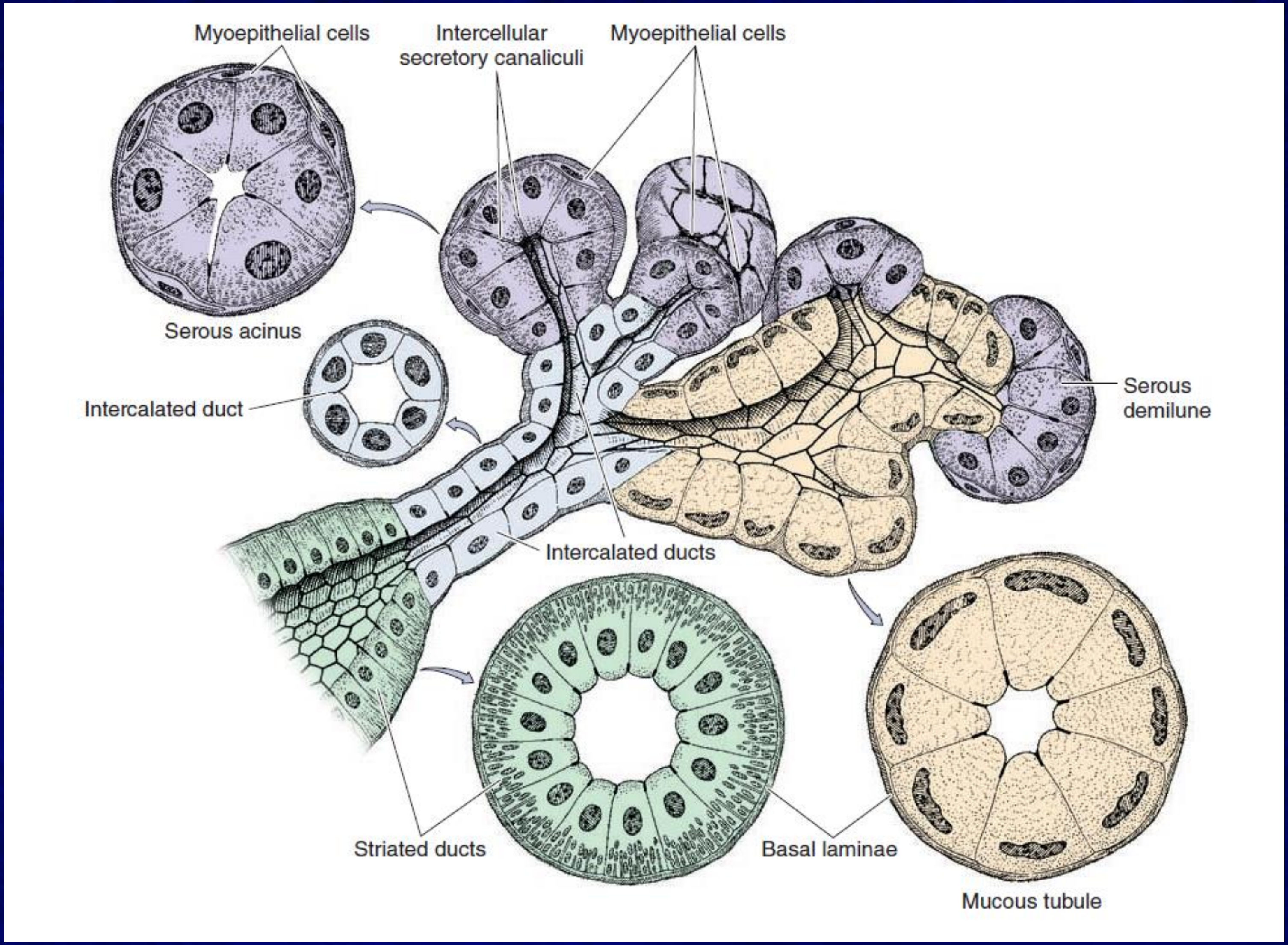
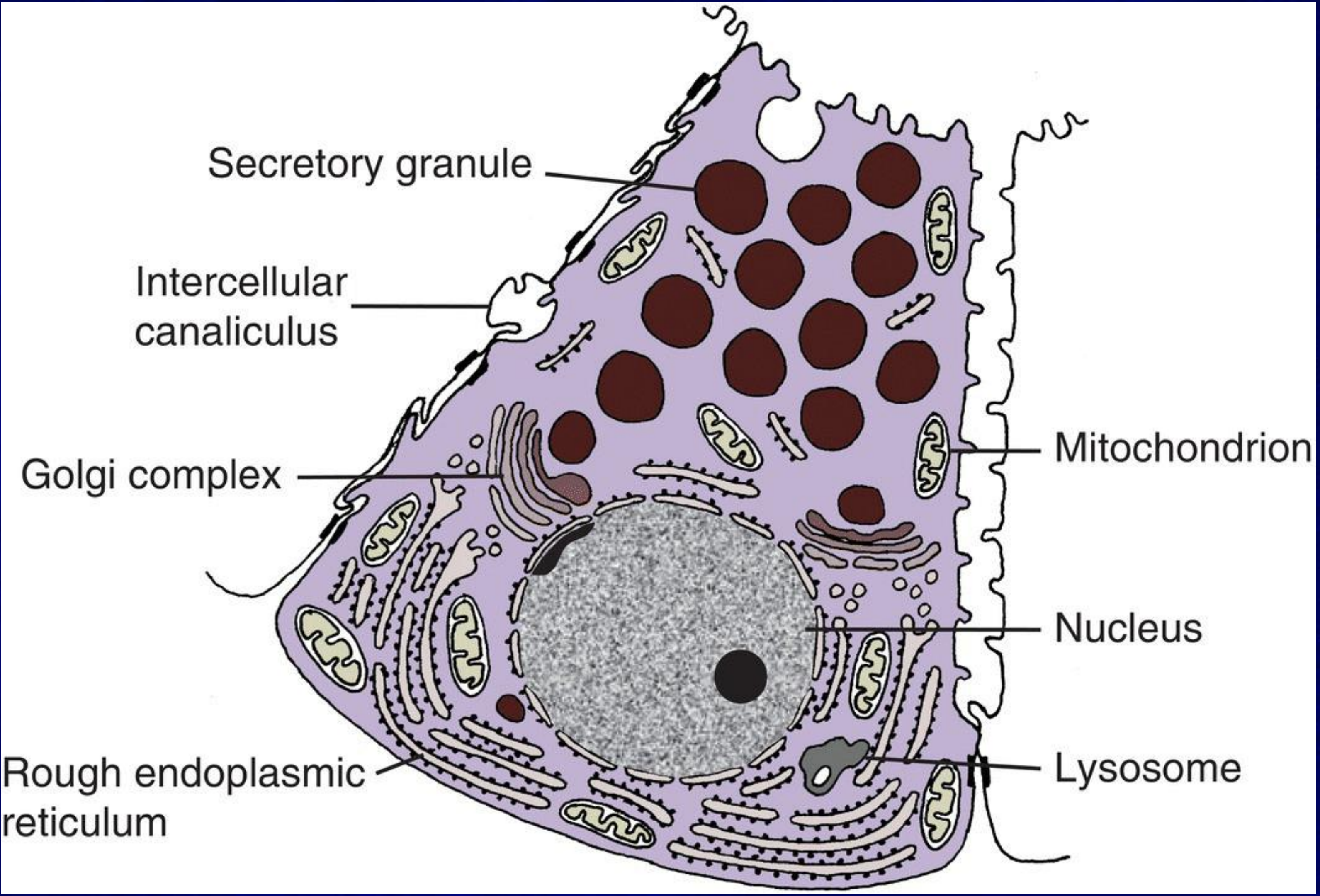
HISTOLOGY OF ACCESSORY ORGANS OF GIT

SALIVARY GLANDS

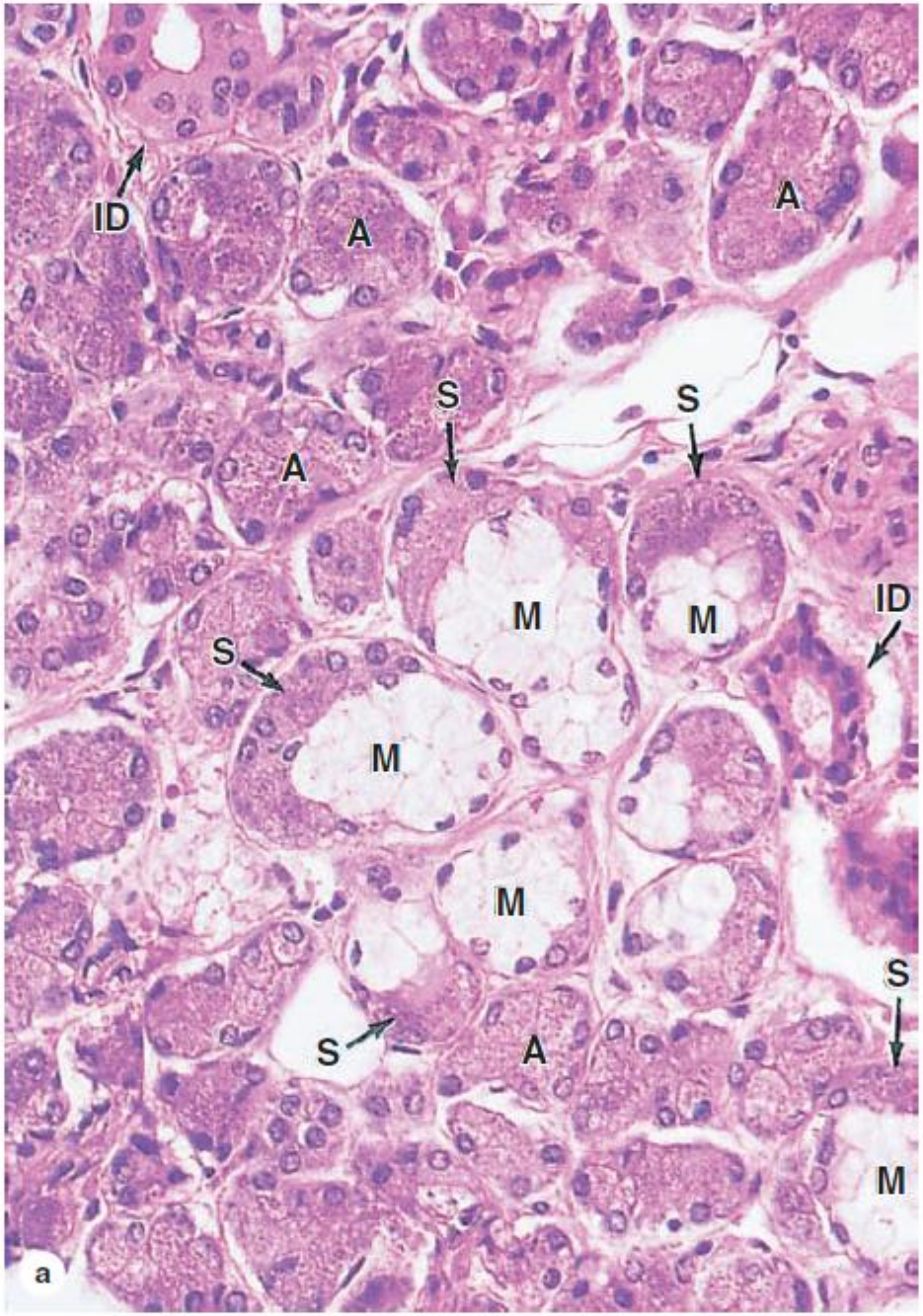


Epithelial components of a submandibular gland lobule. The secretory portions are composed of pyramidal serous (violet) and mucous (tan) cells.

- *Three epithelial cell types* comprise the **salivary secretory units:**

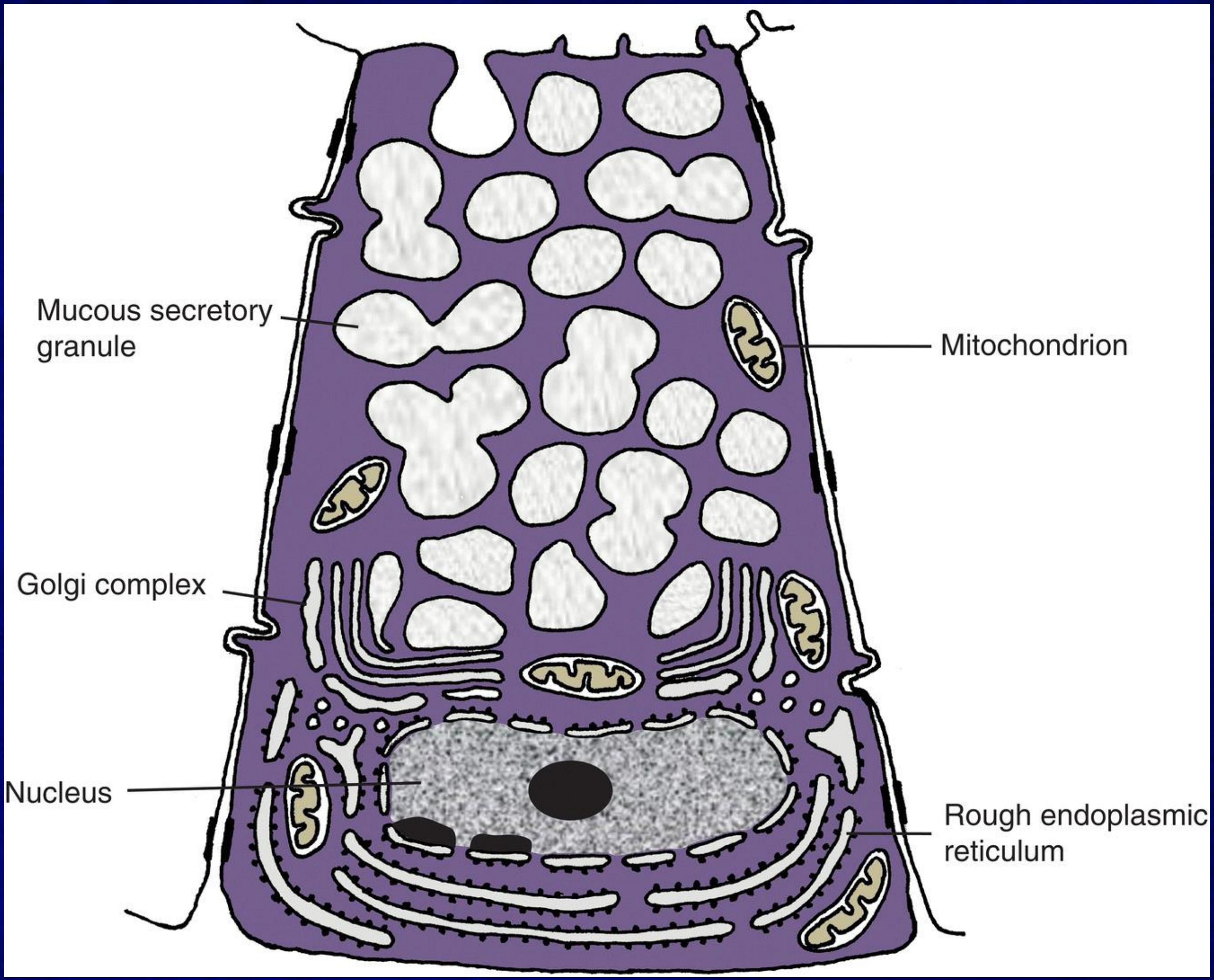


1. **Serous cells** are polarized protein-secreting cells, usually pyramidal in shape, with round nuclei, RER, and apical secretory granules.



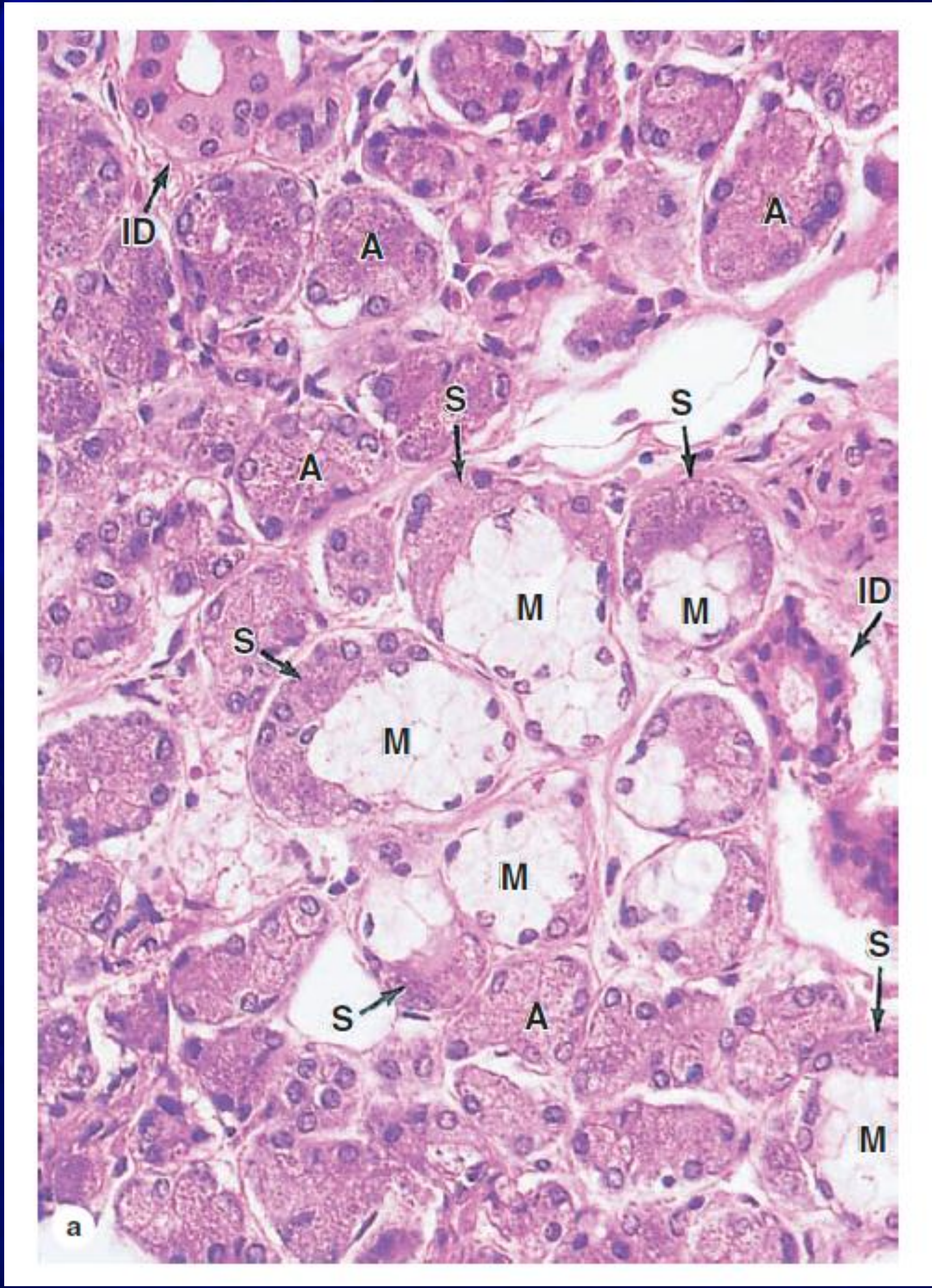
- Joined apically by **tight and adherent junctions**, serous cells form a somewhat spherical unit called an **acinus,** with a very small central lumen.
- Serous acinar cells secrete enzymes and other proteins.

(a) The submandibular gland is a mixed serous and mucous gland (serous cells predominate), and shows well-stained serous acini (A) and serous demilunes (S) and pale-staining mucous cells (M) grouped as tubules in this tubuloacinar gland. Small intralobular ducts (ID) drain each lobule. X340. H&E.



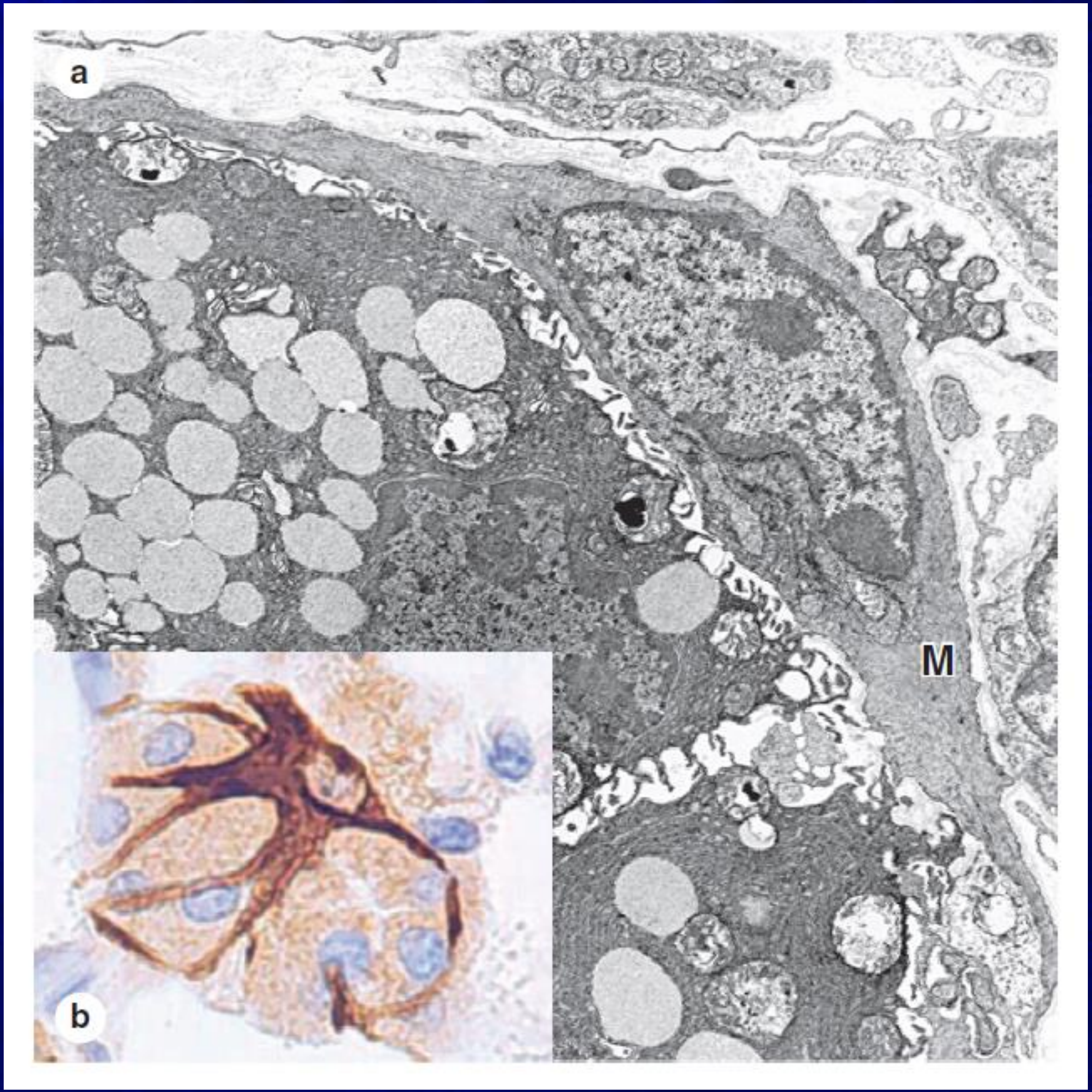
2. **Mucous cells** are somewhat more columnar in shape, with more compressed basal nuclei.

- Mucous cells contain apical granules with hydrophilic mucins that provide lubricating properties in saliva.



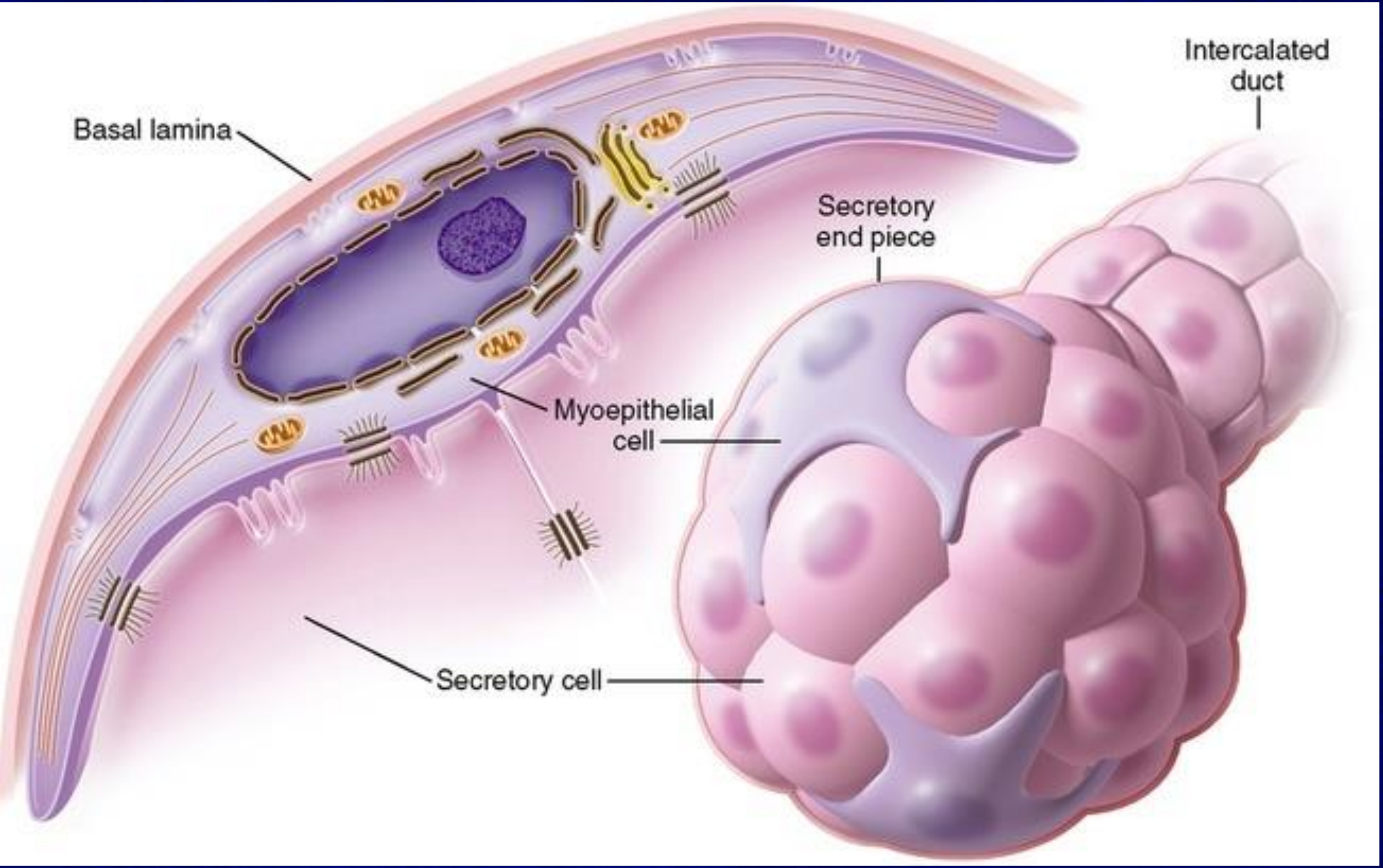
- Mucous cells are most often organized as cylindrical **tubules** rather than acini.

