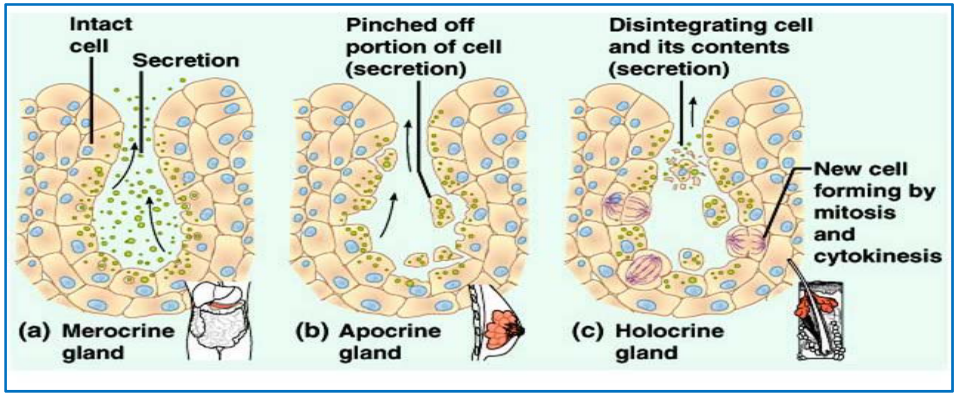
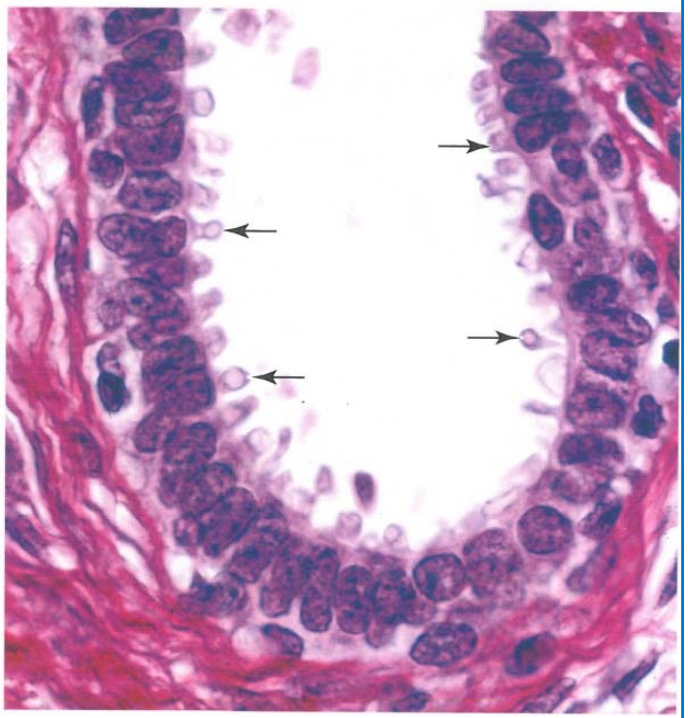

Intact cell
Secretion
(a) Merocrine gland
Pinched off portion of cell (secretion)
(b) Apocrine gland
Disintegrating cell and its contents (secretion)
New cell forming by mitosis and cytokinesis
(c) Holocrine gland

FIGURE 4–22 Holocrine secretion in a sebaceous gland.

In holocrine secretion, best seen in the sebaceous gland adjacent to hair follicles, entire cells fill with a lipid-rich product as they differentiate. Mature (terminally differentiated) cells separate and completely disintegrate, releasing the lipid that serves to protect and lubricate adjacent skin and hair. Sebaceous glands lack myoepithelial cells; cell proliferation inside a dense, inelastic connective tissue capsule continuously forces product into the duct. X200. H&E.

FIGURE 4–23 Apocrine secretion in the mammary gland.



The secretory portions of a mammary gland demonstrate apocrine secretion, characterized by extrusion of the secretion product along with a bit of apical cytoplasm (**arrows**). The released portion of cell contains lipid droplet(s). Merocrine secretion also occurs from the same and other cells of the gland. X400. PSH.