(a) The submandibular gland is a mixed serous and mucous gland (serous cells predominate), and shows well-stained serous acini (A) and serous demilunes (S) and pale-staining mucous cells (M) grouped as tubules in this tubuloacinar gland. Small intralobular ducts (ID) drain each lobule. X340. H&E.

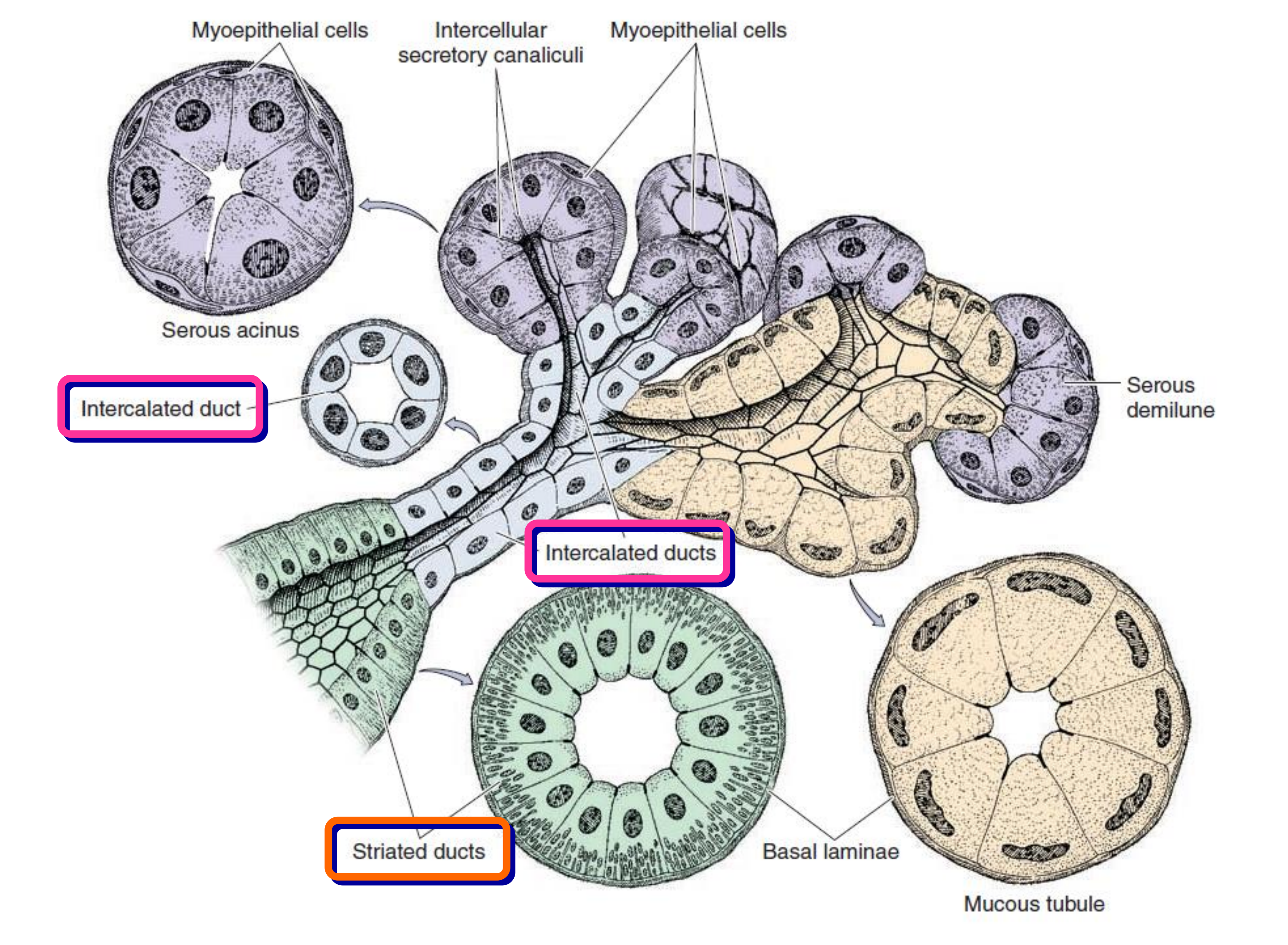


Myoepithelial cells are found inside the basal lamina surrounding acini, tubules, and the proximal ends of the duct system.

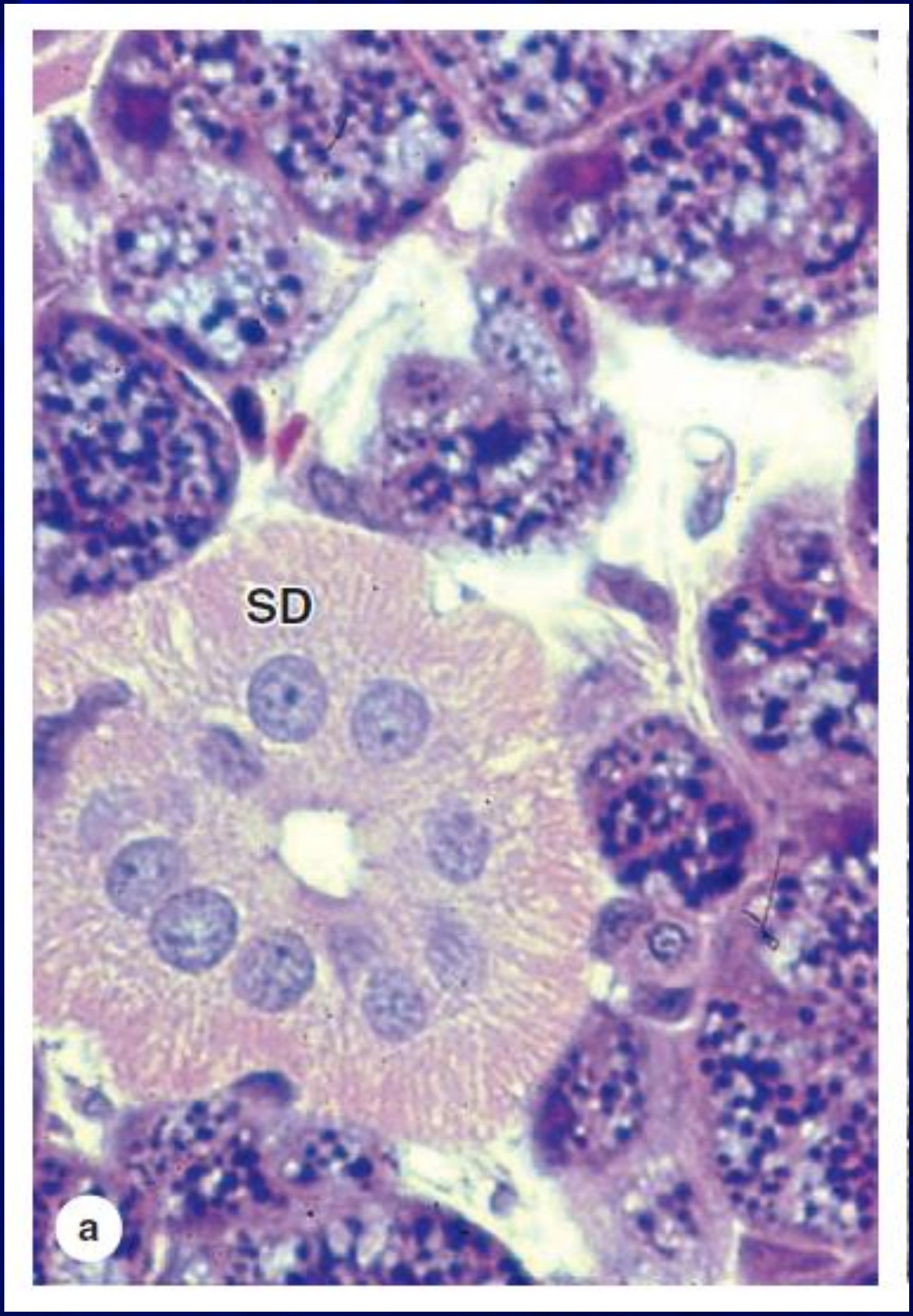
(a) The TEM shows two salivary gland cells containing secretory granules, with an associated myoepithelial cell (M). X20,000. (b) A myoepithelial cell immunostained brown with antibodies against actin shows its association with cells of an acinus stained by H&E. Contraction of the myoepithelial cell compresses the acinus and aids in the expulsion of secretory products into the duct. X200.



- These small, flattened cells extend several contractile processes around the associated secretory unit or duct and their activity is important for *moving secretory products* into and through the ducts.



- In the intralobular duct system, secretory acini and tubules empty into short **intercalated ducts,** lined by cuboidal epithelial cells, and
- several of these ducts join to form a **striated duct.**

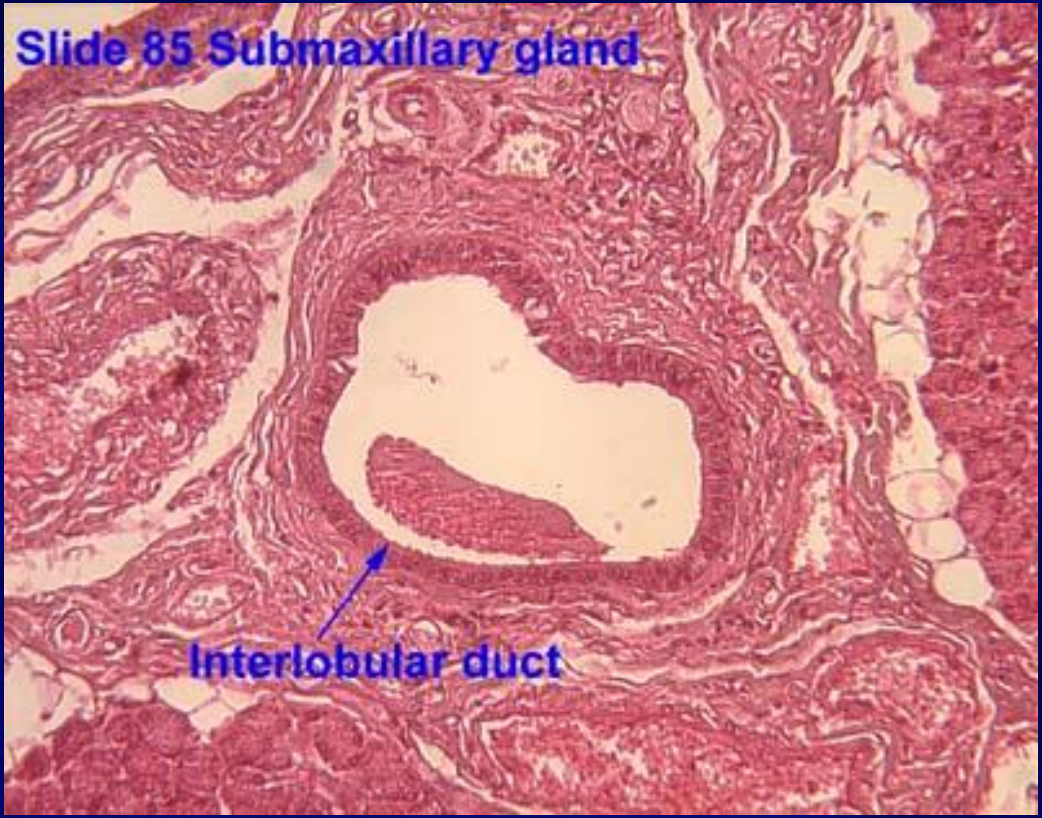


- The more columnar **striated duct cells** have many infoldings of their basolateral membrane, all aligned with numerous mitochondria.

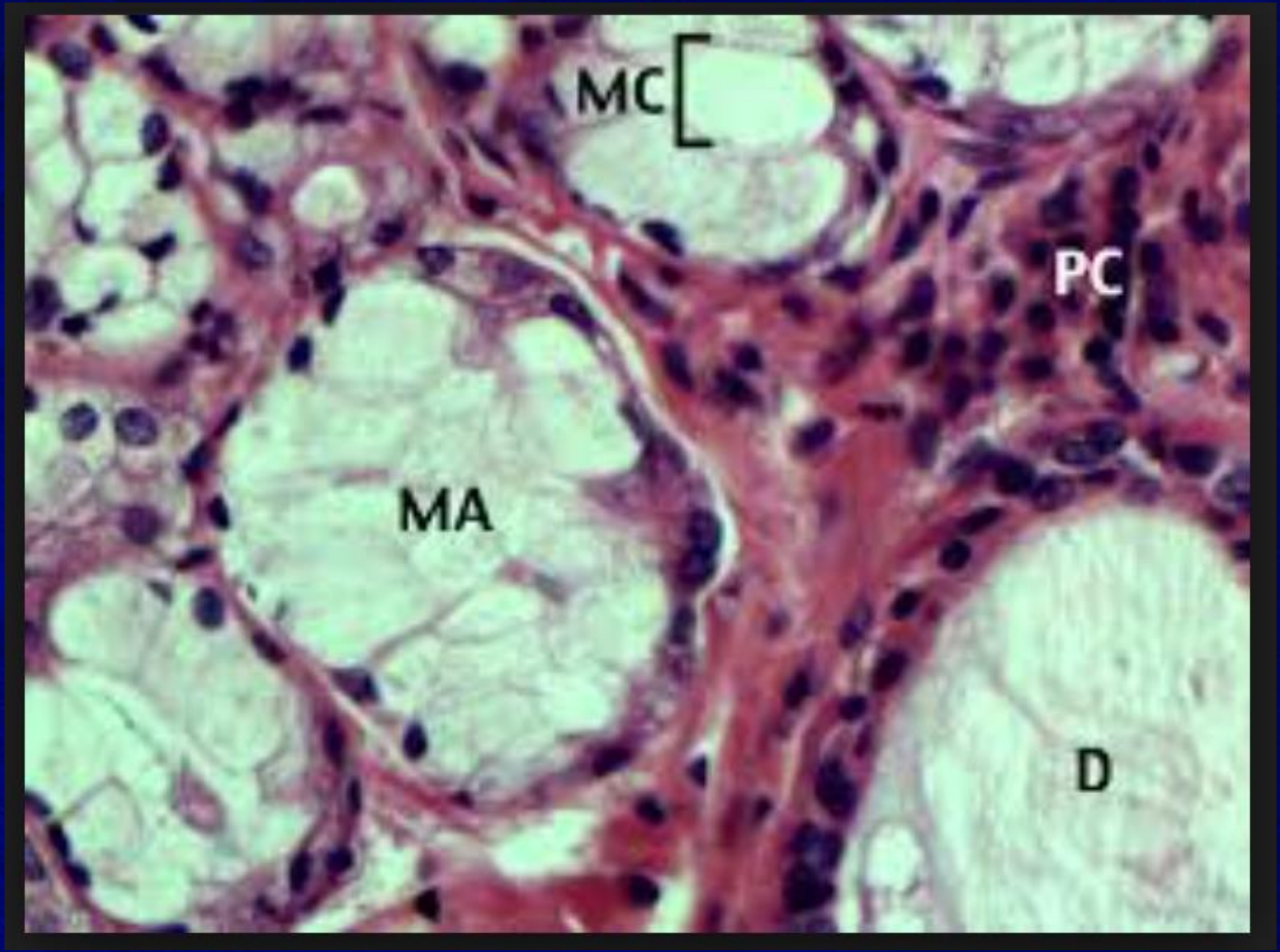
(a) A striated duct (SD) shows very faint striations in the basal half of the columnar cells, which represent mitochondria located in the folds of the lateral cell membrane. X200. H&E.

Ducts from each lobule converge and drain into **interlobular excretory ducts** with increasing size and thicker connective tissue layers.

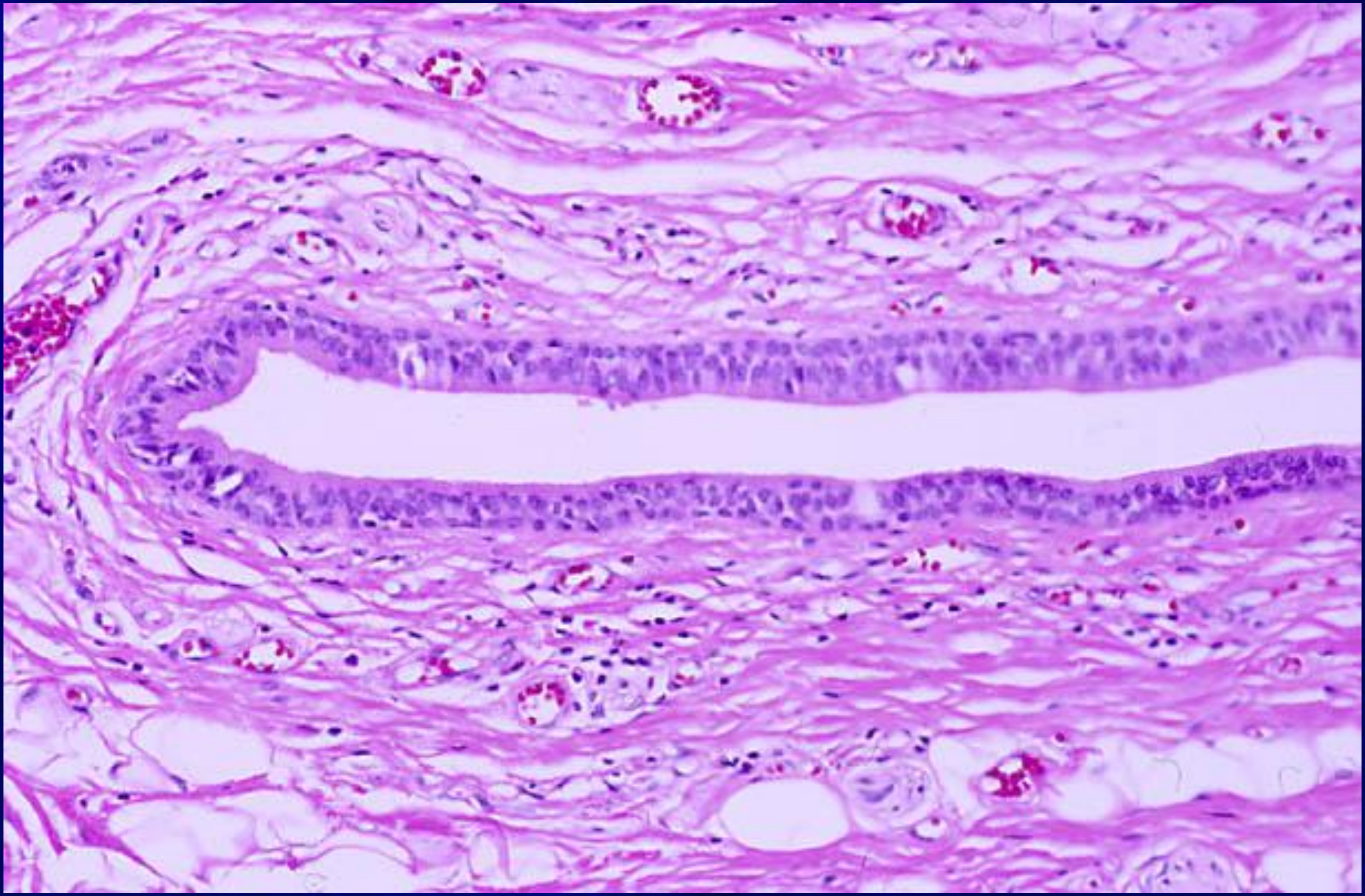
The lining of these ducts is unusual, combining various epithelial types, including simple cuboidal or columnar, stratified cuboidal or columnar, and pseudostratified epithelia, distributed in no apparent pattern.



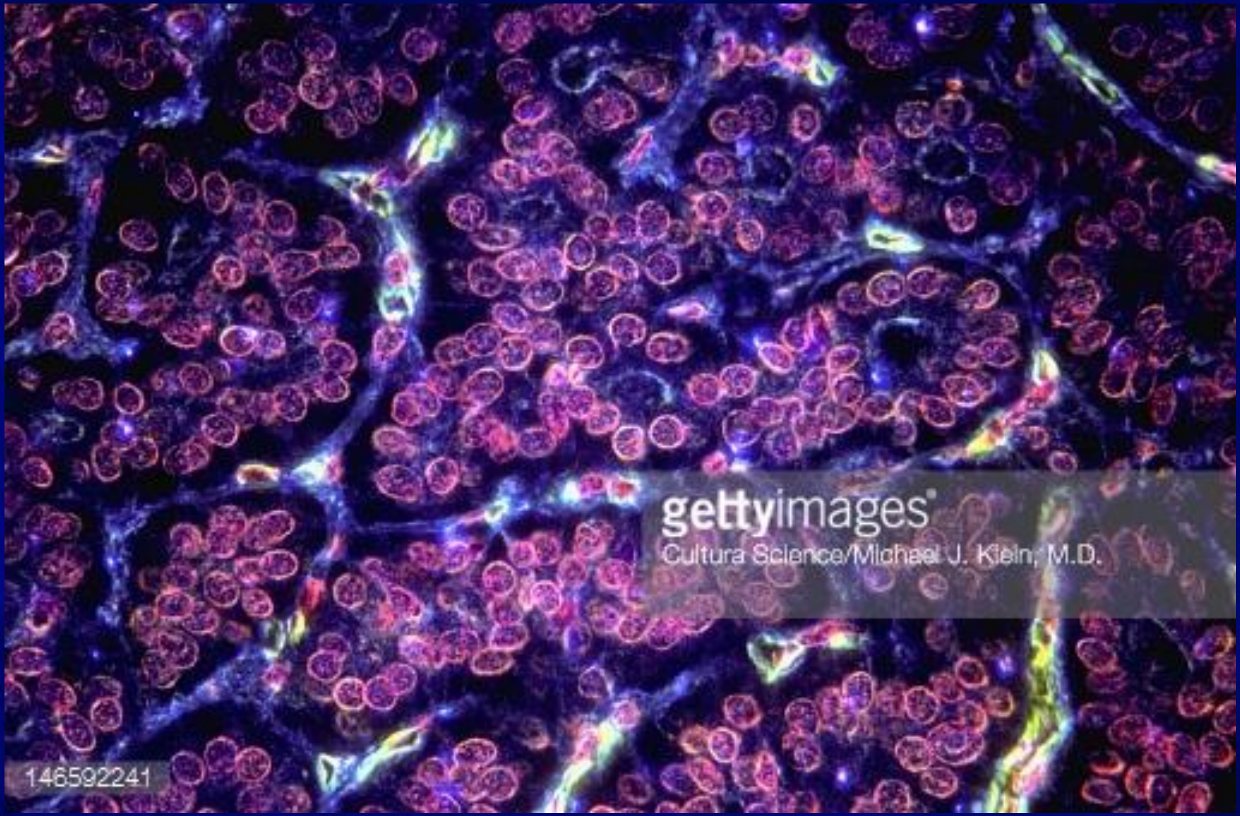
- These atypical epithelia may reflect their composition of **cells with many diverse functions,** including:
- ✓ cells for ion reabsorption,
- ✓ cells for secretion of mucin and other proteins,
- ✓ enteroendocrine cells
- ✓ basal stem cells,
- all in highly branched ducts of small diameter.



- **Plasma cells (PC)** in the connective tissue surrounding the small **intralobular ducts (D) release IgA,** which forms a complex with the secretory component synthesized by the epithelial cells of the serous acini and intralobular ducts.
- *Transferred into the saliva, the IgA complex released into the saliva provides defense against specific pathogens in the oral cavity.*



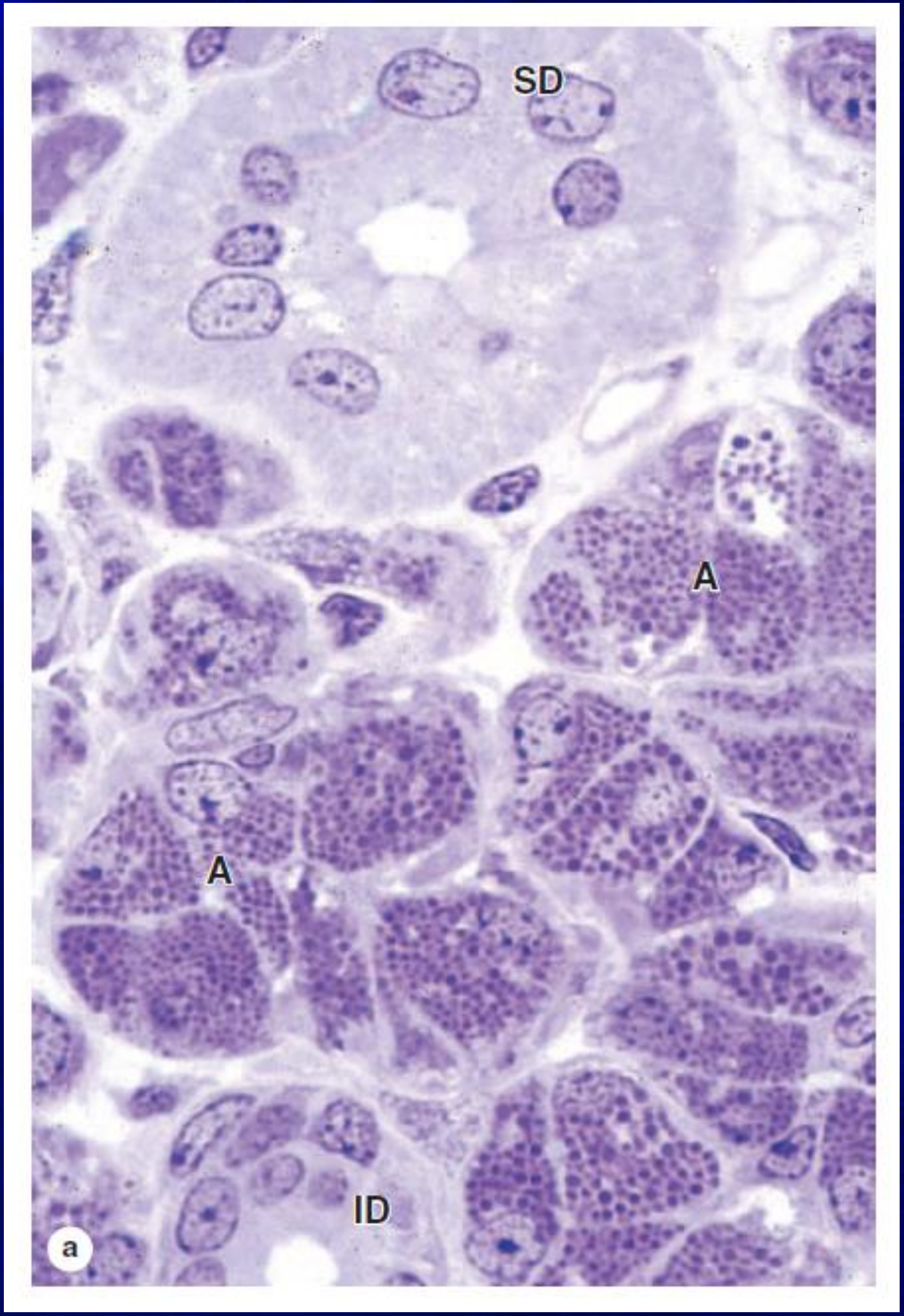
- Before emptying into the oral cavity, the **main duct** of each gland is lined with **nonkeratinized stratified squamous epithelium.**



Salivary gland parenchyma in human parotid gland. The pink ovoids represent nuclei of acinar cells and the branched yellow structures are capillaries. Darkfield 400x, hematoxylin-eosin

- Vessels and nerves enter the large salivary glands at a hilum and gradually branch into the lobules.
- *A rich vascular and nerve plexus surrounds the secretory and duct components of each lobule.*
- The capillaries surrounding the secretory units provide fluid important for saliva production, which is stimulated by the autonomic nervous system.

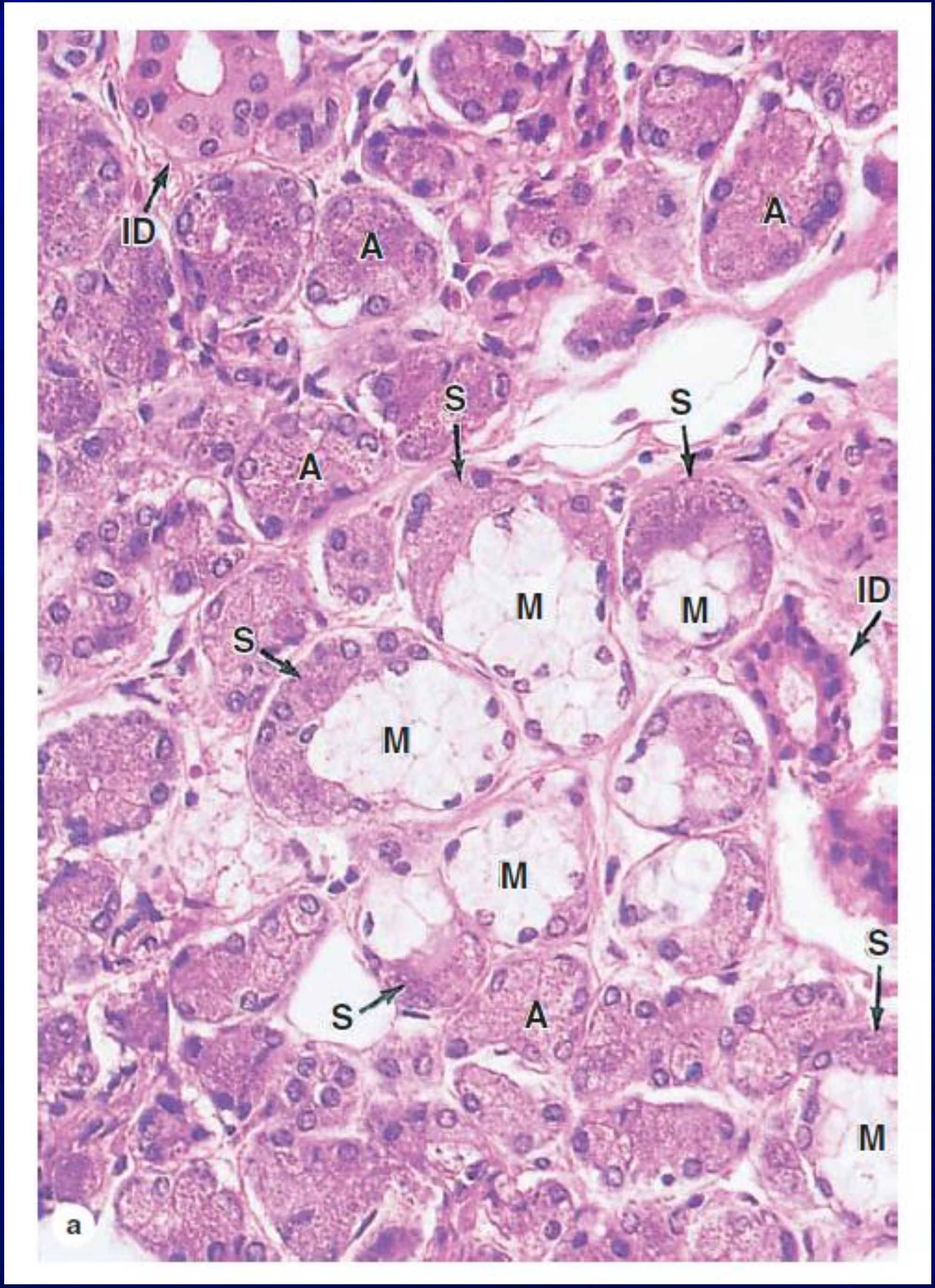
Parotid Glands



- Features specific to each group of major salivary glands include the following:
- **Parotid glands,** located in each cheek near the ear, are **branched acinar glands** with *exclusively serous acini.*
- **Serous cells of parotid glands secrete abundant α-amylase** that initiates hydrolysis of carbohydrates and **proline-rich proteins** with antimicrobial and other protective properties.

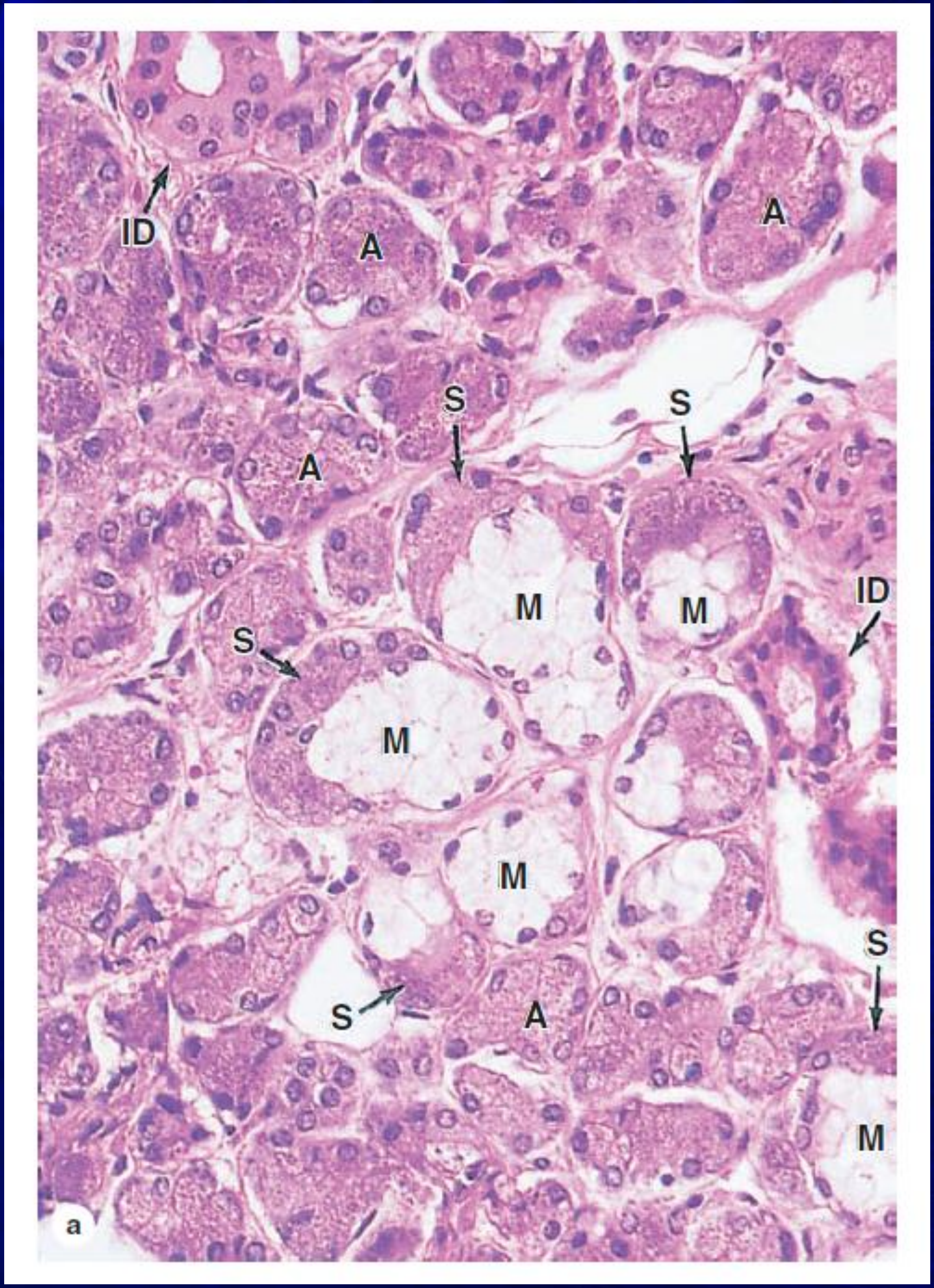
(a) Micrograph of a parotid gland shows densely packed serous acini (A) with ducts. Secretory granules of serous cells are clearly shown in this plastic section, as well as an intercalated duct (ID) and striated duct (SD), both cut transversely. X400. PT.

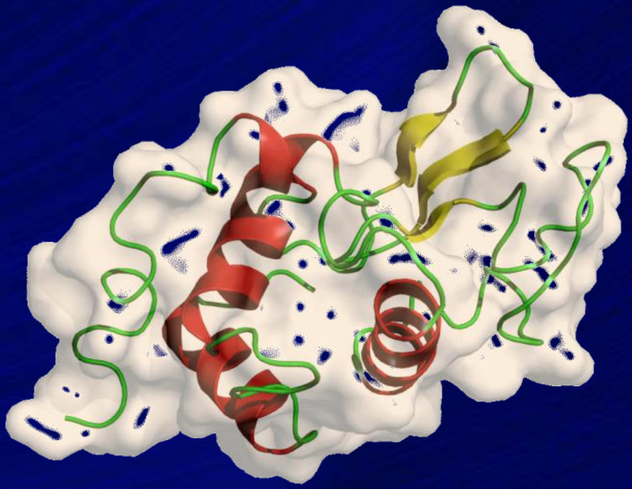
Submandibular Glands



Submandibular glands, which produce two-thirds of all saliva, are **bran-ched tubuloacinar glands,** *having primarily serous acini,* **but with many mixed tubulo-acinar secretory units.**

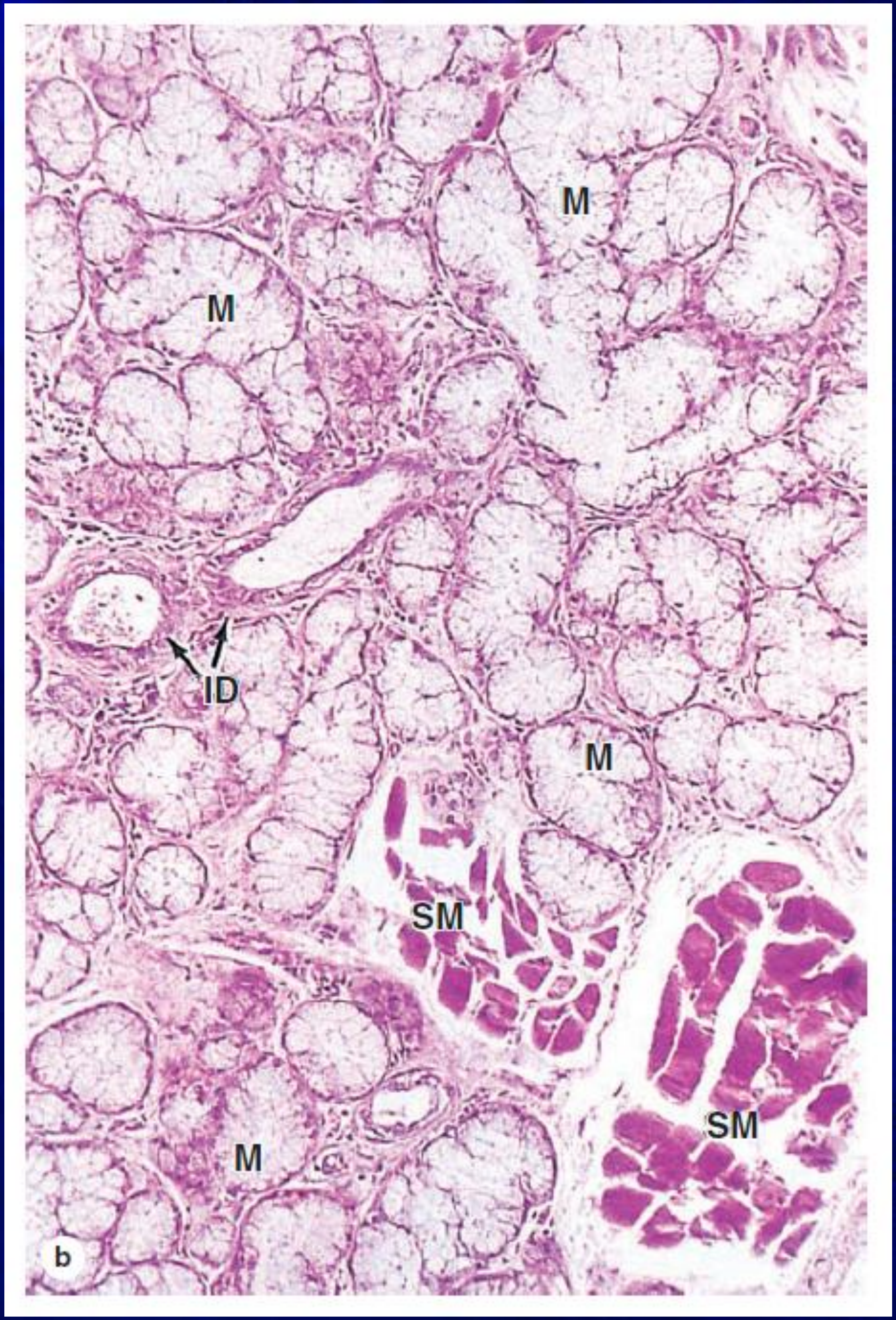
(a) The submandibular gland is a mixed serous and mucous gland (serous cells predo-minate), and shows well-stained serous acini (A) and serous demilunes (S) and pale-staining mucous cells (M) grouped as tubules in this tubuloacinar gland. Small intralobular ducts (ID) drain each lobule. X340. H&E.





In addition to α-amylase and proline-rich proteins, serous cells of the submandibular gland secrete other enzymes, including **lysozyme** for bacterial wall hydrolysis.

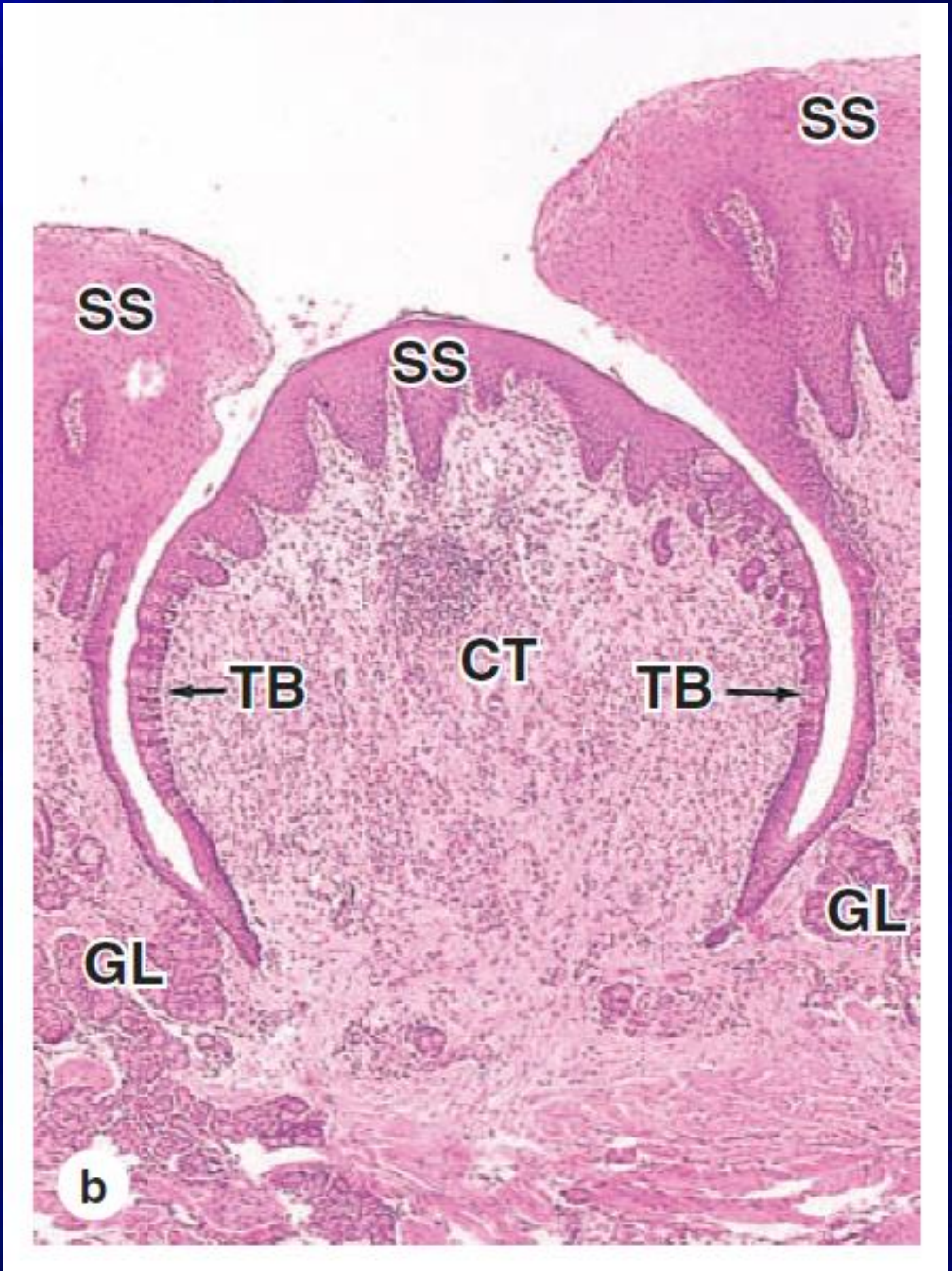
Sublingual Glands



- **Sublingual glands,** the smallest of the major glands, are also considered branched tubuloacinar glands, but here **secretory tubules of mucous cells predominate** and **the main product of the gland is mucus.**
- The few serous cells present add amylase and lysozyme to the secretion.

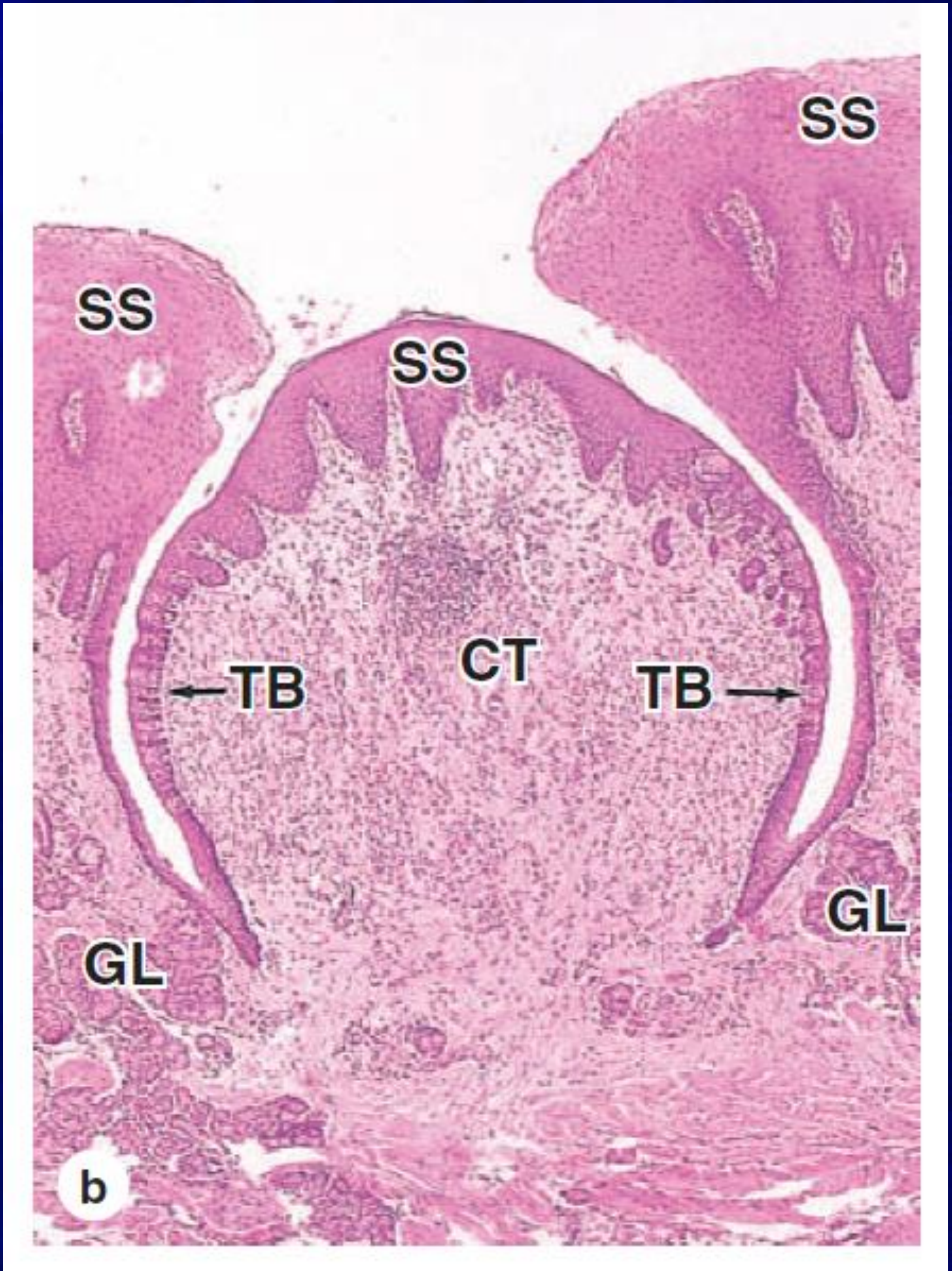
(b) The sublingual gland is a mixed but largely mucous gland with a tubuloacinar arrangement of poorly stained mucous cells (M). Small intralobular ducts (ID) are seen in connective tissue, as well as small fascicles of lingual striated muscle (SM). X140. H&E.

Nonencapsulated Salivary Glands



Small, nonencapsulated salivary glands are distributed throughout the oral mucosa and submucosa with short ducts to the oral cavity.

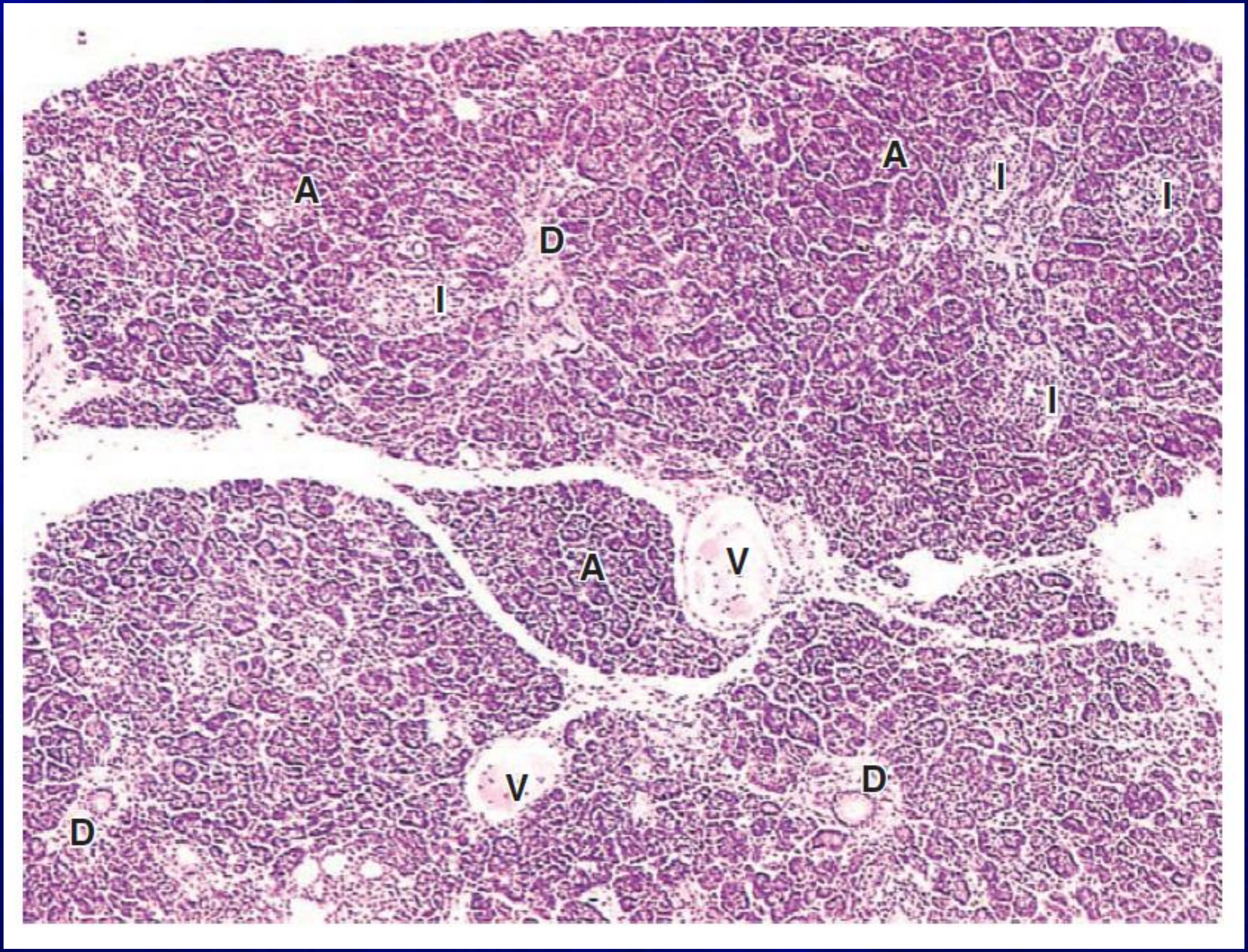
(b) Micrograph shows a single very large vallate papilla with two distinctive features: many taste buds (TB) around the sides and several small salivary glands (GL) emptying into the cleft or moat formed by the elevated mucosa surrounding the papilla. These glands continuously flush the cleft, renewing the fluid in contact with the taste buds. Both X20. H&E.