Merocrine secretion

- **Serous (nonglycosilated Pr.)**

Basophilic & acidophilic staining

Pancrease & salivary glands

- **Mucous (glycosilated Pr.)**

Goblet cells

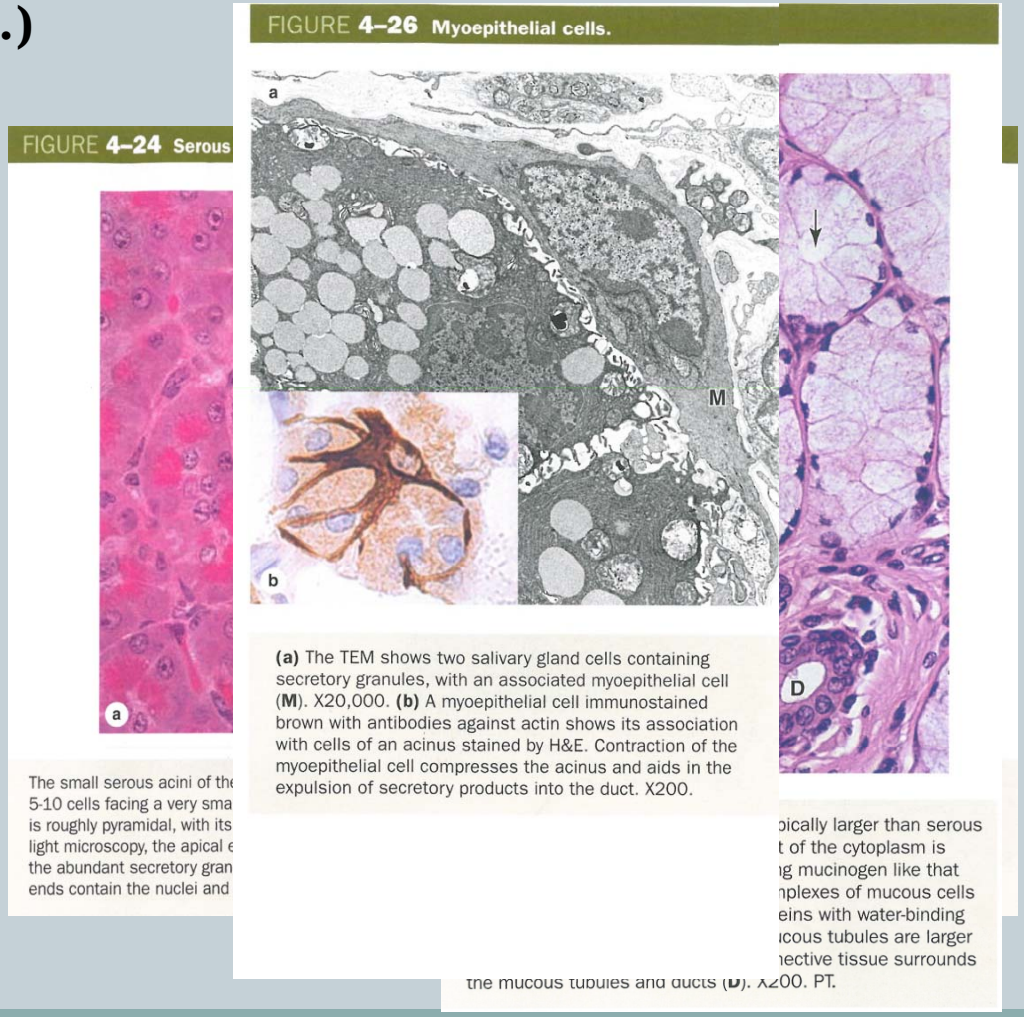
Mucins

Eosin

PAS

- **Seromucous glands**

Myoephithelial cells



- Endocrine

Proteins (RER)

Steroids (SER)