- These minor salivary glands are usually *mucous,* **except for the small serous glands at the bases of circumvallate papillae.**

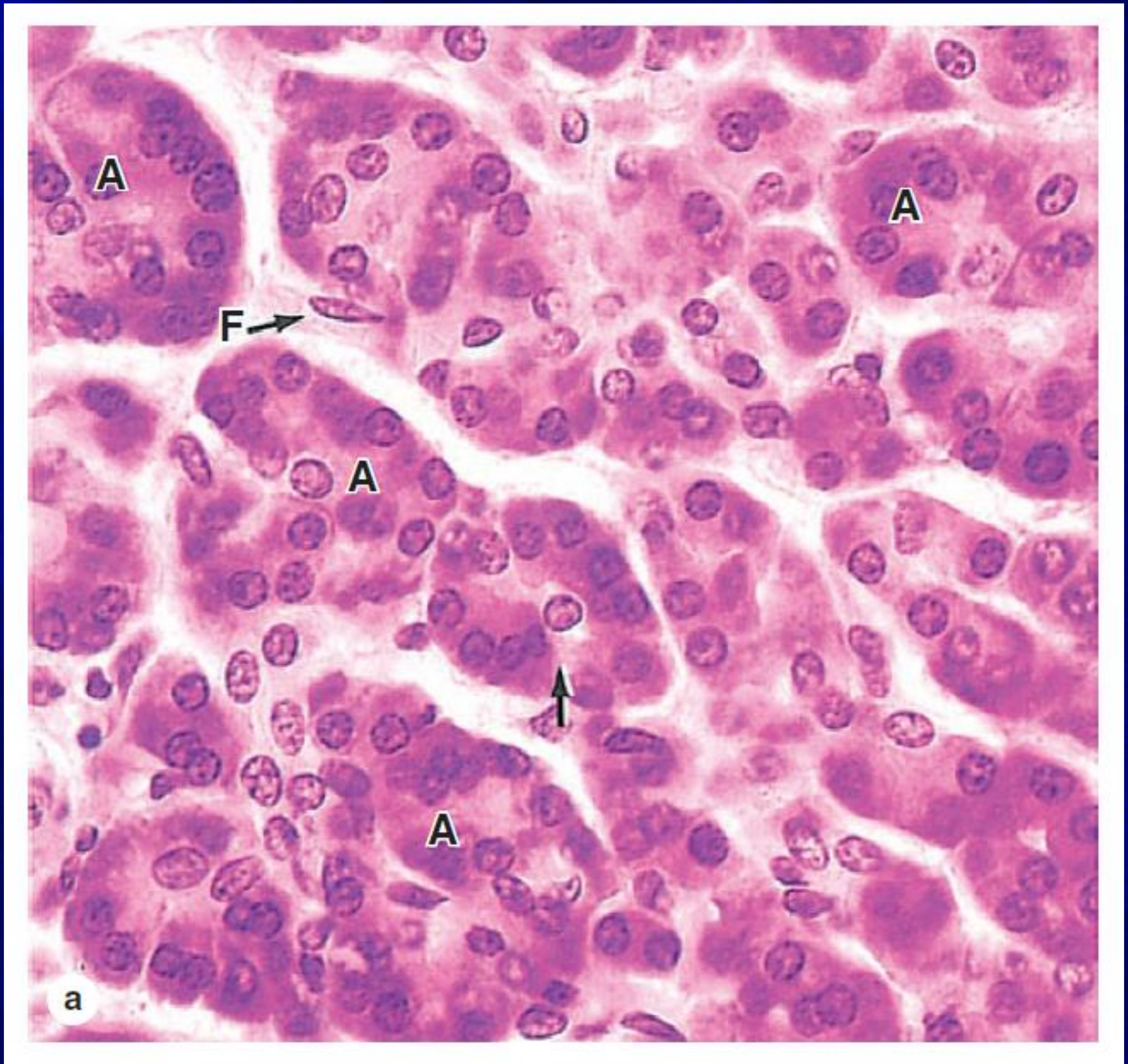
- Plasma cells releasing IgA are also common within the minor salivary glands

Pancreas



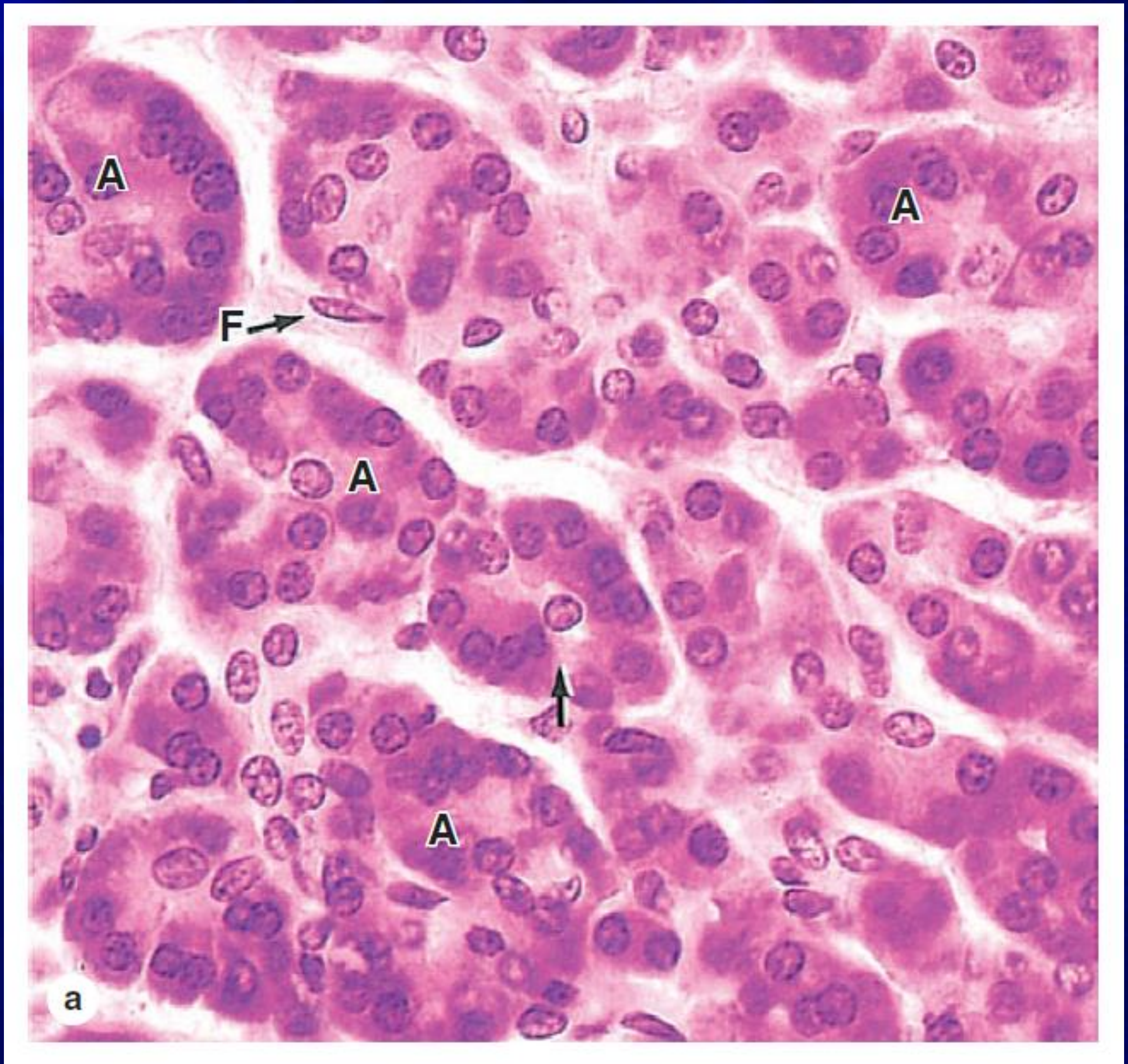
Low-power view of pancreas includes several islets (I) surrounded by many serous acini (A). The larger intralobular ducts (D) are lined by simple columnar epithelium. The ducts and blood vessels (V) are located in connective tissue, which also provides a thin capsule to the entire gland and thin septa separating the lobules of secretory acini. X20. H&E.

The **pancreas** has a **thin capsule of connective tissue,** from which **septa** extend to cover the larger vessels and ducts and to separate the parenchyma into **lobules.**



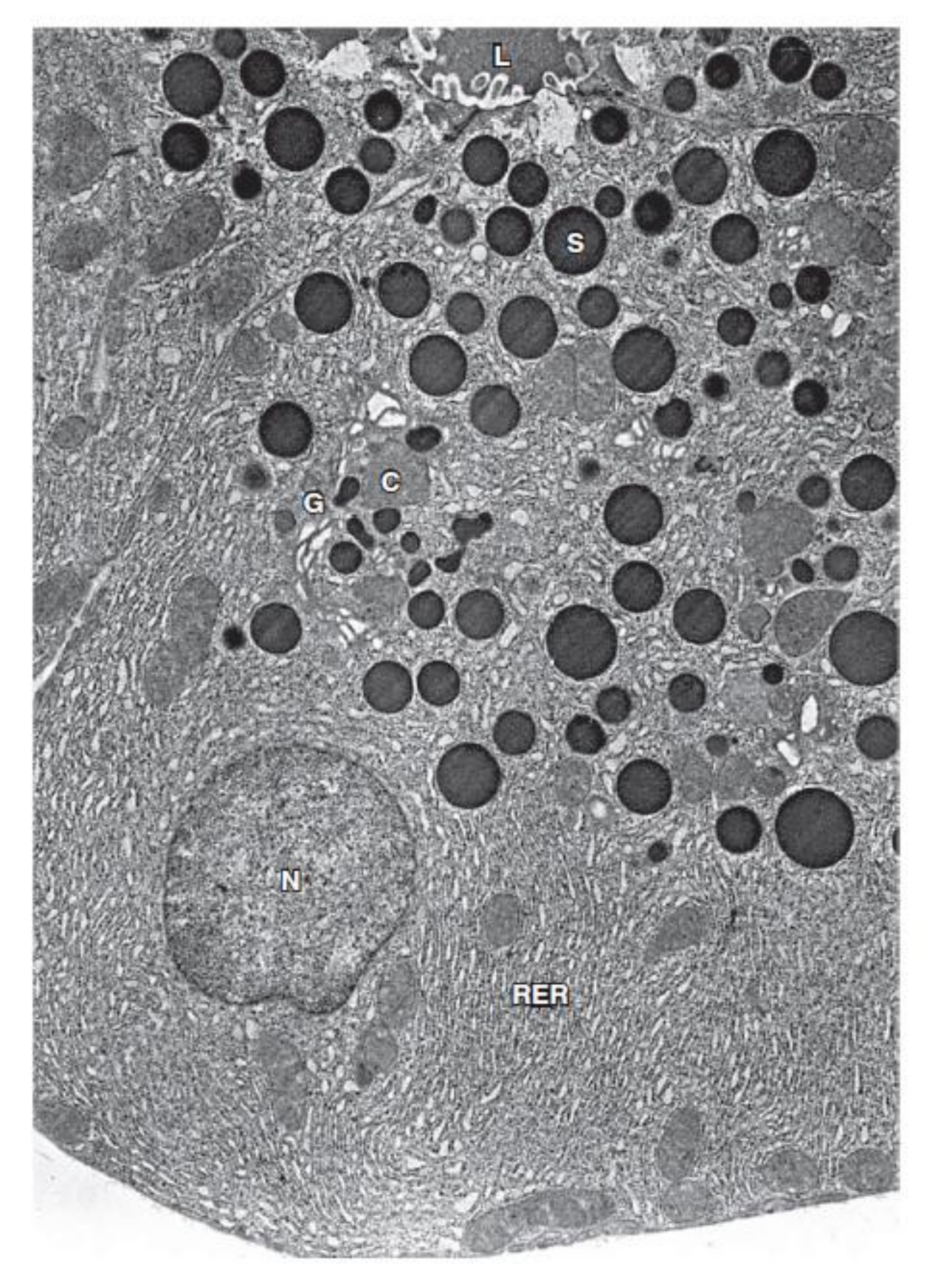
The **secretory acini** are surrounded by a basal lamina that is supported only by a delicate sheath of reticular fibers with a rich capillary network.

(a) Micrograph of exocrine pancreas shows the serous, enzyme-producing cells arranged in small acini (A) with very small lumens. Acini are surrounded by only small amounts of connective tissue with fibroblasts (F). Each acinus is drained by an intercalated duct with its initial cells, the centroacinar cells (arrow), inserted into the acinar lumen. X200. H&E.



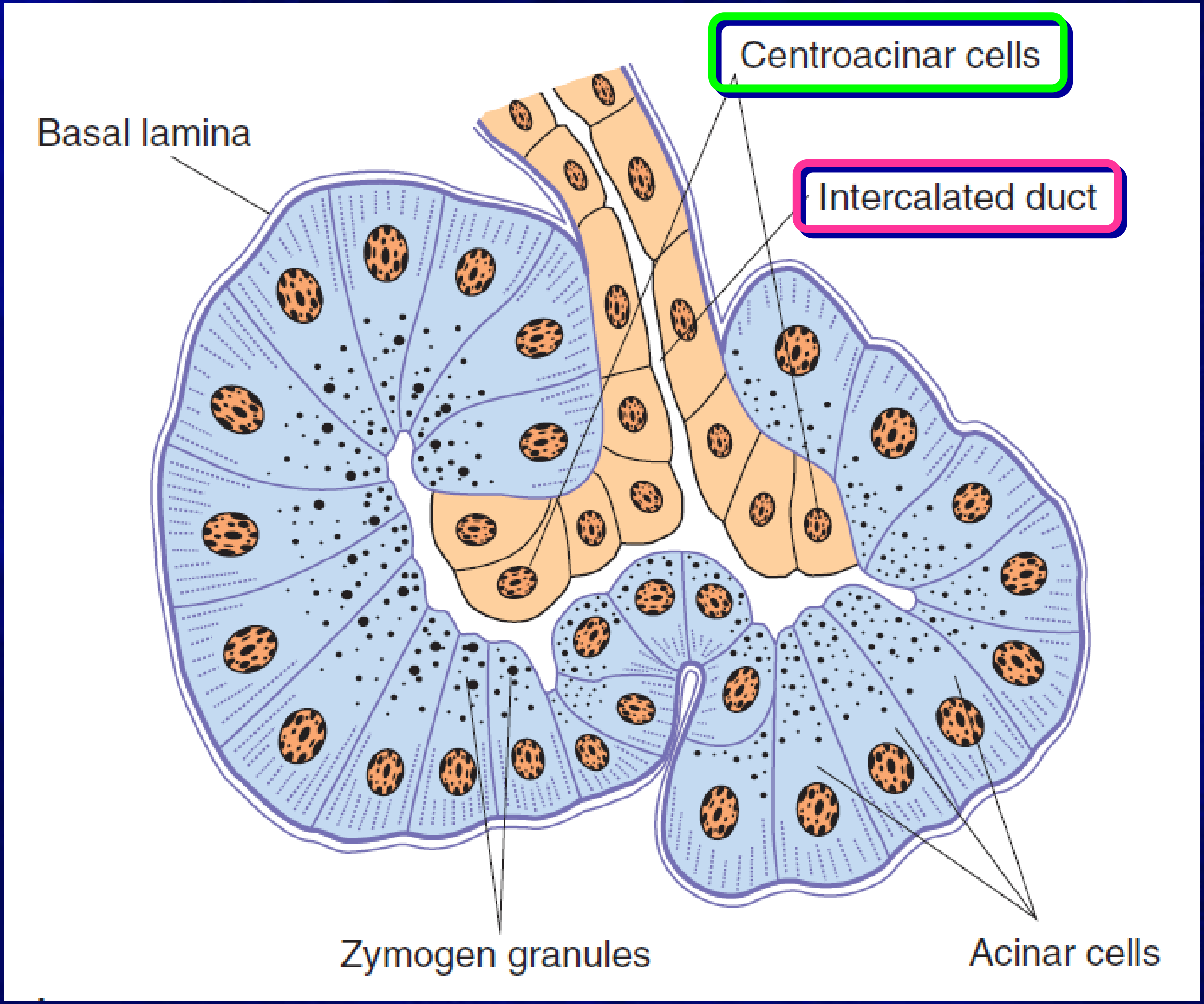
- The **digestive enzymes** are produced by cells of <u>serous acini</u> in the larger exocrine portion of the pancreas.
- Each **pancreatic acinus** consists of several serous cells surrounding a very small lumen, *without myoepithelial cells.*

(a) Micrograph of exocrine pancreas shows the serous, enzyme-producing cells arranged in small acini (A) with very small lumens. Acini are surrounded by only small amounts of connective tissue with fibroblasts (F). Each acinus is drained by an intercalated duct with its initial cells, the centroacinar cells (arrow), inserted into the acinar lumen. X200. H&E.



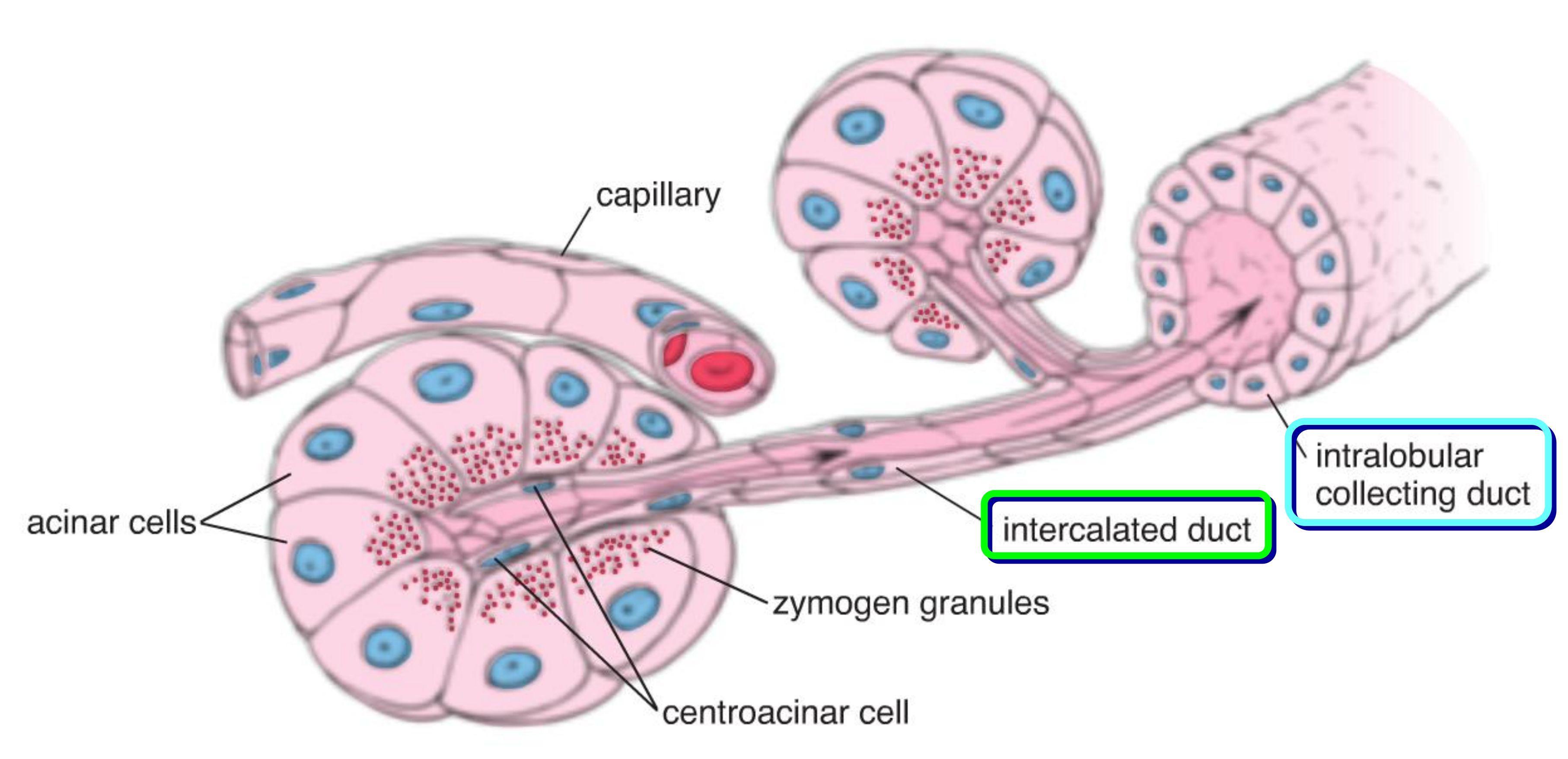
The **acinar cells** are <u>polarized</u>, with round basal nuclei, and numerous zymogen granules apically, typical of *protein-secreting cells.*

TEM of a pancreatic acinar cell shows its pyramidal shape and the round, basal nucleus (N) surrounded by cytoplasm packed with cisternae of rough ER (RER). The Golgi apparatus (G) is situated at the apical side of the nucleus and is associated with condensing vacuoles (C) and numerous secretory granules (S) with zymogen. The small lumen (L) of the acinus contains proteins recently released from the cell by exocytosis. Exocytosis of digestive enzymes from secretory granules is promoted by CCK, released by enteroendocrine cells of the duodenum when food enters that region from the stomach. X8000.



- Each acinus is drained by a short **intercalated duct** of simple squamous epithelium.
- *The initial cells of these small ducts extend into the lumen of the acinus* as small **centro-acinar cells** that are unique to the pancreas.

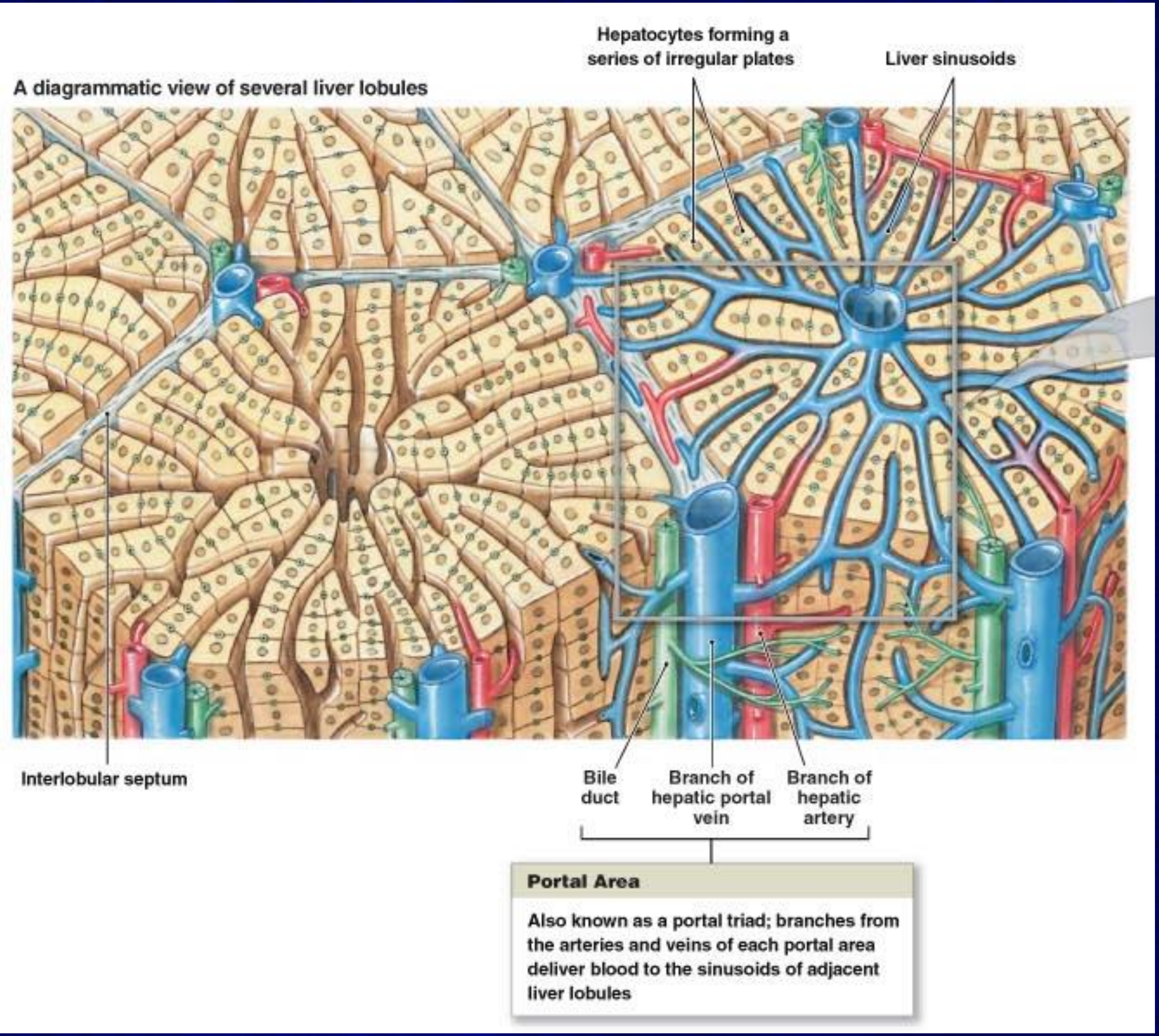
Cells of the intercalated ducts secrete a large volume of fluid, rich in HCO_3^- (bicarbonate ions), which alkalinizes and transports hydrolytic enzymes produced in the acini.



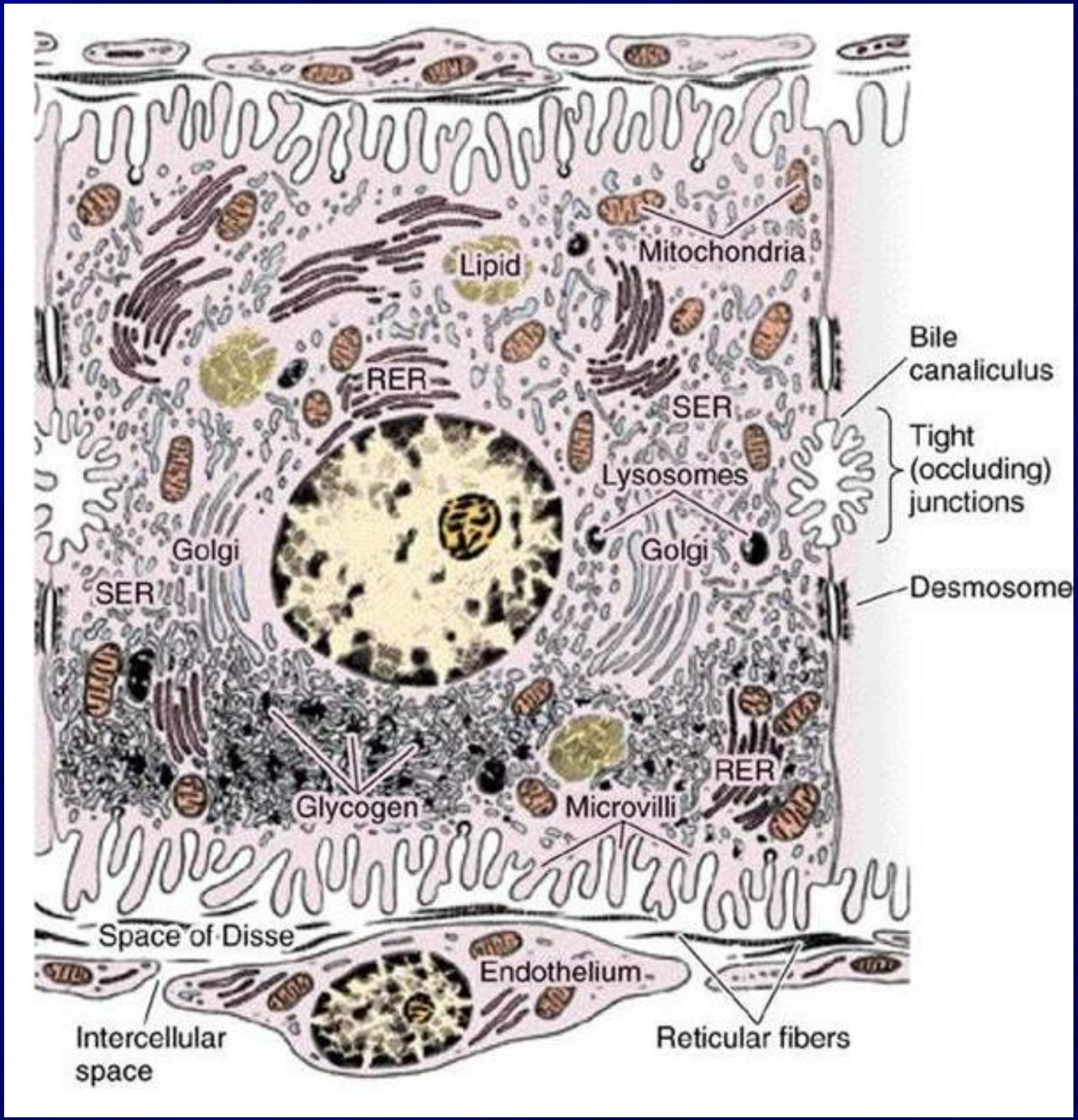
The **intercalated ducts** merge with **intralobular ducts** and larger **interlobular ducts,** which have increasingly columnar epithelia before joining the main pancreatic duct that runs the length of the gland.

LIVER

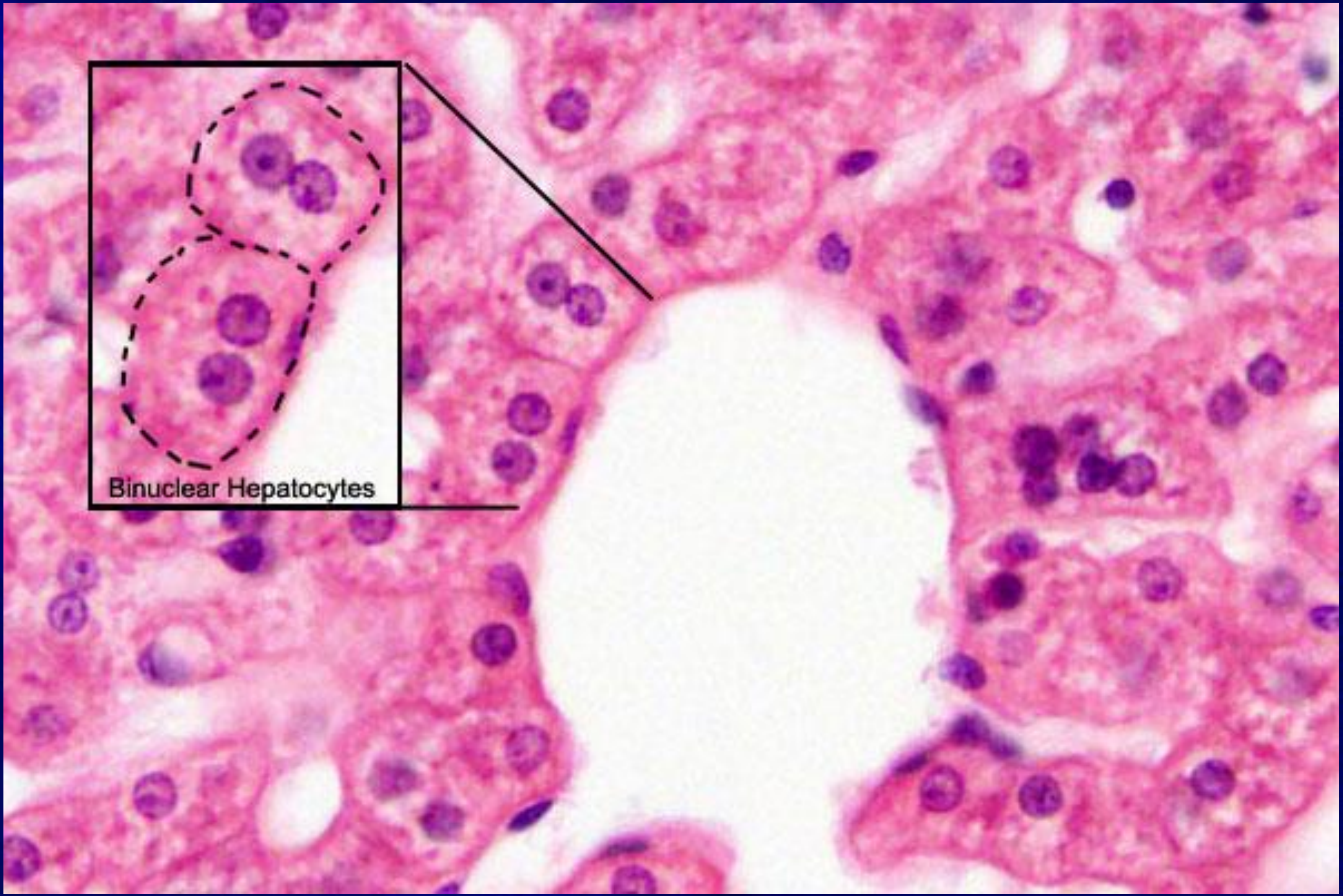
Hepatocytes & Hepatic Lobules



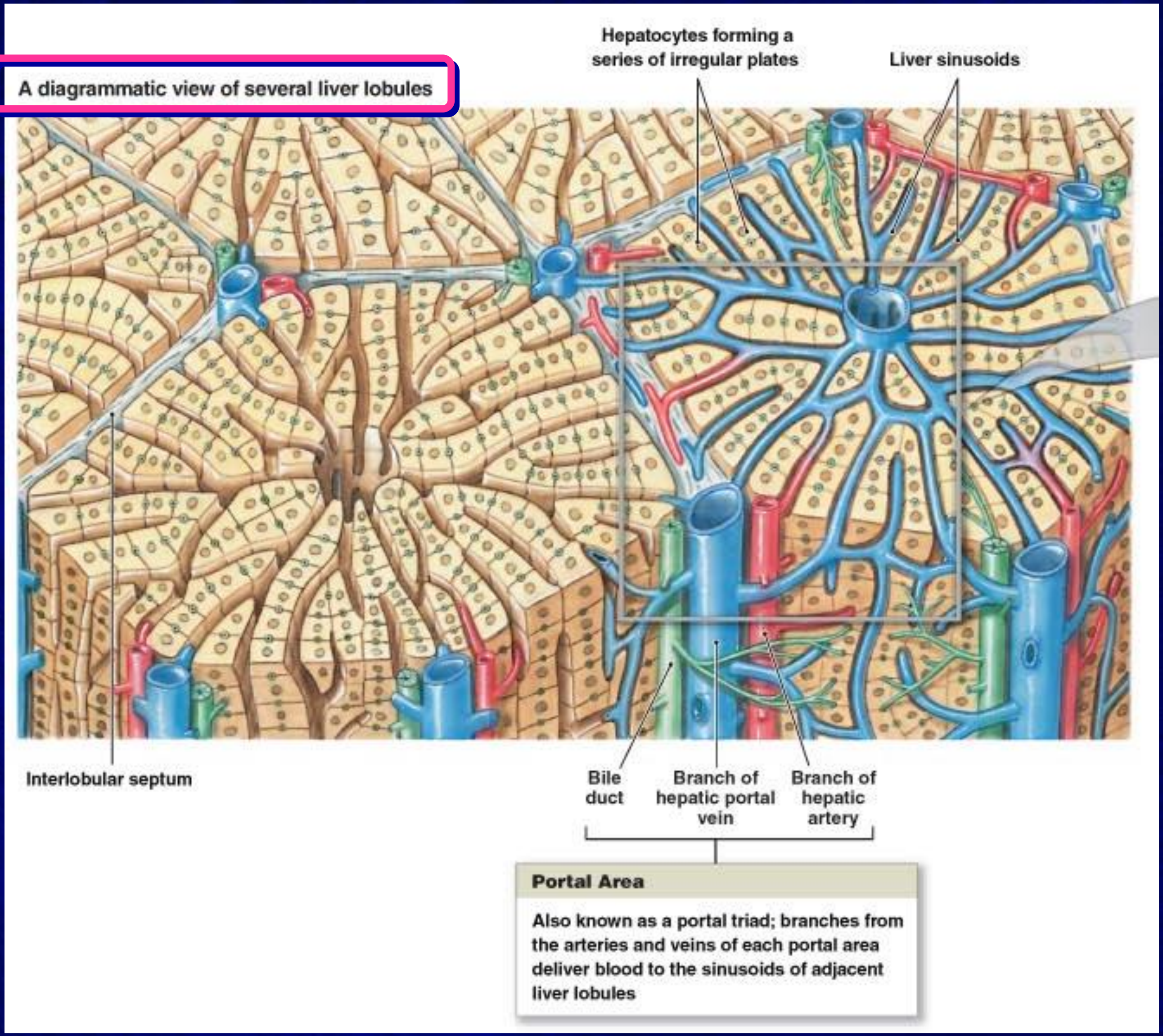
The liver's *unique histologic organization* and microvasculature allow hepatocytes to perform their diverse metabolic, exocrine, and endocrine functions.



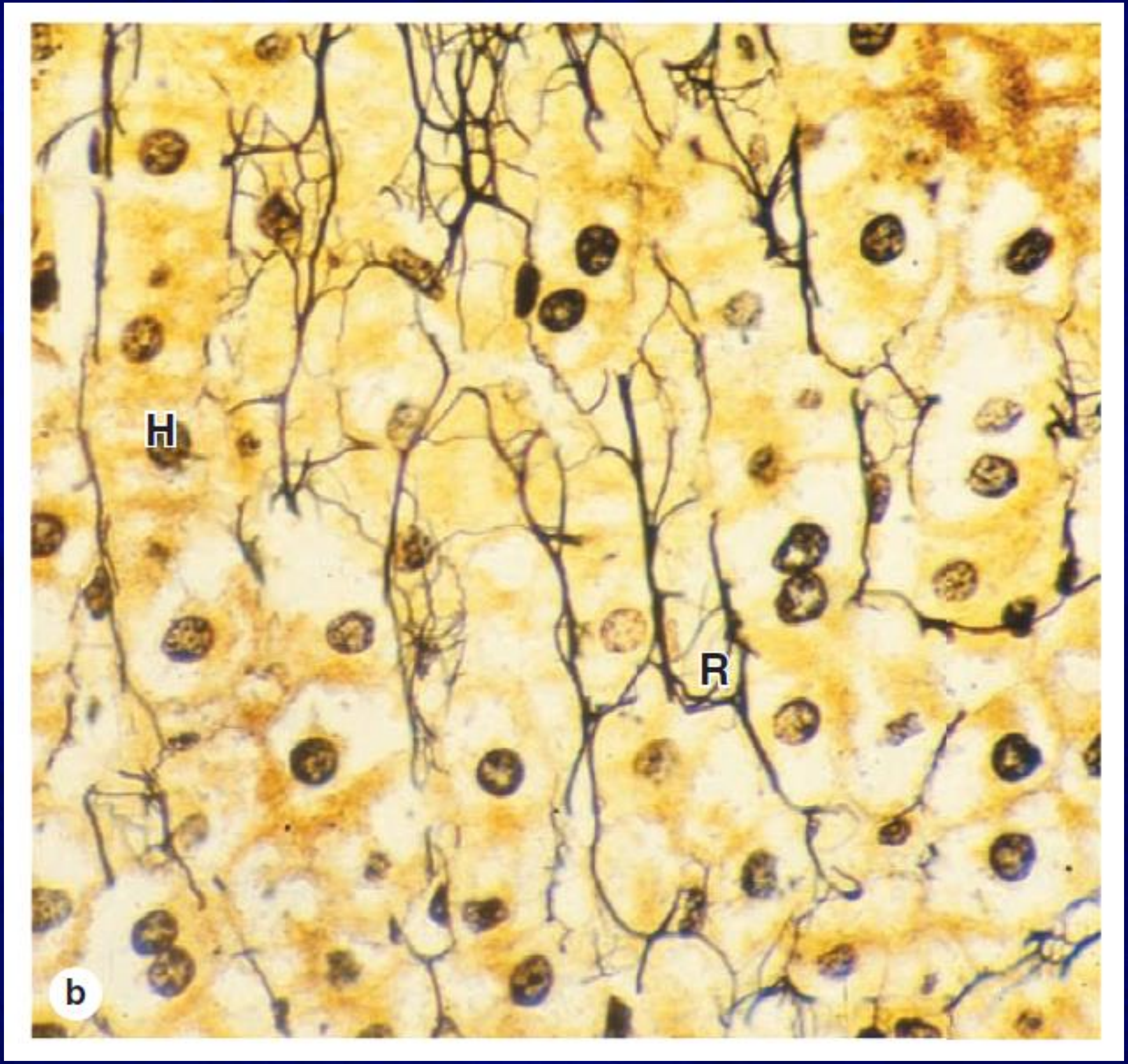
Hepatocytes are large cuboidal or polyhedral epithelial cells, with large, round central nuclei and cytoplasm rich in mitochondria.



The cells are **frequently binucleated** and *about 50% of them are polyploid,* with two to eight times the normal chromosome number.

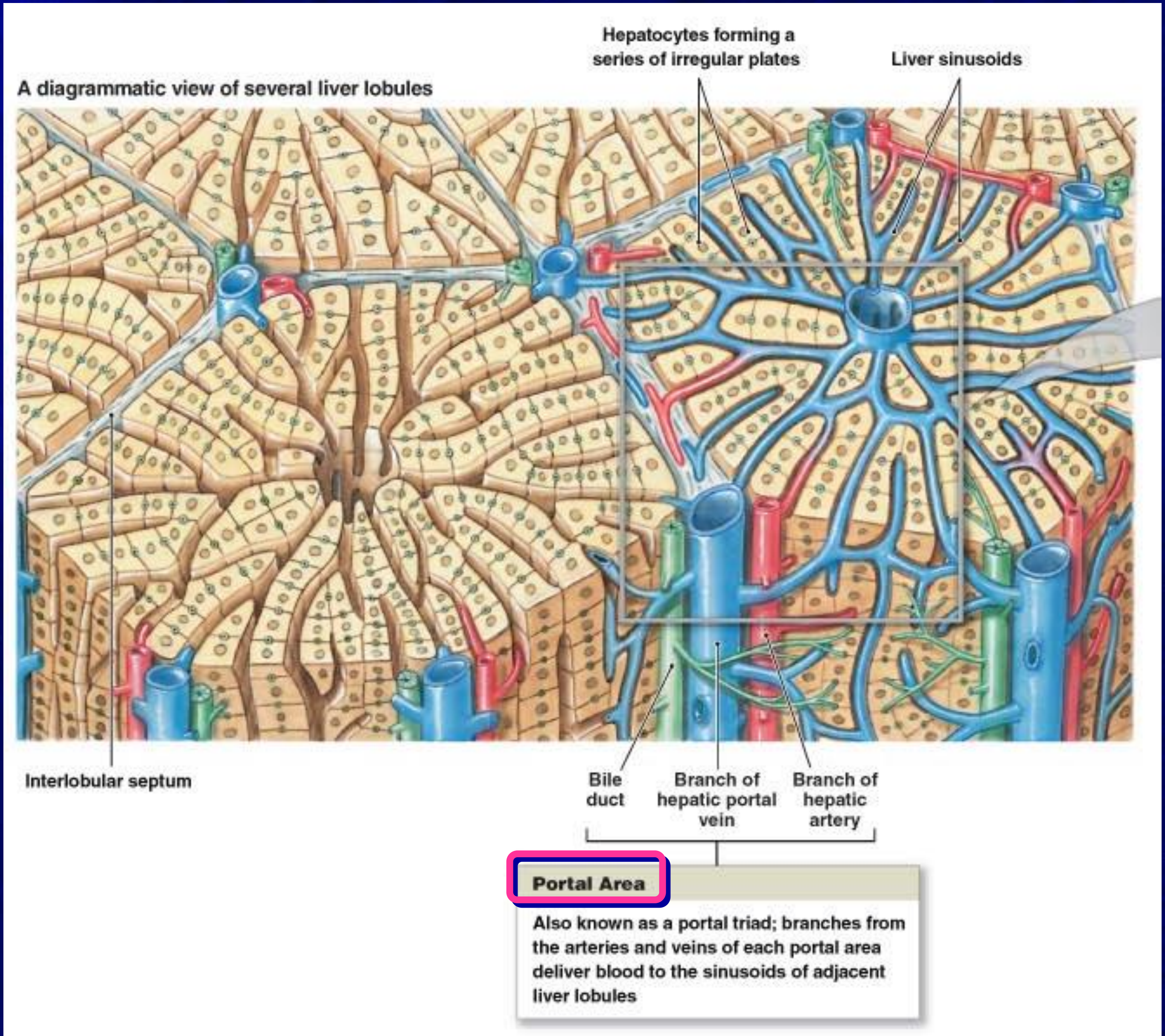


The liver parenchyma is organized as thousands of small (~0.7 × 2 mm) **hepatic lobules** in which hepatocytes form hundreds of irregular plates *arranged radially around a small central vein.*

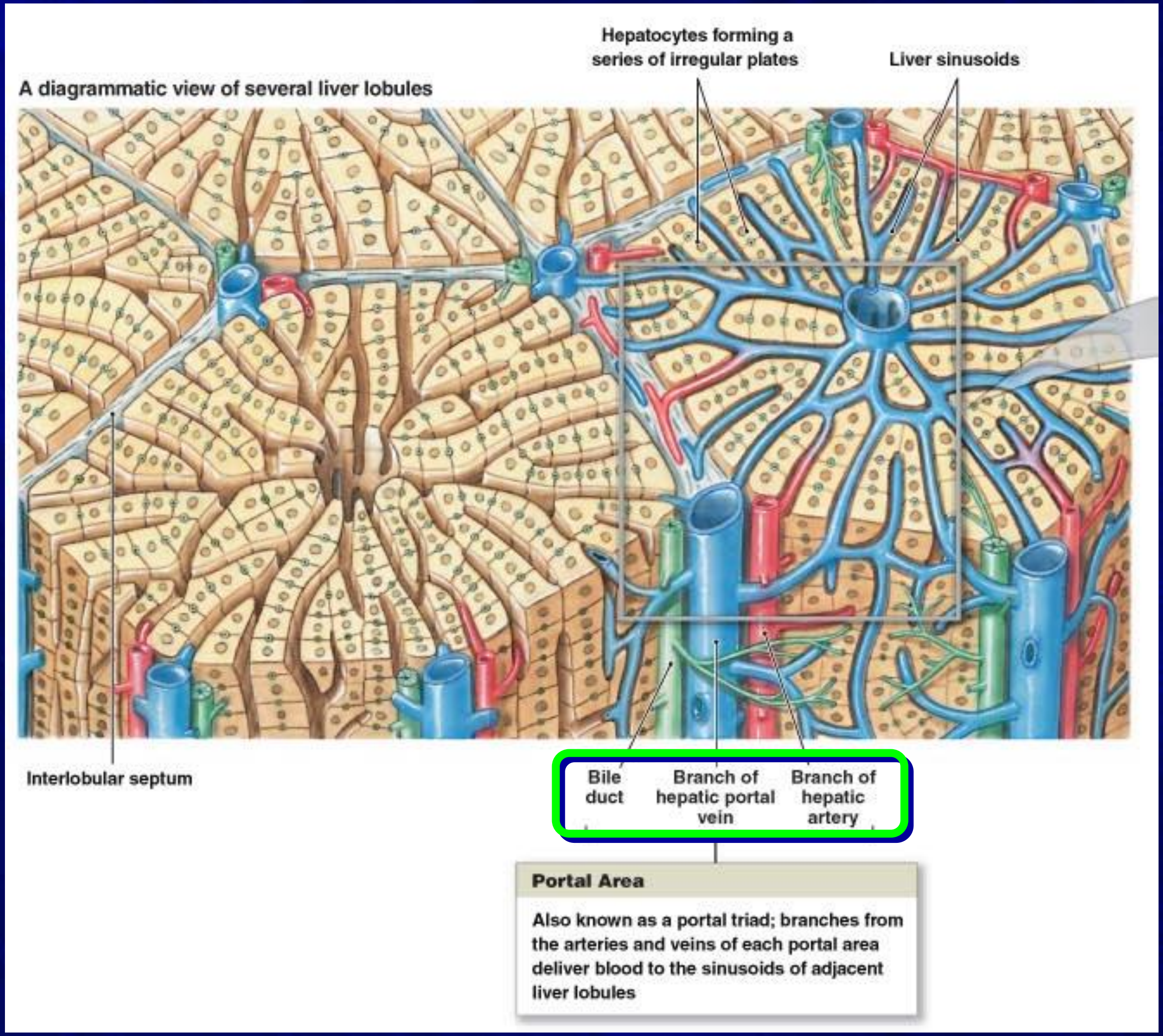


(b) ***Reticulin (collagen type III) fibers (R)*** ***running along the plates of hepatocytes (H), supporting these and the intervening sinusoids. Most connective tissue in the liver is found in the septa and portal tracts. X400. Silver.***

The hepatocyte plates are supported by a **delicate stroma of reticulin fibers.**



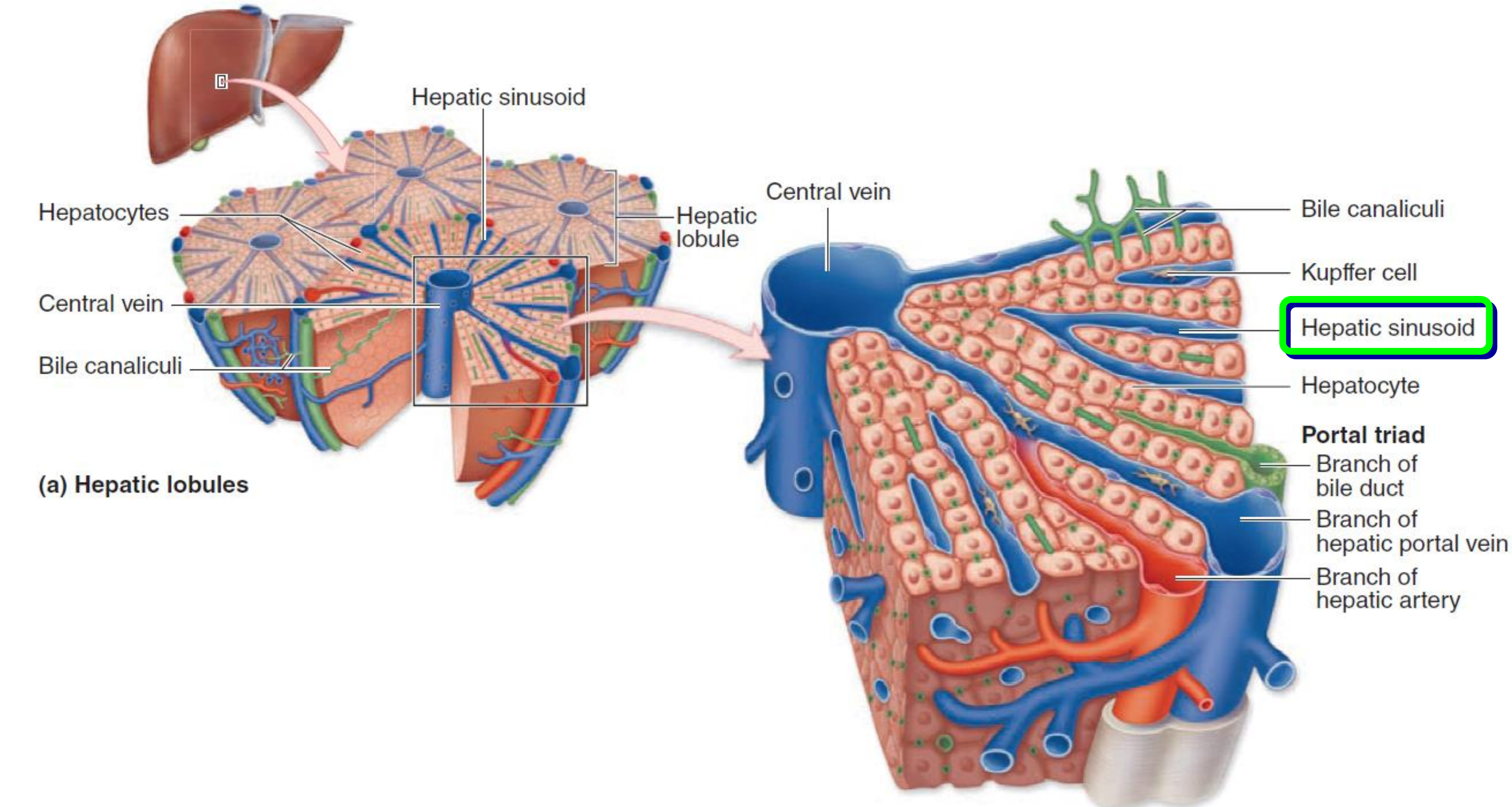
Peripherally each lobule has three to six **portal areas** with more fibrous connective tissue, each of which contains three interlobular structures that comprise the **portal triad**



The portal triad:

1. A **venule branch** of the portal vein, with blood rich in nutrients but low in O_2,
2. An **arteriole branch** of the hepatic artery that supplies O_2,
3. One or two small **bile ductules** of cuboidal epithelium, branches of the bile conducting system.

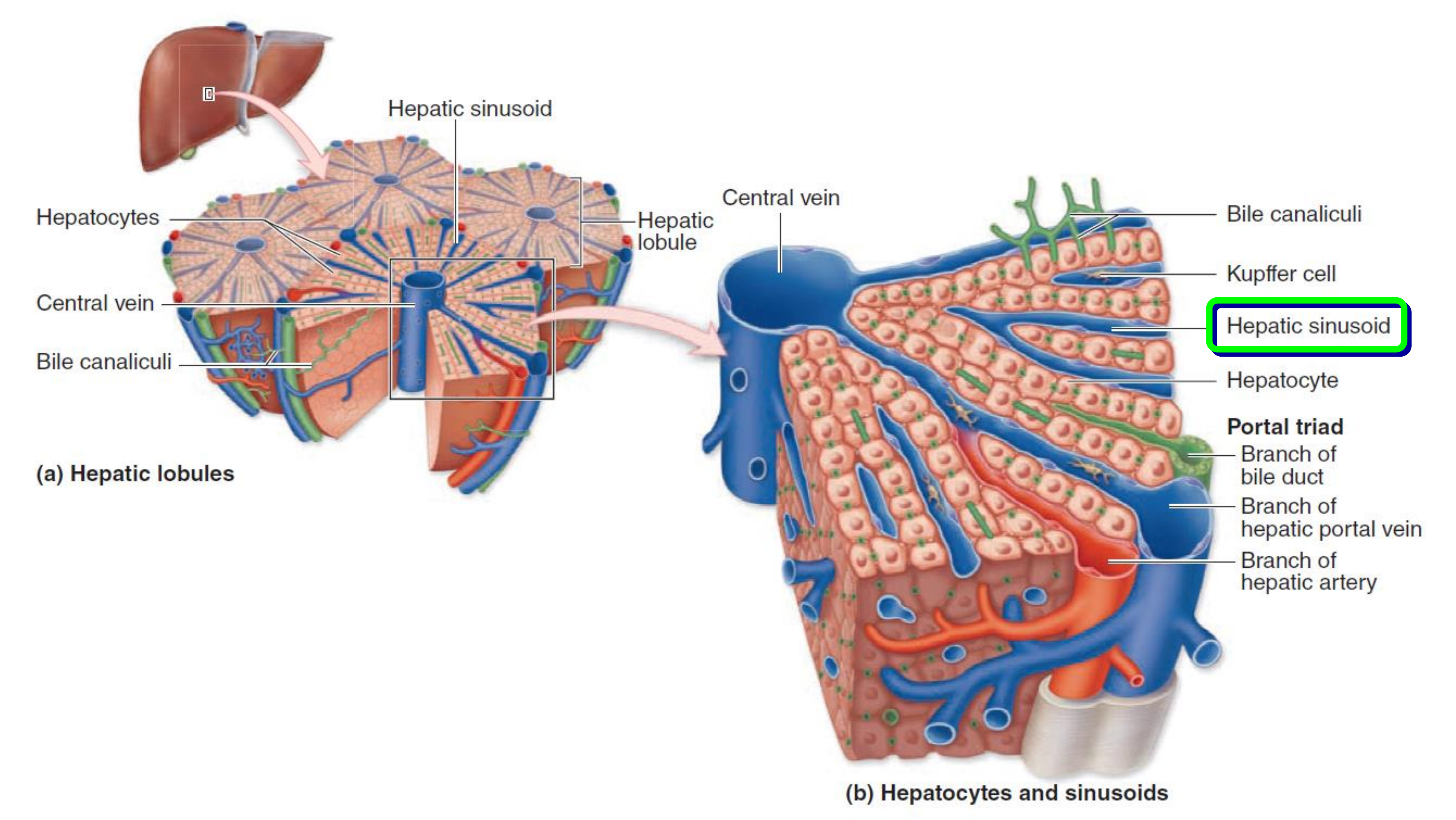
- Most of the peripheral portal areas also contain lymphatics and nerve fibers.