- Paracrine
- Autocrine

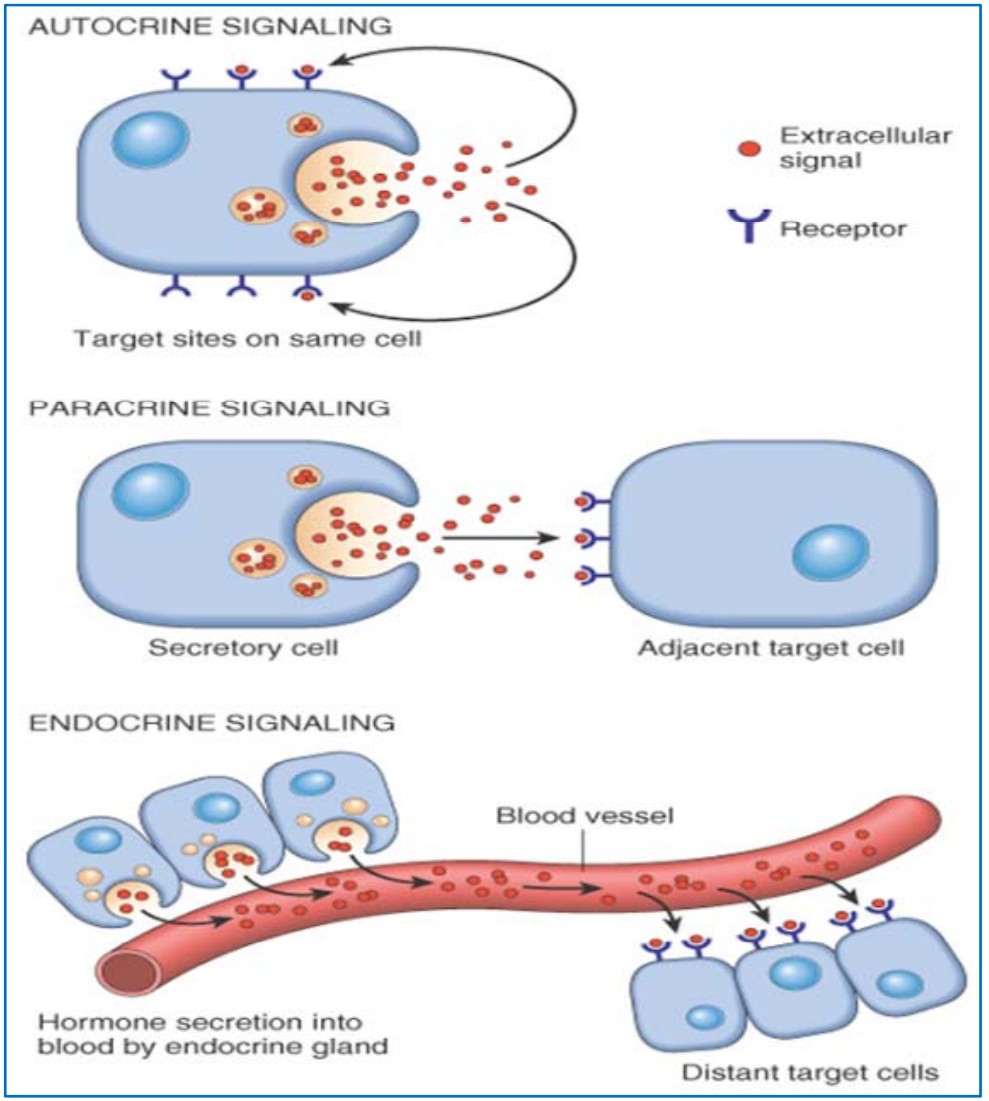
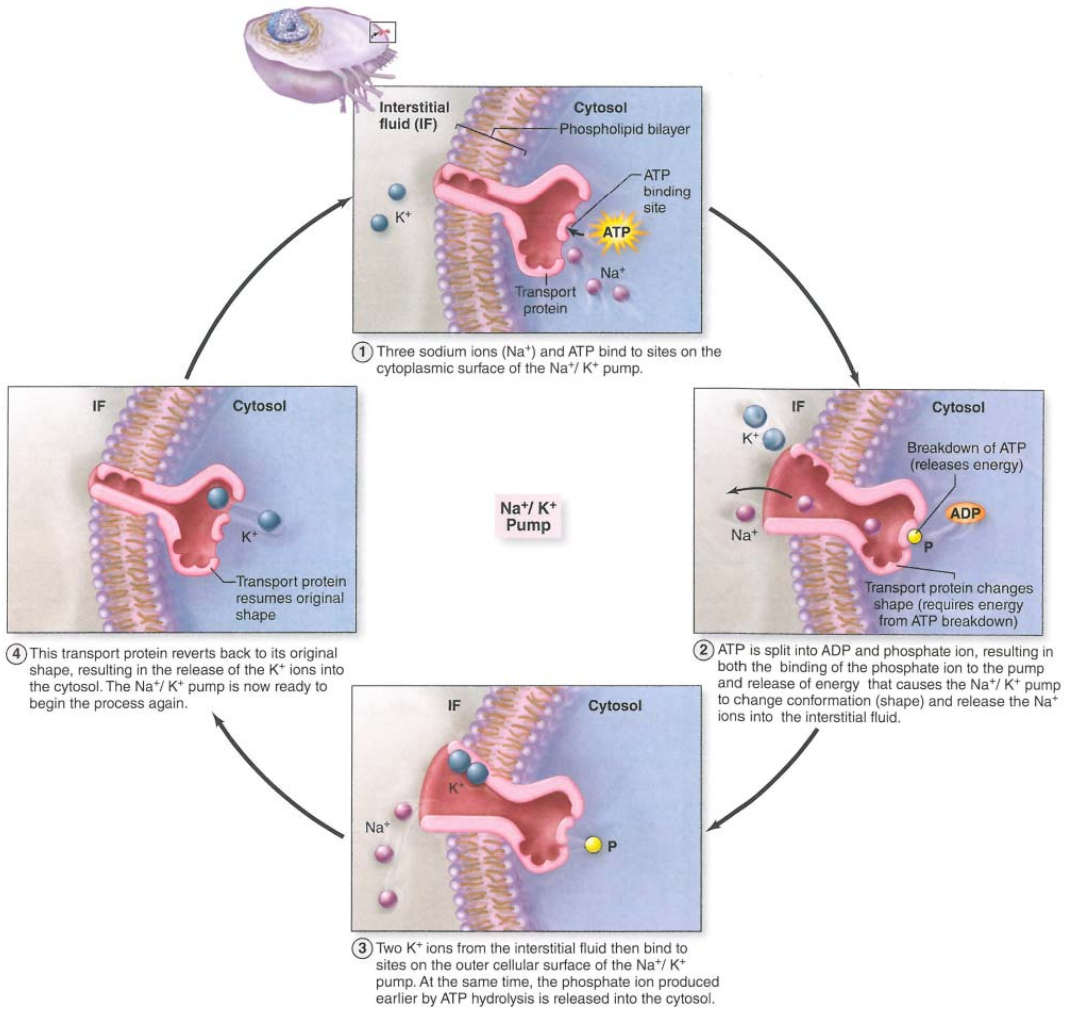
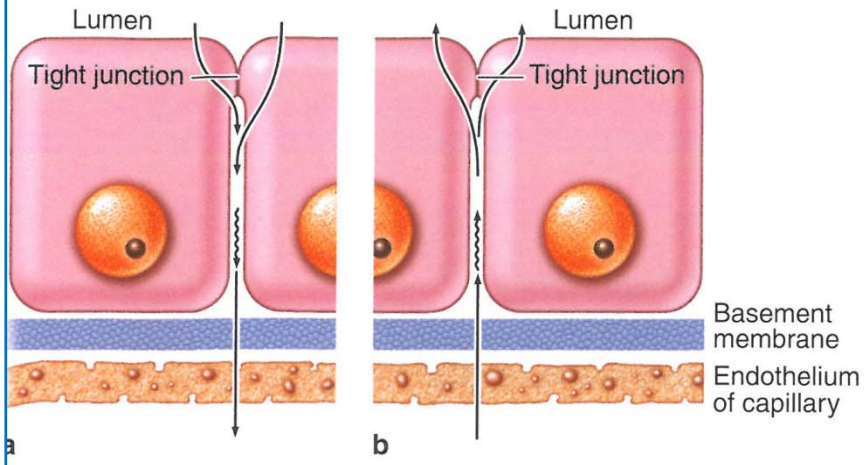