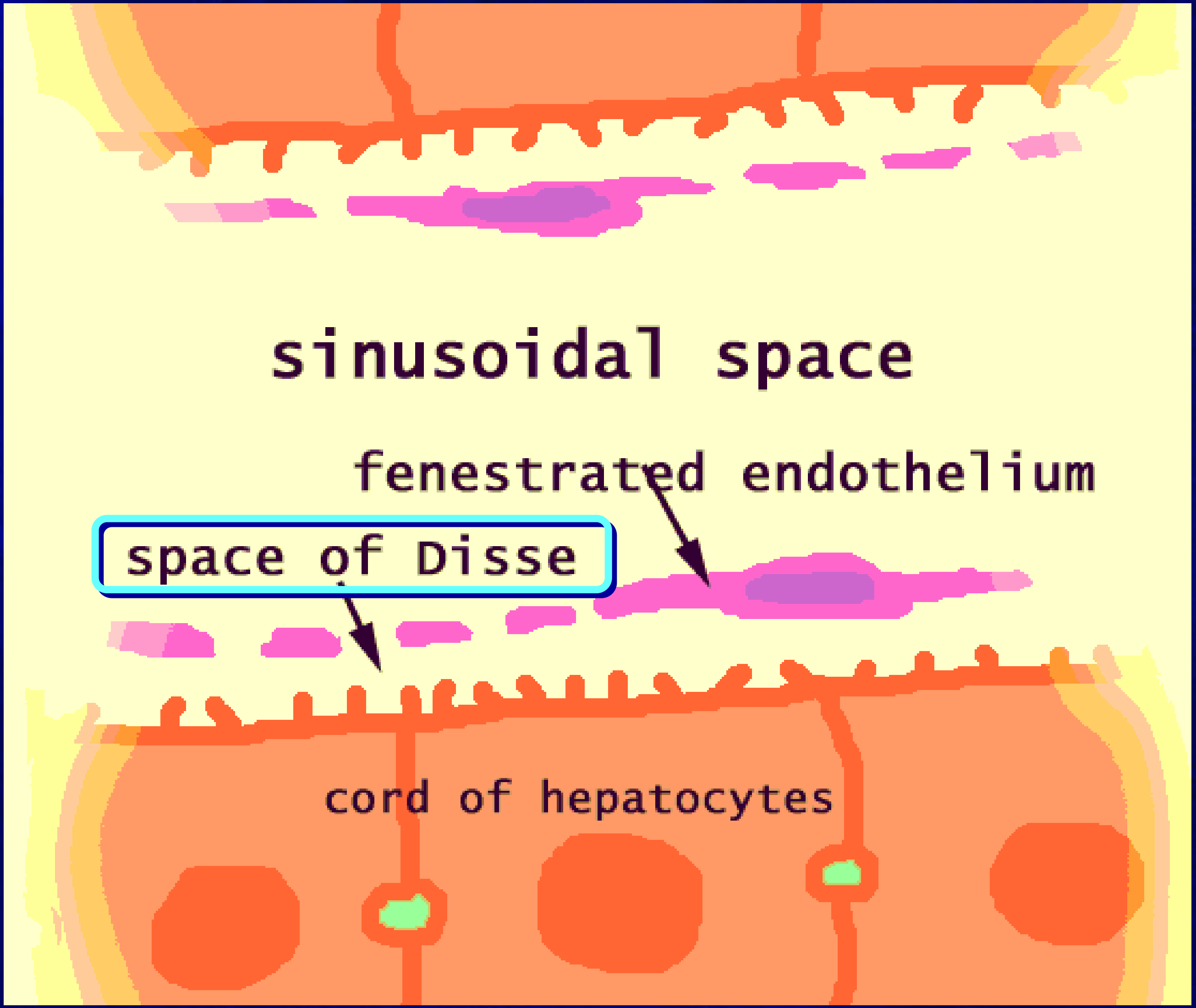
(a) Hepatic lobules

(b) Hepatocytes and sinusoids

Between all of the anastomosing plates of hepatocytes of a hepatic lobule are important **vascular sinusoids** that emerge from the peripheral branches of the portal vein and hepatic artery and converge on the lobule's central vein.

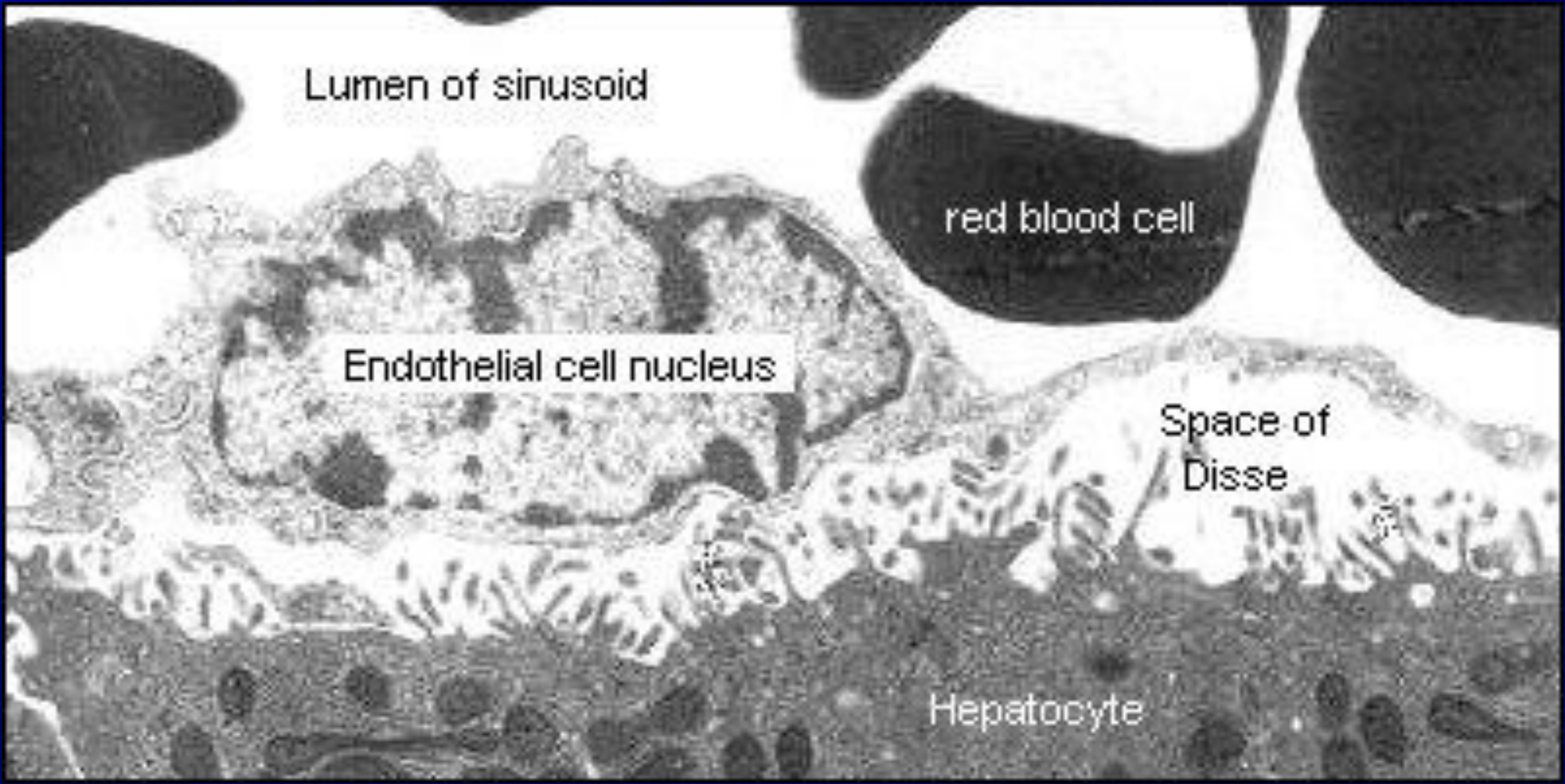


The venous and arterial blood *mixes* in these irregular hepatic sinusoids.



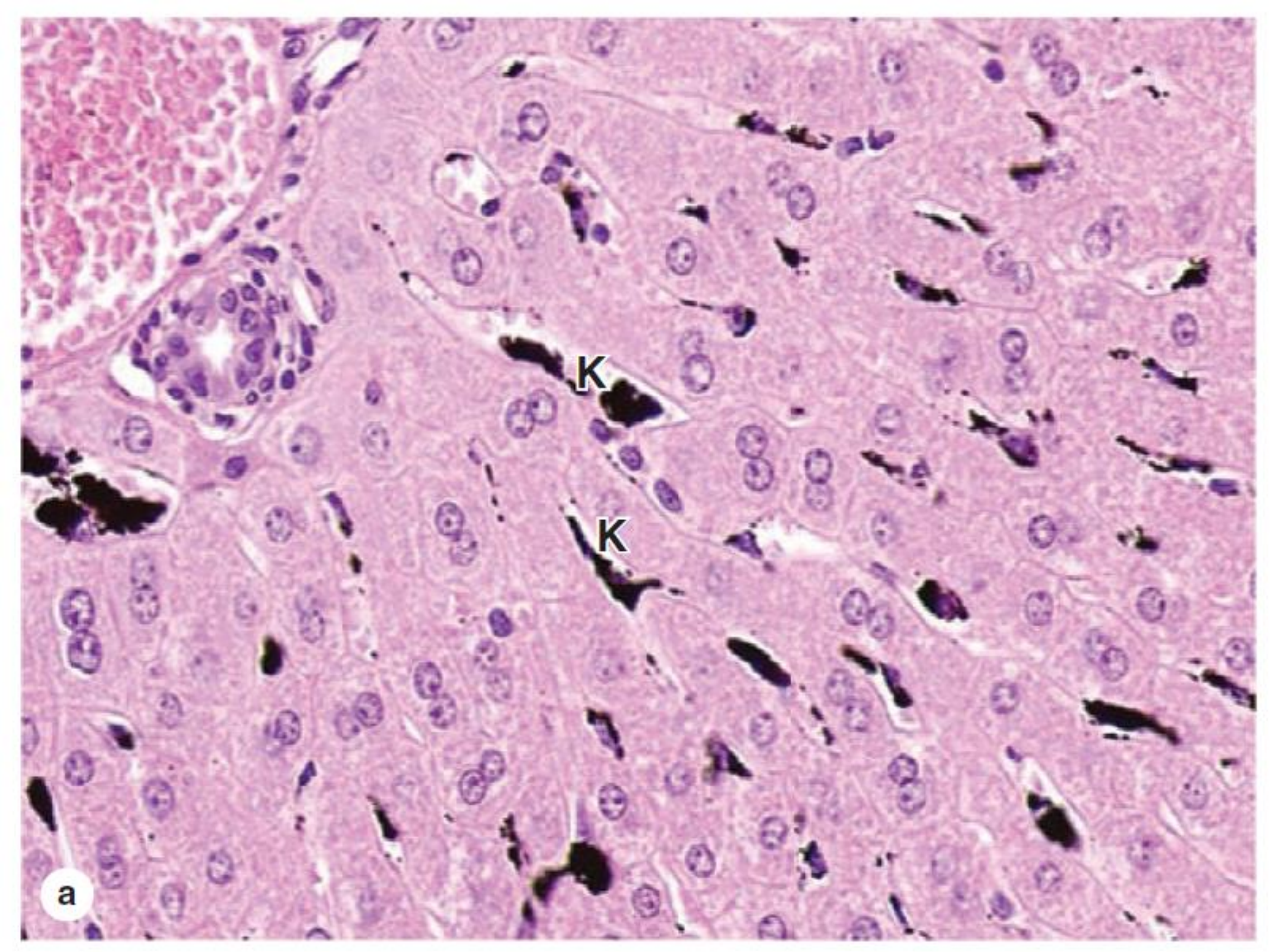
The anasto-mosing sinu-soids have *thin, discontinuous linings of fenestrated endothelial cells* surrounded by sparse basal lamina and reticular fibers.

The discontinuities and fenestrations allow **plasma** to fill a narrow **perisinusoidal space (or space of Disse)** and directly bathe the many irregular microvilli projecting from the hepatocytes into this space.



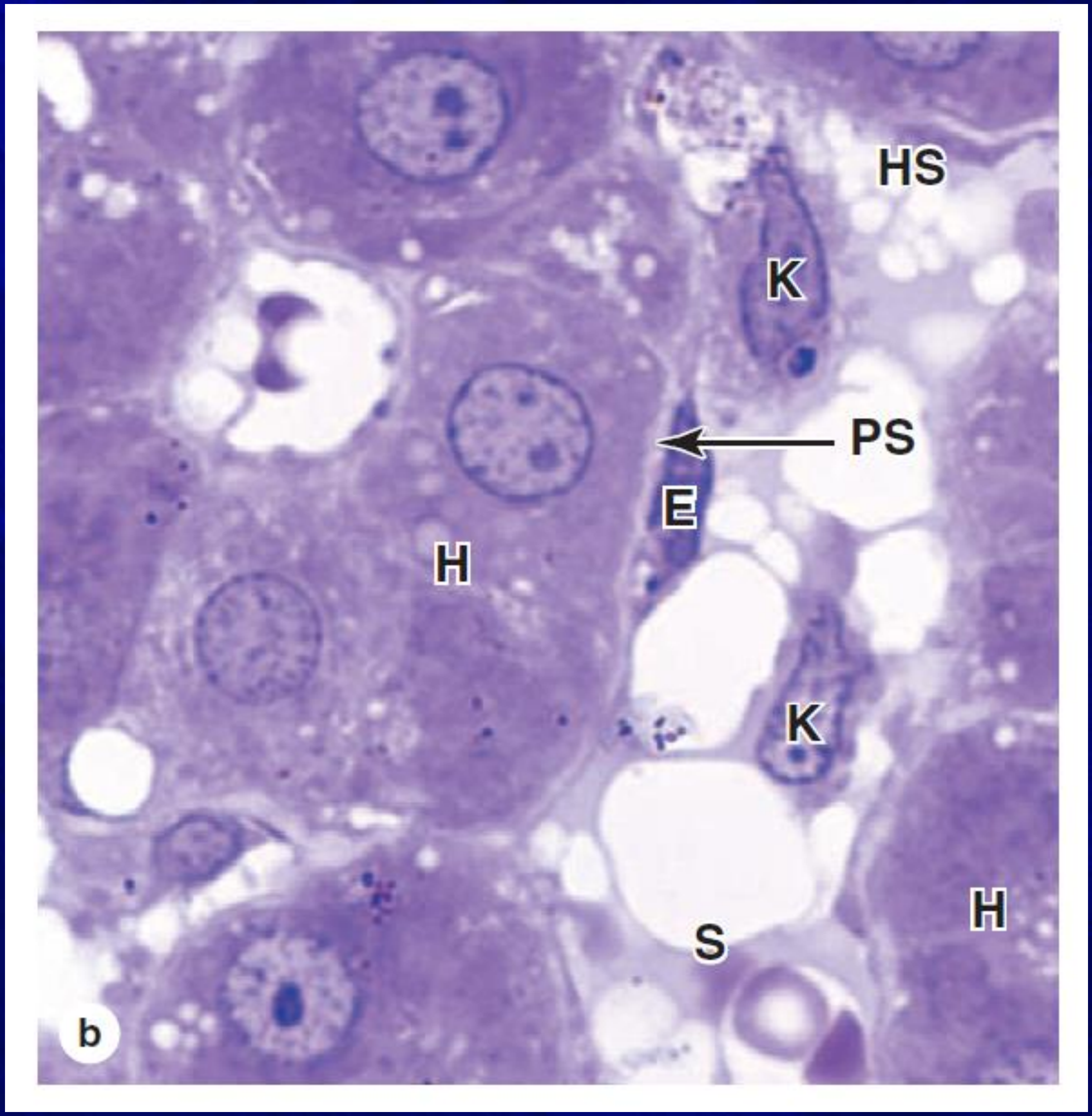
The numerous small structures in the space of Disse are microvilli on the surface of the hepatocyte.

This **direct contact between hepatocytes and plasma** *facilitates most key hepatocyte functions* that involve uptake and release of nutrients, proteins, and potential toxins.



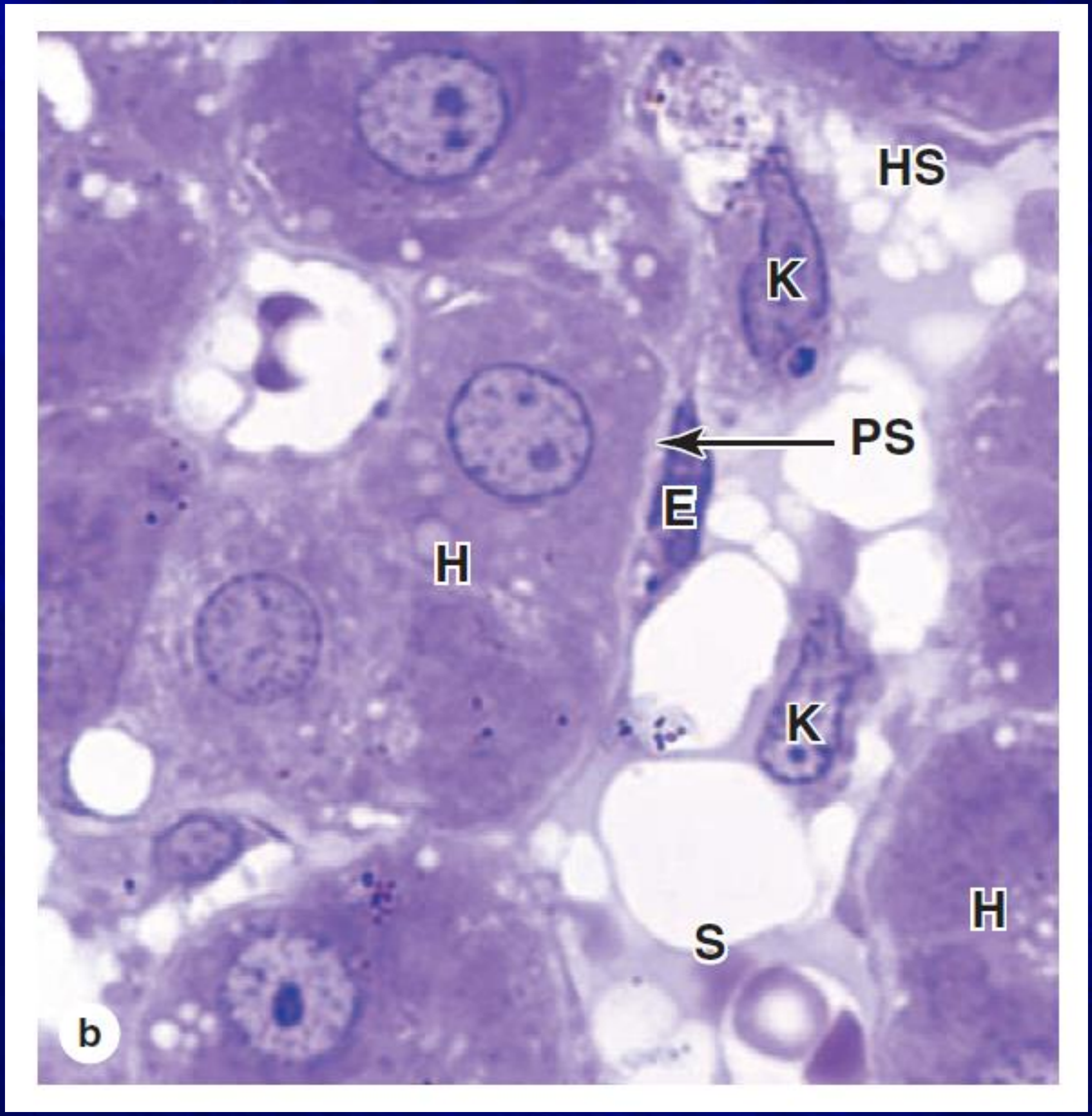
In the endothelial lining of the hepatic sinusoids are numerous specialized stellate macrophages or ***Kupffer cells*** *that detect and phagocytose effete erythrocytes. (a) Kupffer cells (K) are seen as black cells in a liver lobule from a rat injected with particulate India ink. X200. H&E.*

- Two other functionally important cells are found with the sinusoids of hepatic lobules:
- Numerous specialized stellate macrophages, usually called **Kupffer cells,** are found within the sinusoid lining.



- These cells recognize and *phagocytose* aged erythrocytes, freeing heme and iron for reuse or storage in ferritin complexes.
- **Kupffer cells** are also *antigen-presenting cells* and *remove any bacteria or debris* present in the portal blood.

(b) In a plastic section, Kupffer cells (K) are seen in the sinusoid (S) between two groups of hepatocytes (H). They are larger than the flattened endothelial cells (E).

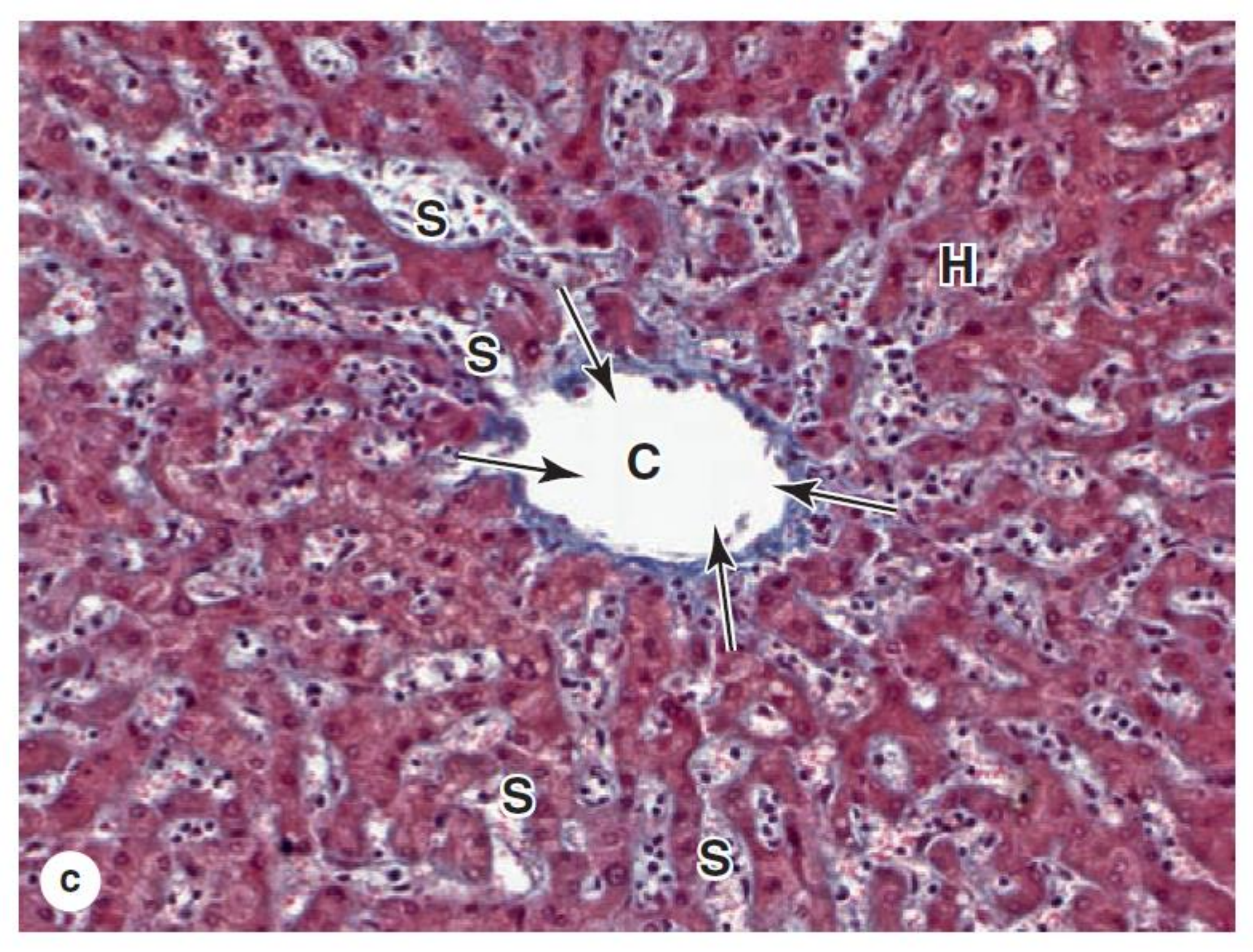


(b) *In a plastic section, between the endothelium and the hepatocytes is a very thin space called the perisinusoidal space (PS) of Disse, in which are located small hepatic stellate cells (HS), or Ito cells, that maintain the very sparse ECM of this compartment and also store vitamin A in small lipid droplets.*

- In the perisinusoidal space are **hepatic stellate cells (or Ito cells)** with small lipid droplets that store vitamin A and other fat-soluble vitamins.
- These mesenchymal cells also produce:

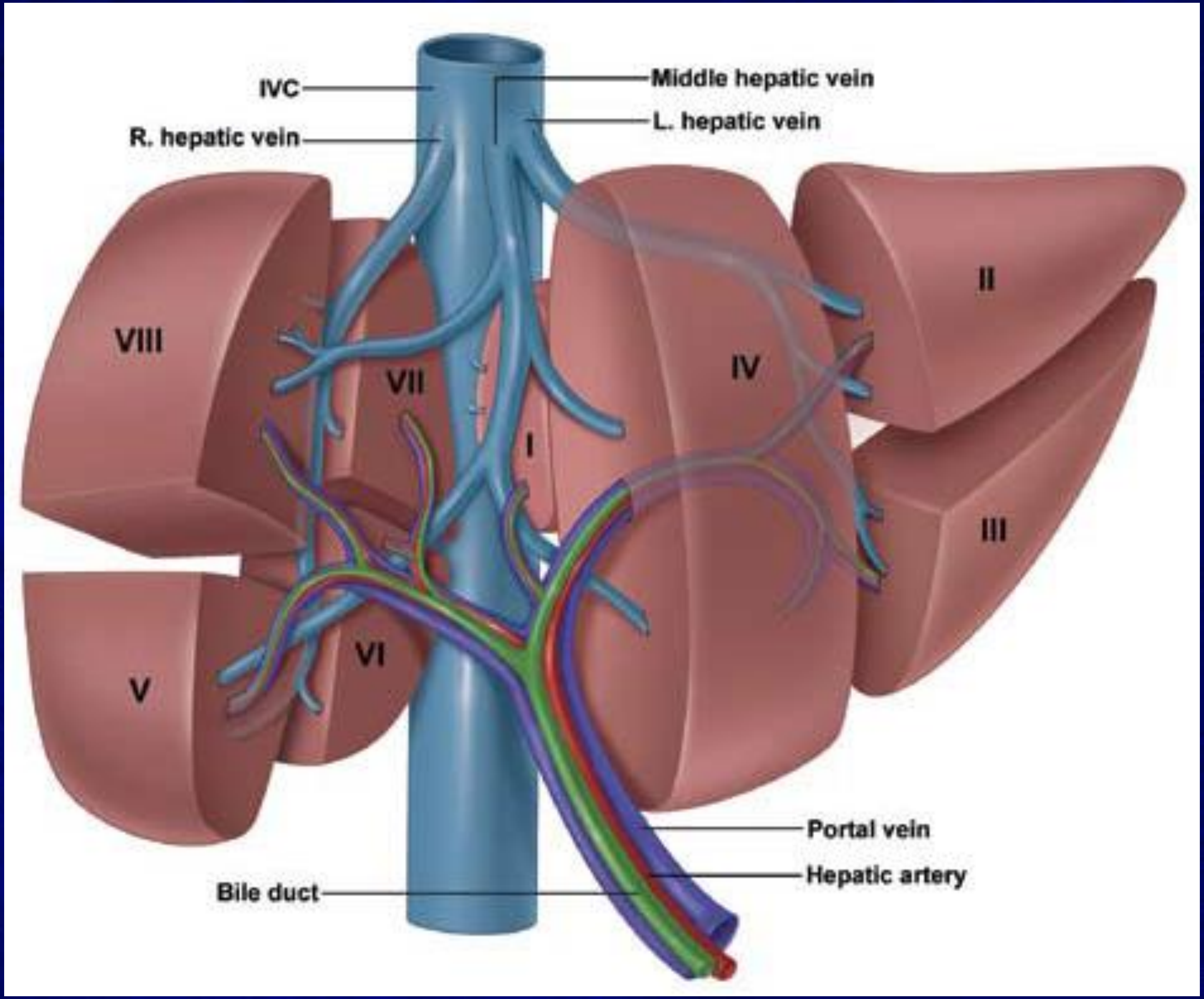
✓ **extracellular matrix (ECM) components** (becoming myofibroblasts after liver injury) and

✓ **cytokines that help regulate Kupffer cell activity.**

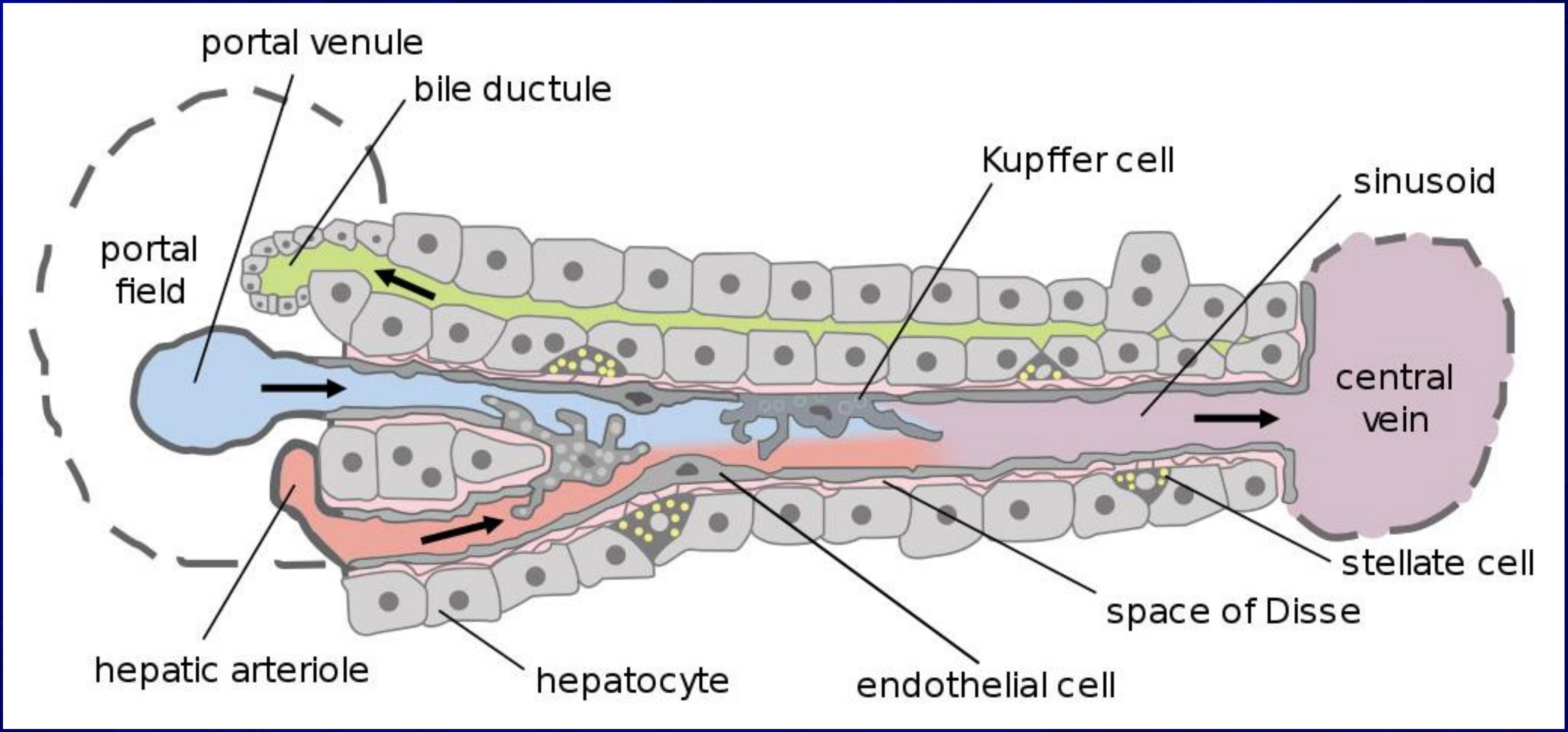


(c) With plates of hepatocytes (H) appearing to radiate from it, the central vein (C) of the lobule has more collagen than the smaller sinusoids (S) that drain into it from all directions (arrows). X200. Mallory trichrome.

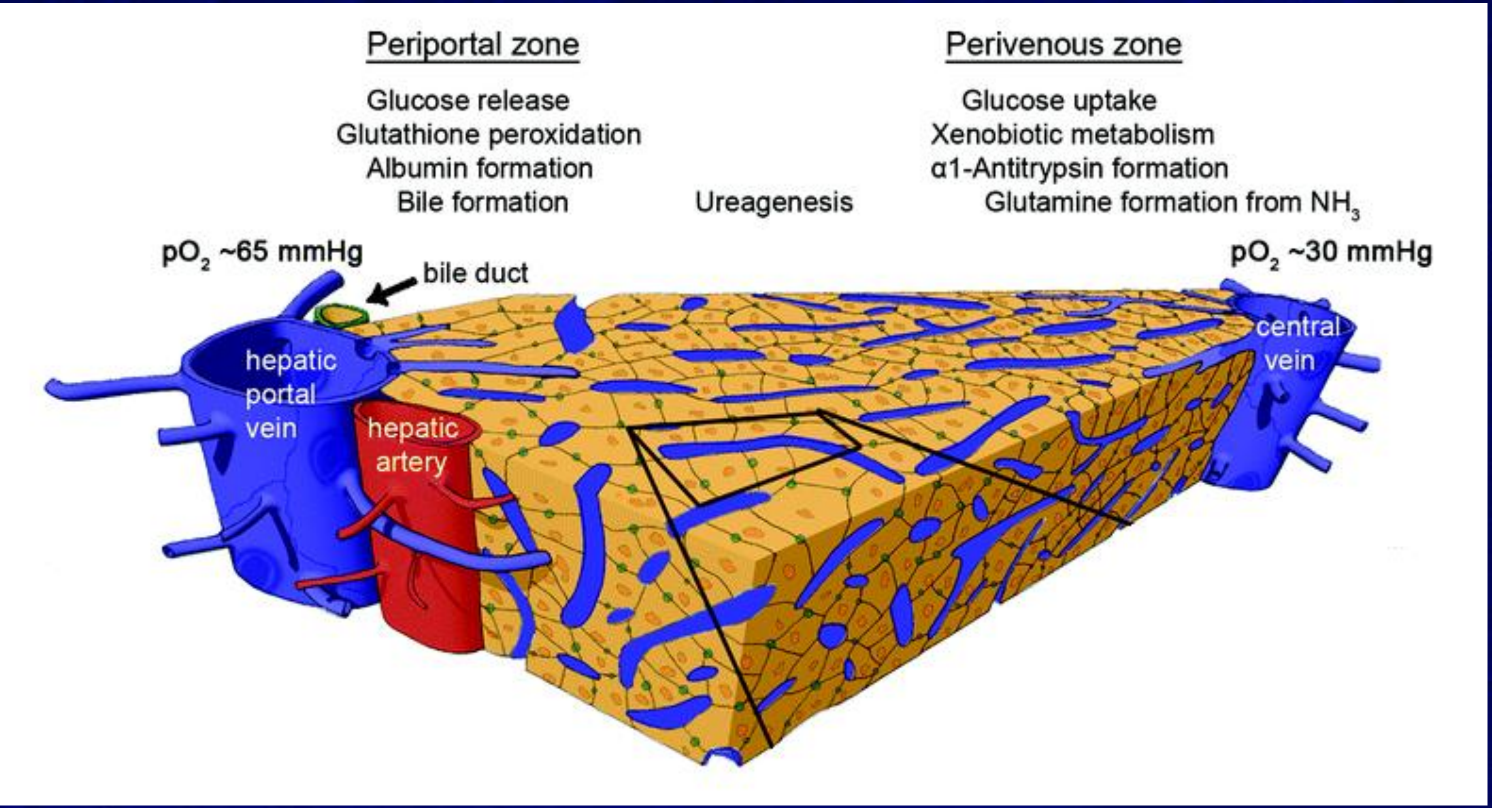
The endothelium of the central vein in the middle of each hepatic lobule is supported by a very thin layer of **fibrous connective tissue.**



Central venules from each lobule converge into larger veins, which eventually form two or more large hepatic veins that empty into the inferior vena cava.



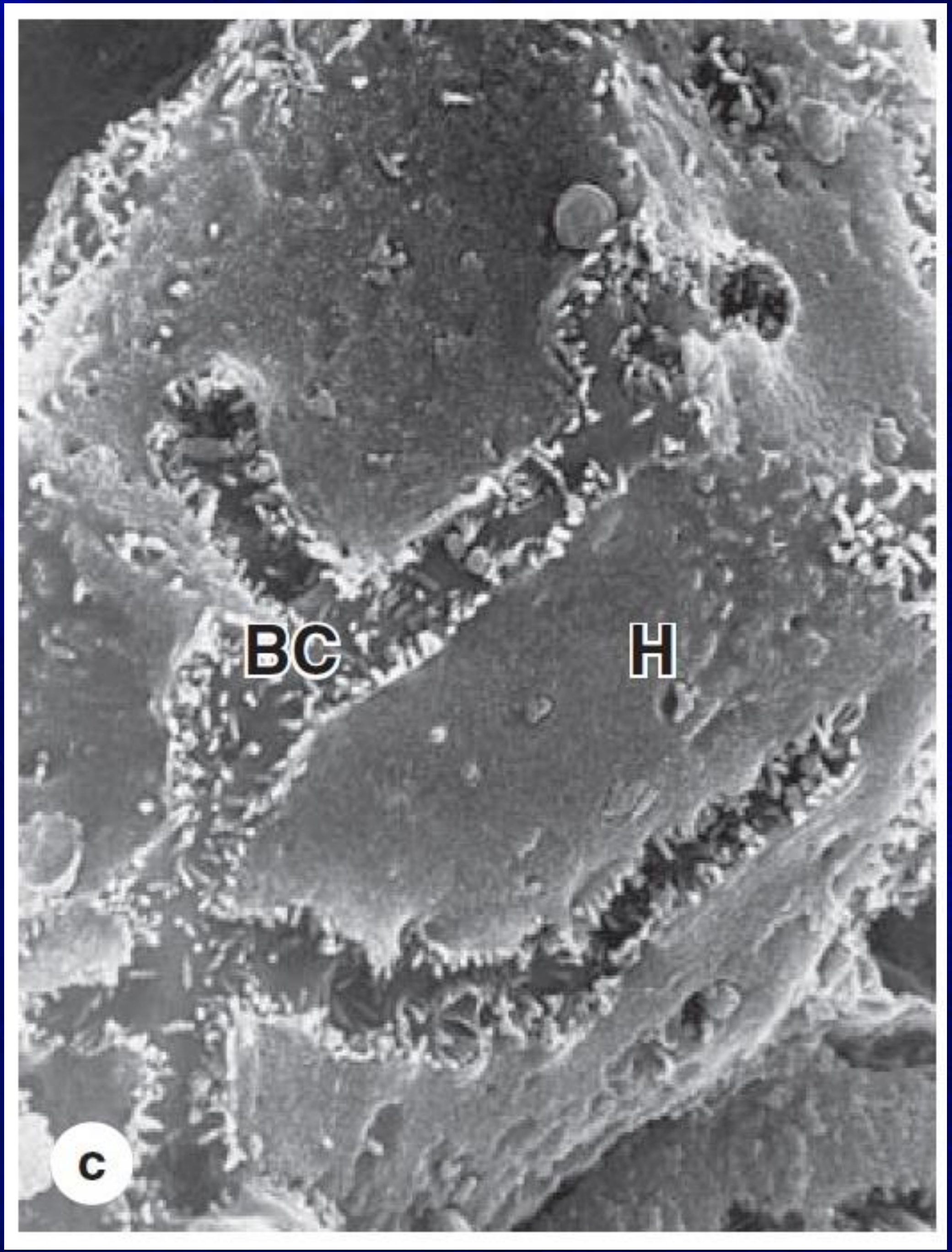
- **Blood always flows** *from the periphery to the center* **of each hepatic lobule.**
- **Consequently,** *oxygen and metabolites,* **as well as all other toxic or nontoxic substances absorbed in the intestines,** *reach the lobule's peripheral cells first* **and then the more central cells.**



- This direction of blood flow partly explains why **the properties and function of the periportal hepatocytes differ from those of the centrolobular cells.**
- Hepatocytes **near the portal areas** *can rely on aerobic metabolism* and are often more active in protein synthesis,
- while the **more central cells** are exposed to lower concentrations of nutrients and oxygen and *are more involved with detoxification and glycogen metabolism.*

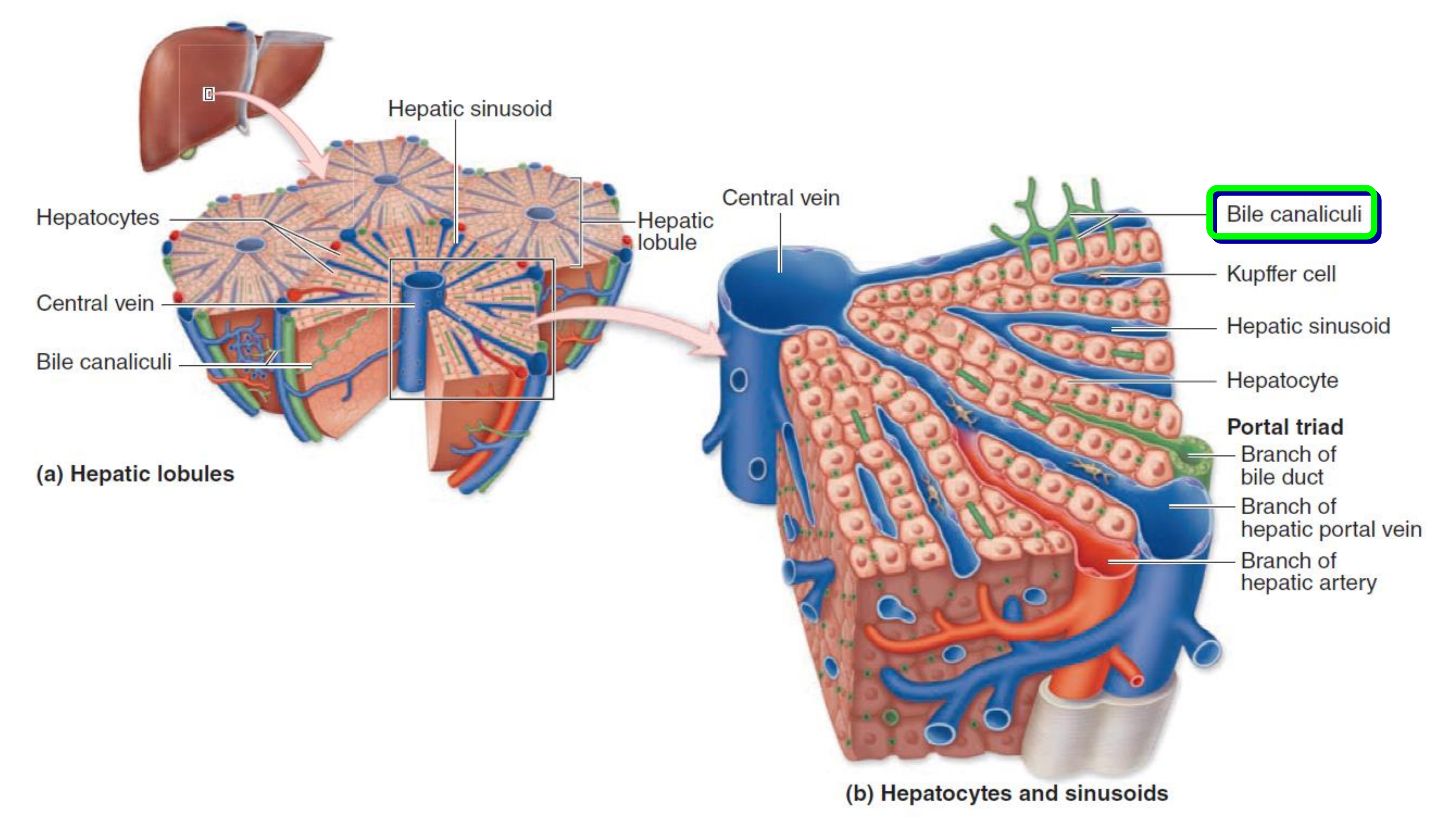
Coloured scanning electron micrograph (SEM). Hepatocytes (brown), blood vessel (green) and a bile canaliculus (dark brown channel with white edges running across upper frame). x3000

- Within the hepatic plates hepatocytes adhere firmly with desmosomes and junctional complexes.
- The apical surfaces of two adherent hepatocytes are grooved and juxtaposed to form the **canaliculus,** sealed by tight junctions, into which bile components are secreted.

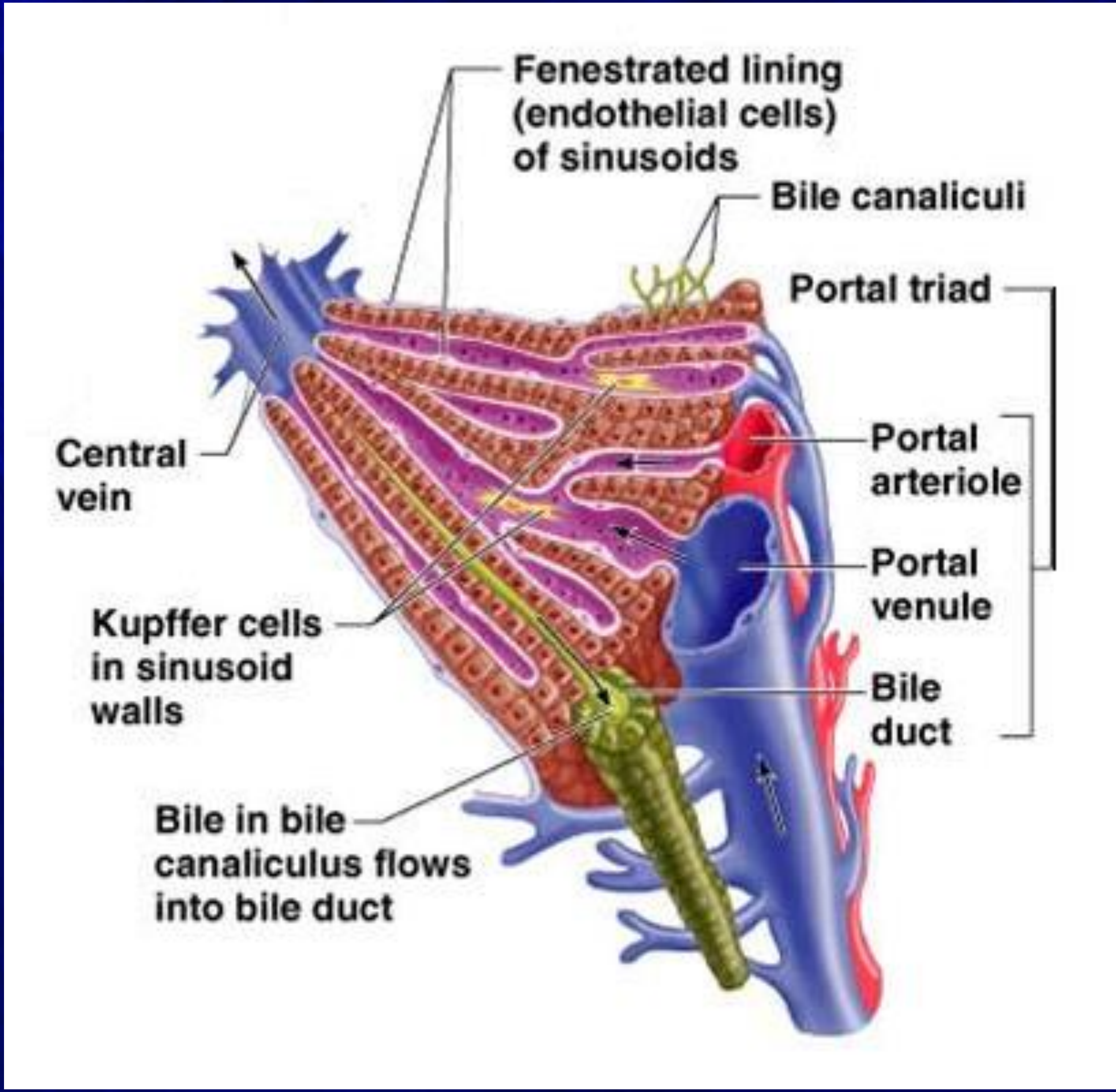


These **canaliculi** are elongated spaces (total length >1 km) with lumens only 0.5-1μm in diameter with large surface areas due to the many **short microvilli** from the constituent hepatocytes.

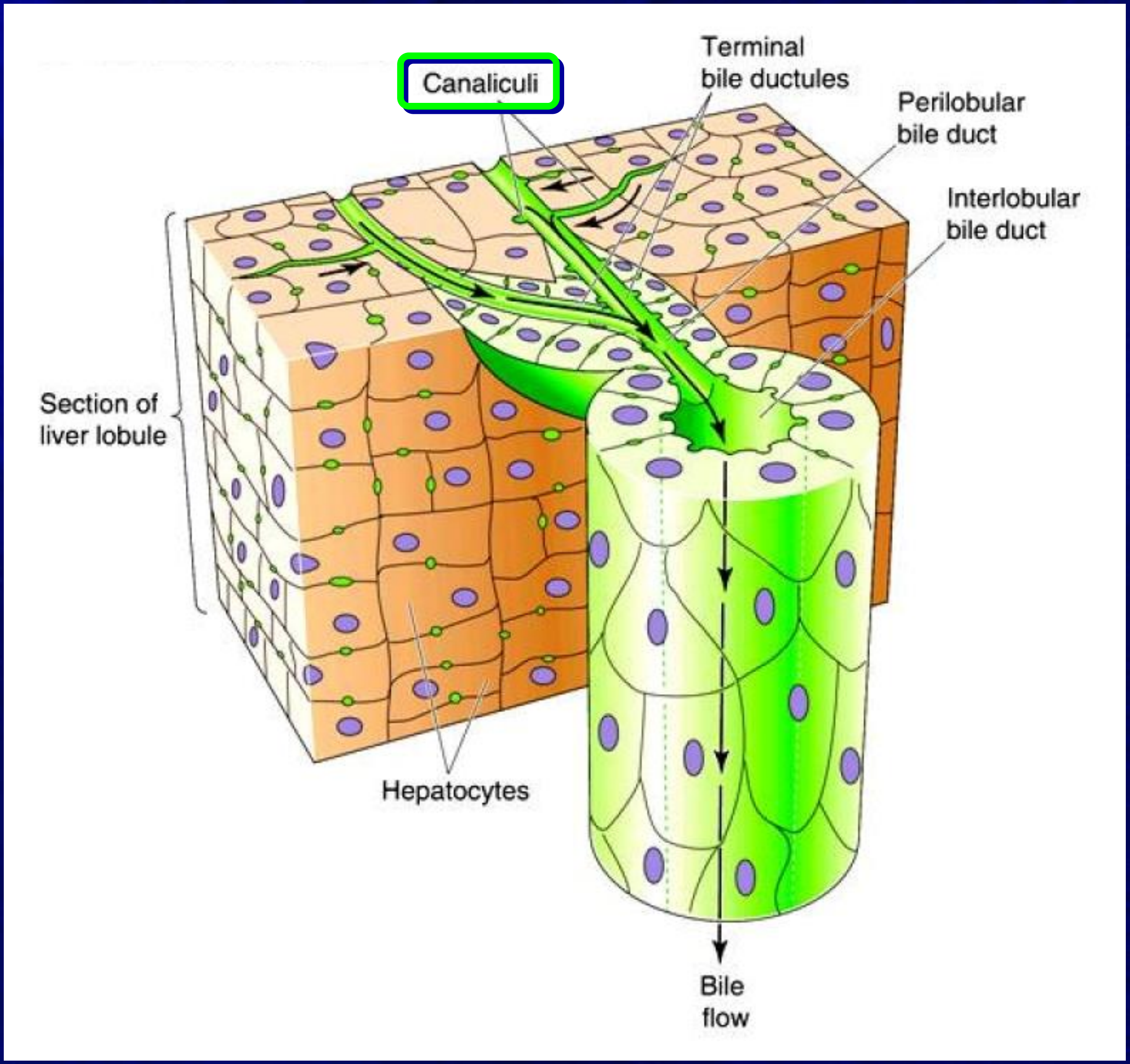
(c) SEM of hepatocytes (H) broken apart from one another reveals the length of a bile canaliculus (BC) along the cell's surface. Such canaliculi run between the cells of the hepatocyte plates in the hepatic lobules and carry bile toward the portal areas where the canaliculi join cuboidal bile ductules. X8000.