FIGURE **4–27** Na^+/K^+ pump.



A Na^+/K^+-ATPase located in the plasma membrane of many cells uses ATP to transport or pump the cations Na^+ and K^+ through the membrane in opposite directions, against their concentrations gradients.

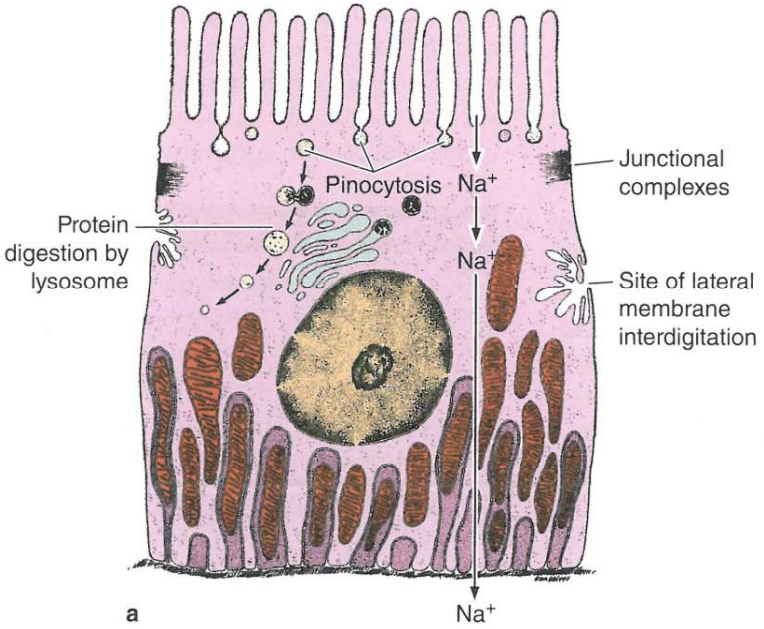
FIGURE 4–28 Ion and water absorption and secretion.

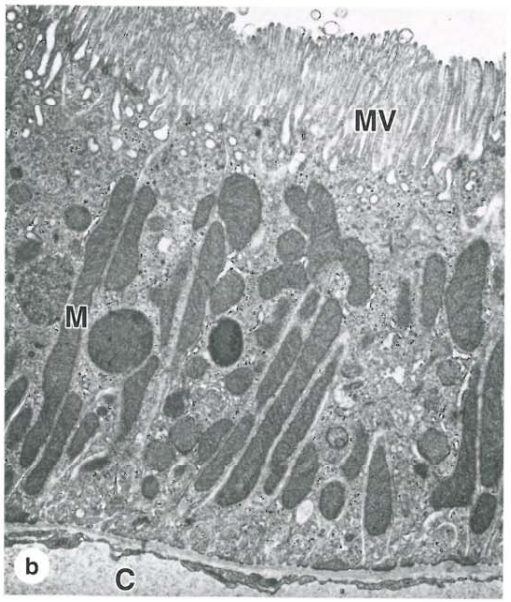


Ion and water transport across epithelia can occur in either direction, depending on which tissue is involved. **(a)** The direction of transport is from the lumen to the blood vessel, as in the gallbladder and intestine. This process is called **absorption**, and serves to concentrate bile and obtain water and ions in these organs.

(b) Transport of water in the other direction from the capillaries into a lumen, as in the choroid plexus and sweat glands, is often part of **secretion** and serves to expel water from the interstitial fluid into specialized aqueous fluids in these tissues. No matter whether an epithelium is absorbing or secreting water, apical occluding junctions are necessary to maintain tight compartmentalization.

FIGURE **4–29** **Absorptive cells.**





A diagram and TEM of epithelial cells highly specialized for absorption: cells of proximal convoluted tubule of the kidney. Typically, long invaginations of the basal cell membrane outline regions with mitochondria (**M**). Interdigitations from neighboring cells are also present laterally. Immediately below the microvilli (**MV**) are many pinocytotic vesicles, which may fuse with lysosomes as shown or mediate transcytosis by secreting their contents at the basolateral membrane. Junctional complexes between individual cells separate the apical and basolateral compartments. Sodium ions diffuse passively through the apical membranes of renal epithelial cells and are actively transported out of the cells by Na^+/K^+-ATPase located in the basolateral membrane. Immediately below the basal lamina is a capillary (**C**) that removes water absorbed across the epithelium. X9600.

Epithelial cell renewal

- Fast (intestine)
- Slow (gland)

- Stem cells in basal part (niche)

>> MEDICAL APPLICATION

Both benign and malignant tumors can arise from most types of epithelial cells. Malignant tumors of epithelial origin are called **carcinomas** (Gr. *karkinos*, cancer + *oma*, tumor). Malignant tumors derived from glandular epithelial tissue are called **adenocarcinomas** (Gr. *adenos*, gland + *karkinos*). Adenocarcinomas are by far the most common tumors in adults after age 45.

>> MEDICAL APPLICATION

Some epithelial cells are prone to abnormal growth or dysplasia, which can progress to precancerous growth called **neoplasia**. Early neoplastic growth is often reversible and does not always result in cancer.

Under certain abnormal conditions, one type of epithelial tissue may undergo transformation into another type in another reversible process called **metaplasia**. In heavy cigarette smokers, the ciliated pseudostratified epithelium lining the bronchi can be transformed into stratified squamous epithelium.

>> MEDICAL APPLICATION

In individuals with chronic vitamin A deficiency, epithelial tissues of the type found in the bronchi and urinary bladder are gradually replaced by stratified squamous epithelium.