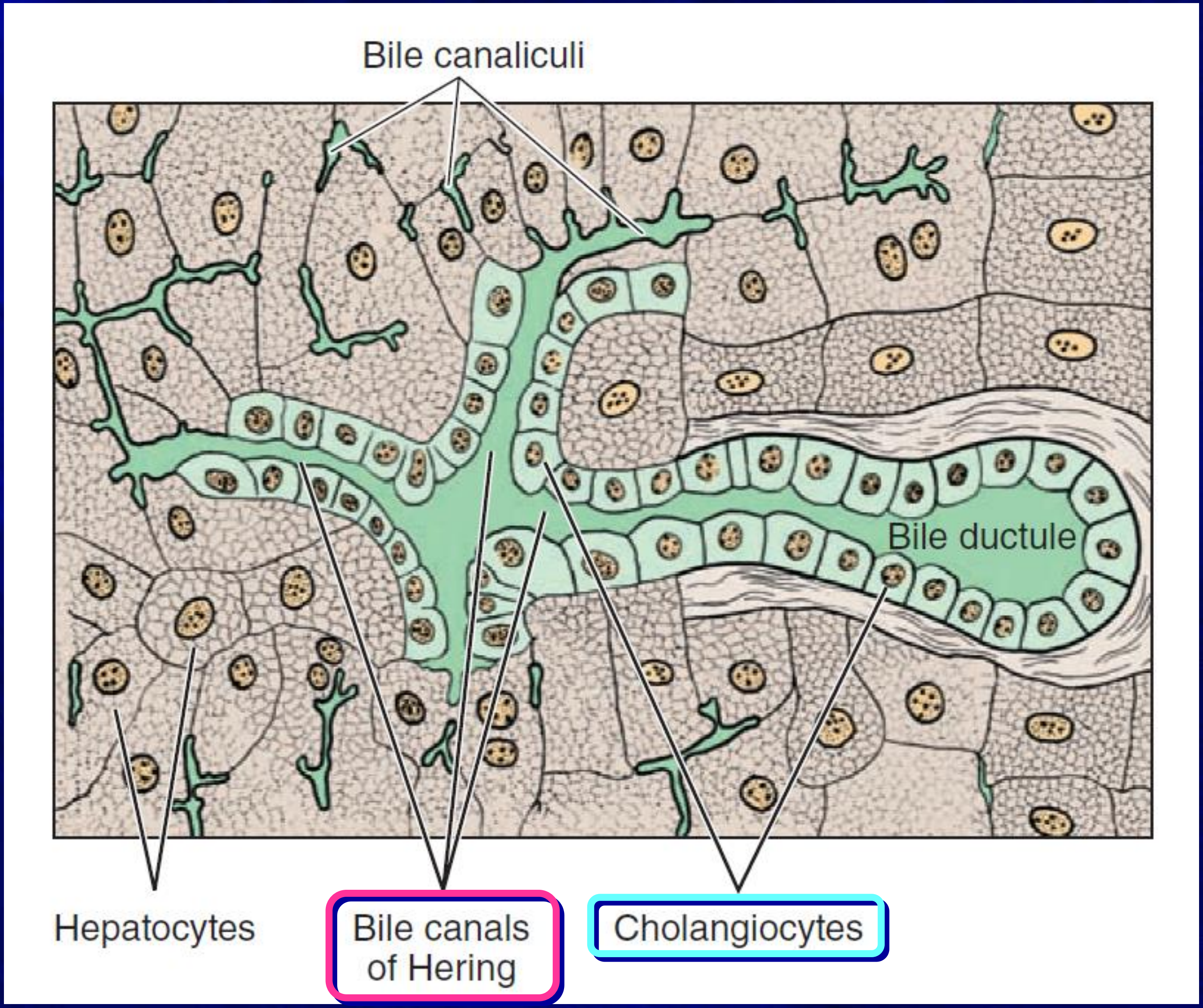
- The **bile canaliculi** form a complex anastomosing network of channels through the hepatocyte plates that end near the portal tracts.



The bile flow therefore progresses in a direction opposite to that of the blood, *that is, from the center of the lobule to its periphery.*

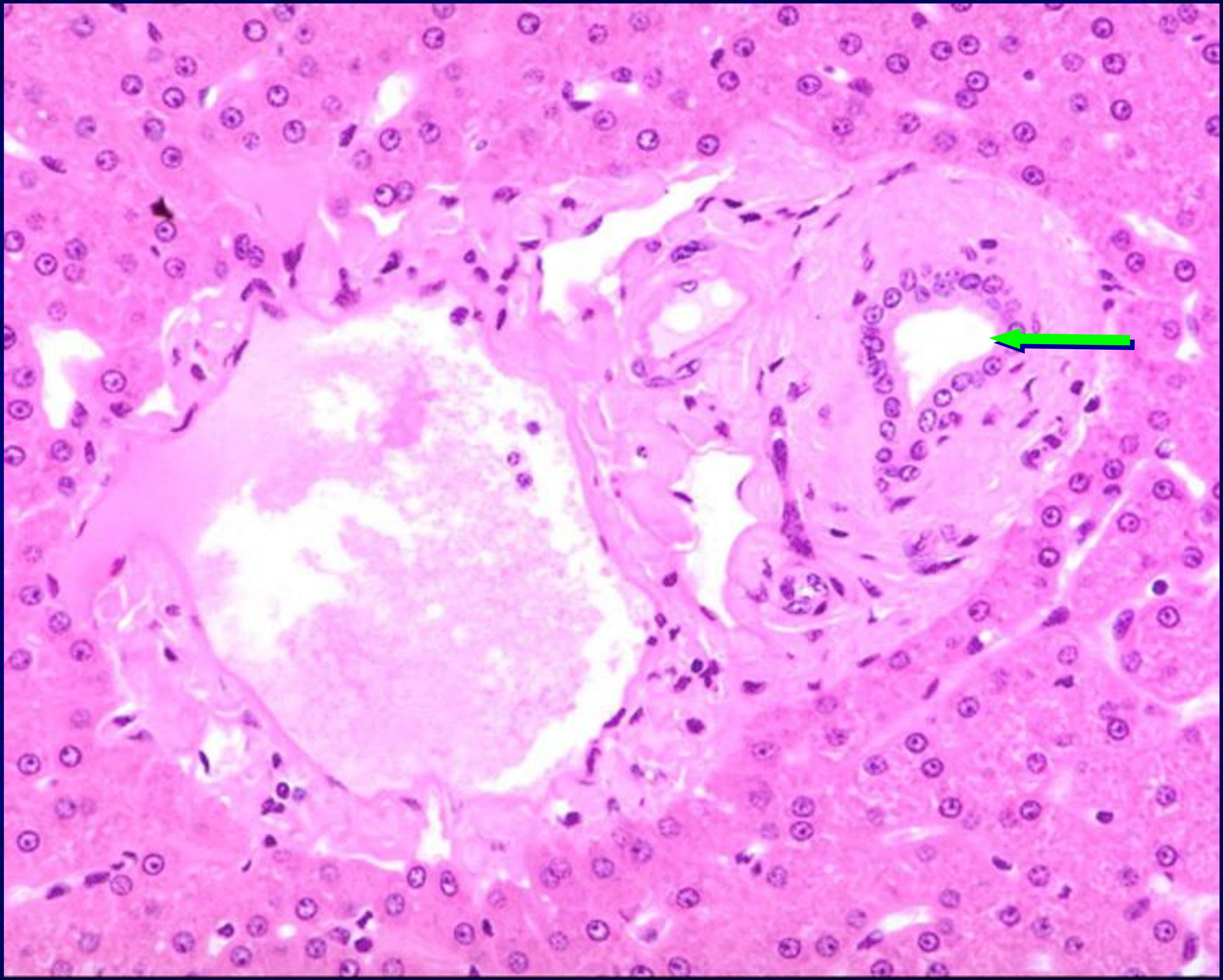


Bile canaliculi are the smallest branches of the biliary tree or bile conducting system.

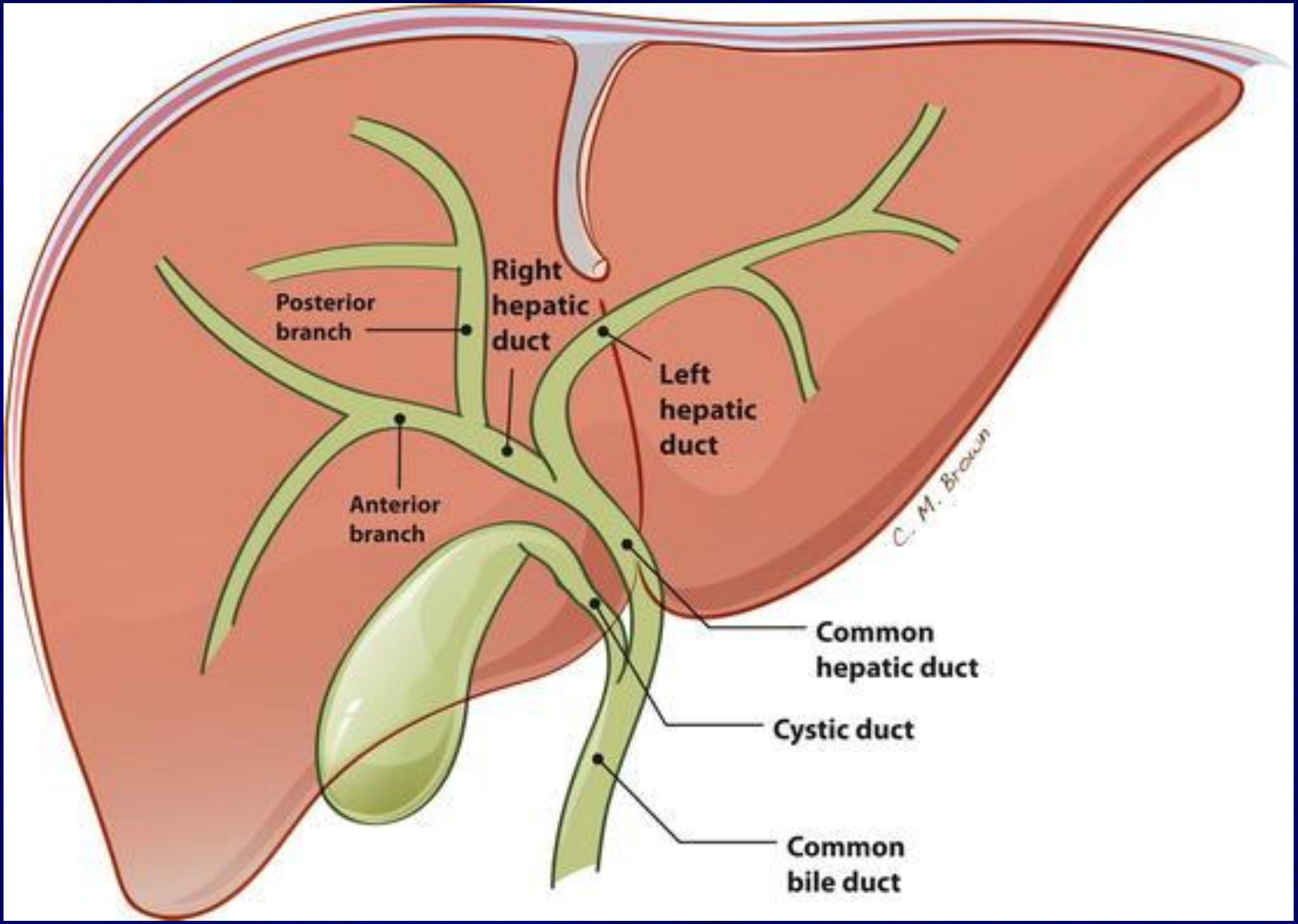


Near the periphery of each hepatic lobule, many bile canaliculi join with the much larger bile canals of Hering, which are lined by cuboidal epithelial cells called cholangiocytes. These canals soon join the bile ductules in the portal areas and drain into the biliary tree.

They empty into **bile canals of Hering** composed of cuboidal epithelial cells called **cholangiocytes.**

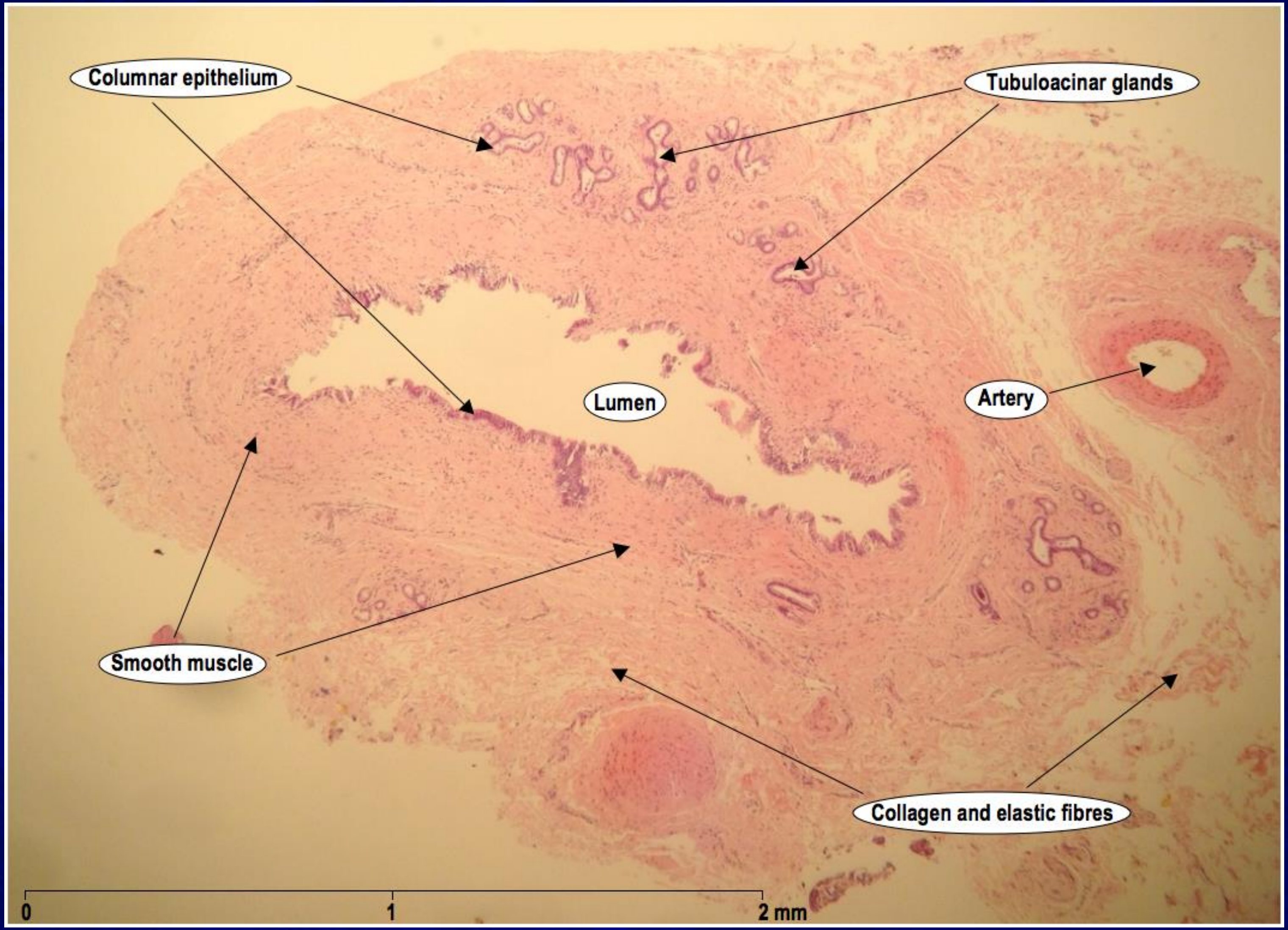


- The short bile canals quickly merge in the portal areas with the **bile ductules** lined by cuboidal or columnar cholangiocytes and with a distinct connective tissue sheath.



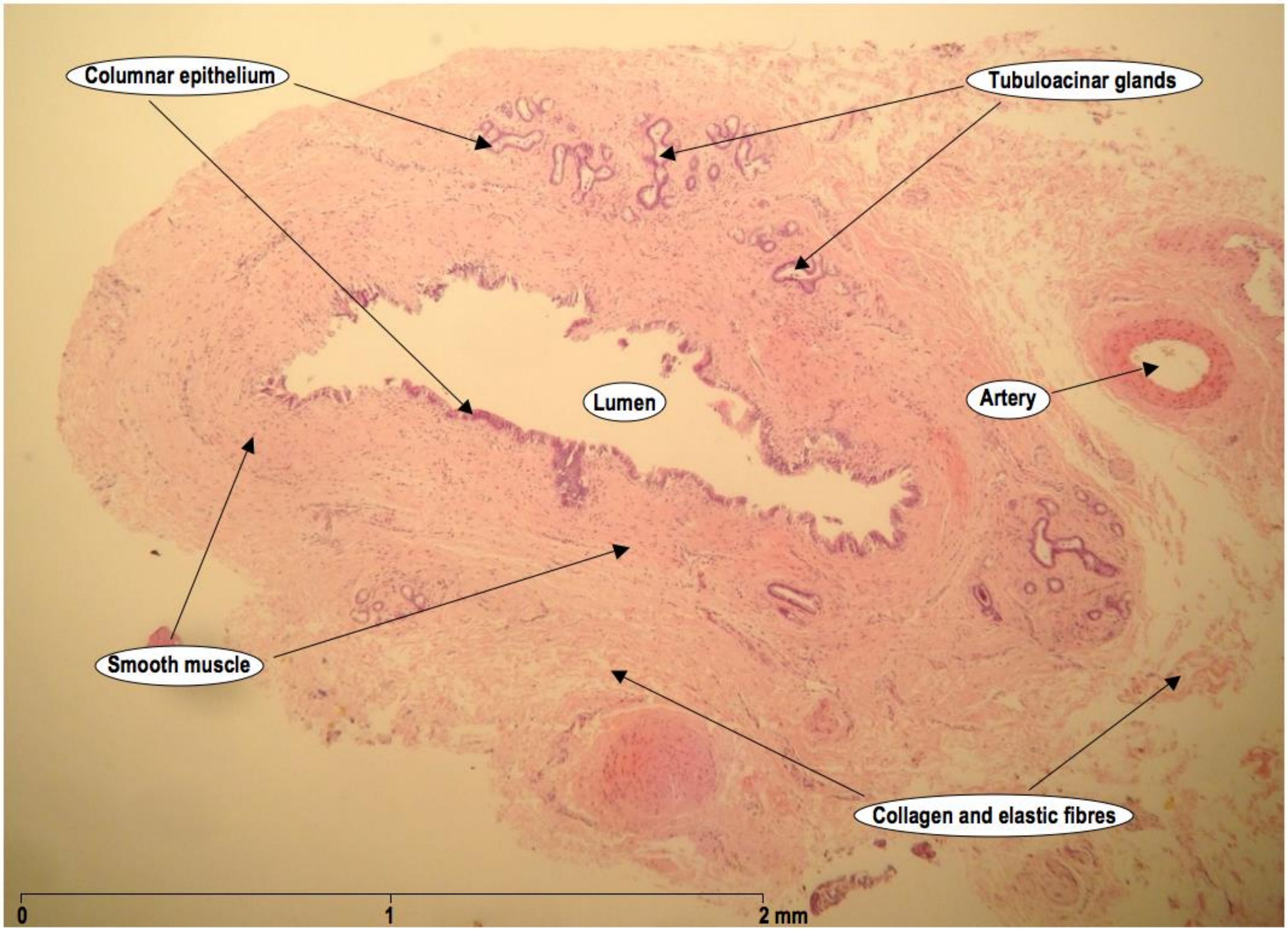
- Bile ductules gradually merge, enlarge, and **form right and left hepatic ducts** leaving the liver.

BILIARY TRACT & GALLBLADDER

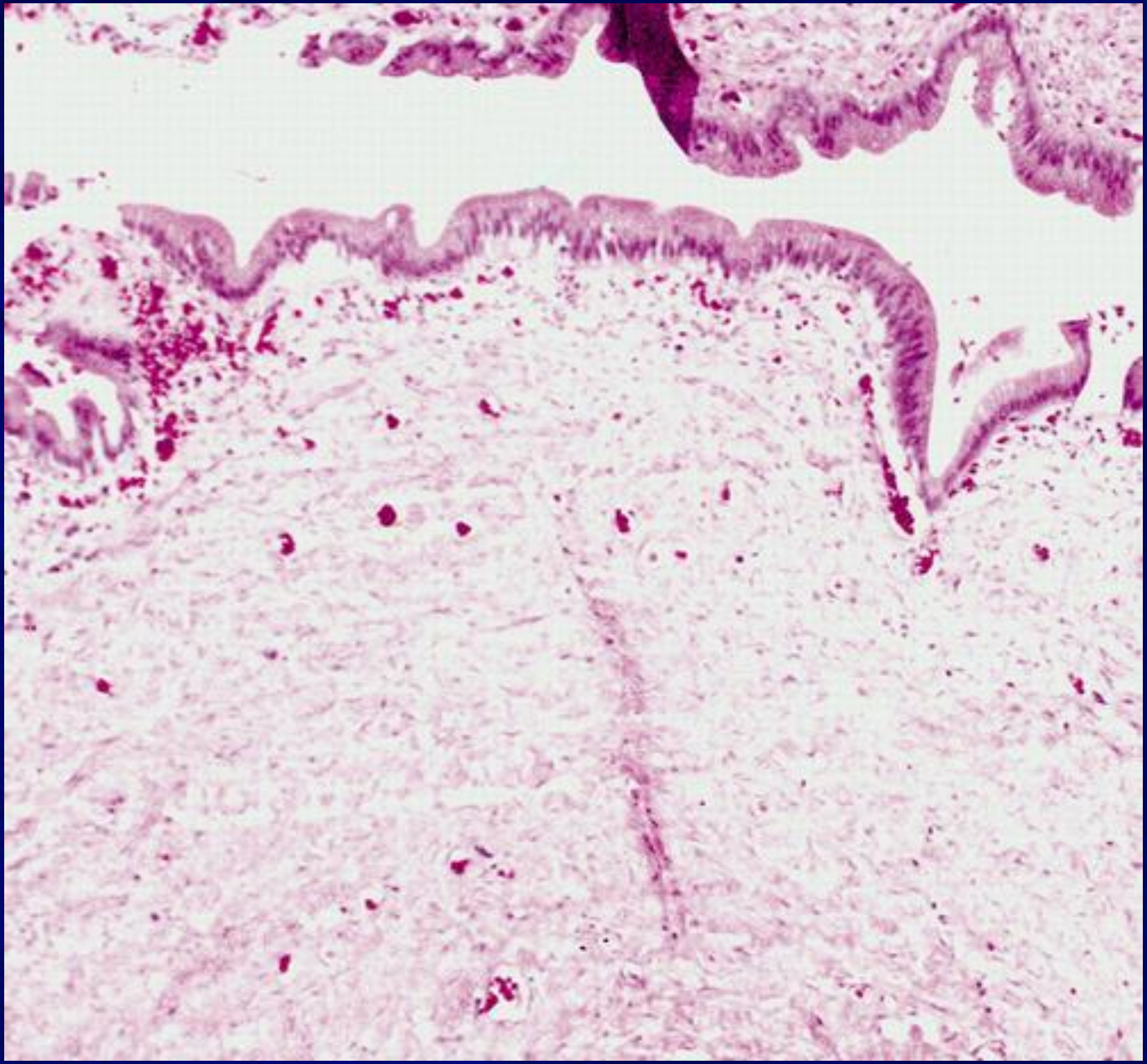


A low power H&E showing the opening of the cystic duct (at the neck region), together with its surrounding tissue components.

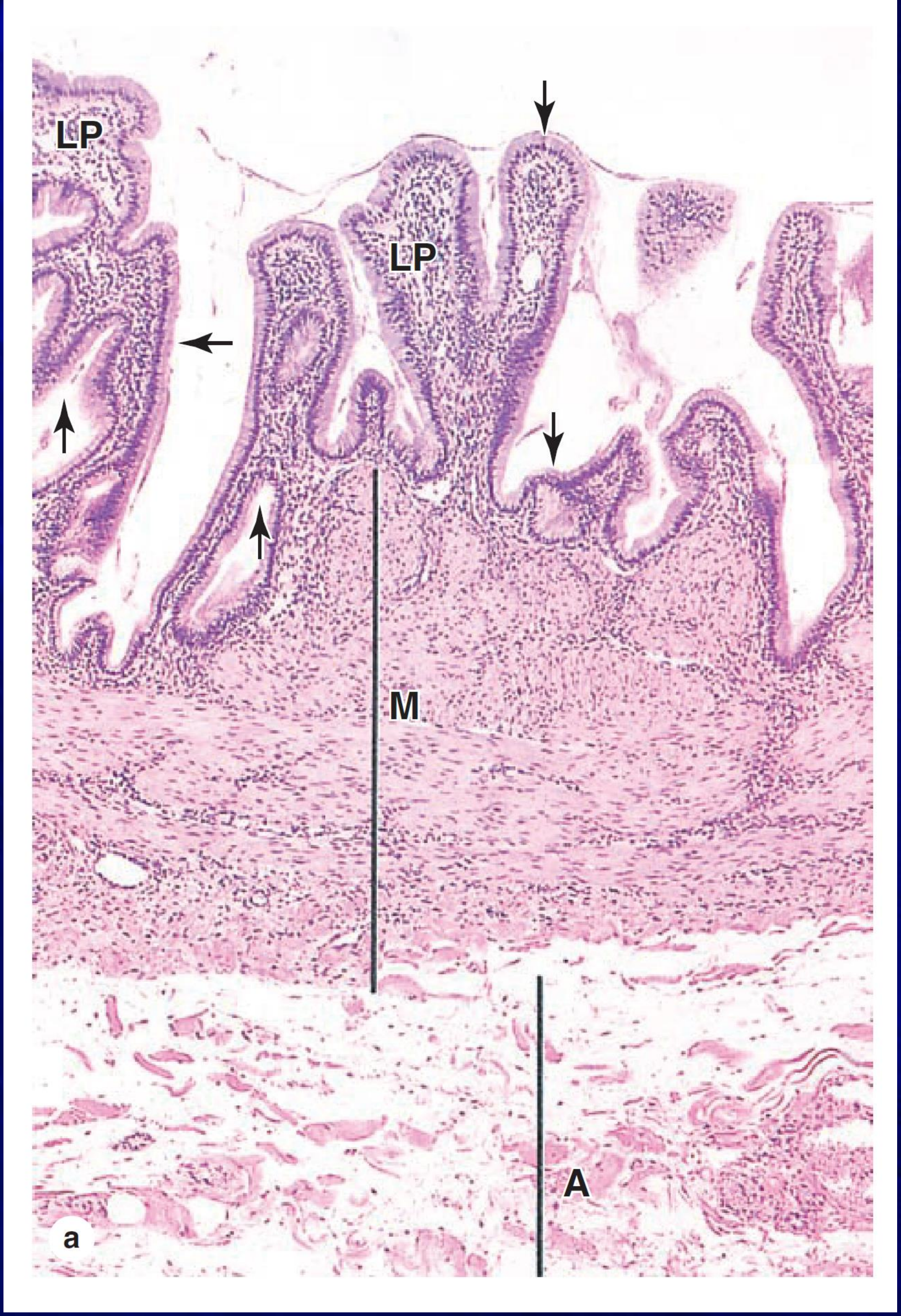
The hepatic, cystic, and common bile ducts are lined with a mucous membrane having a **simple columnar epithelium of cholangiocytes.**



- The lamina propria and submucosa are relatively thin,
- with mucous glands in some areas of the cystic duct, and surrounded by a thin muscularis.

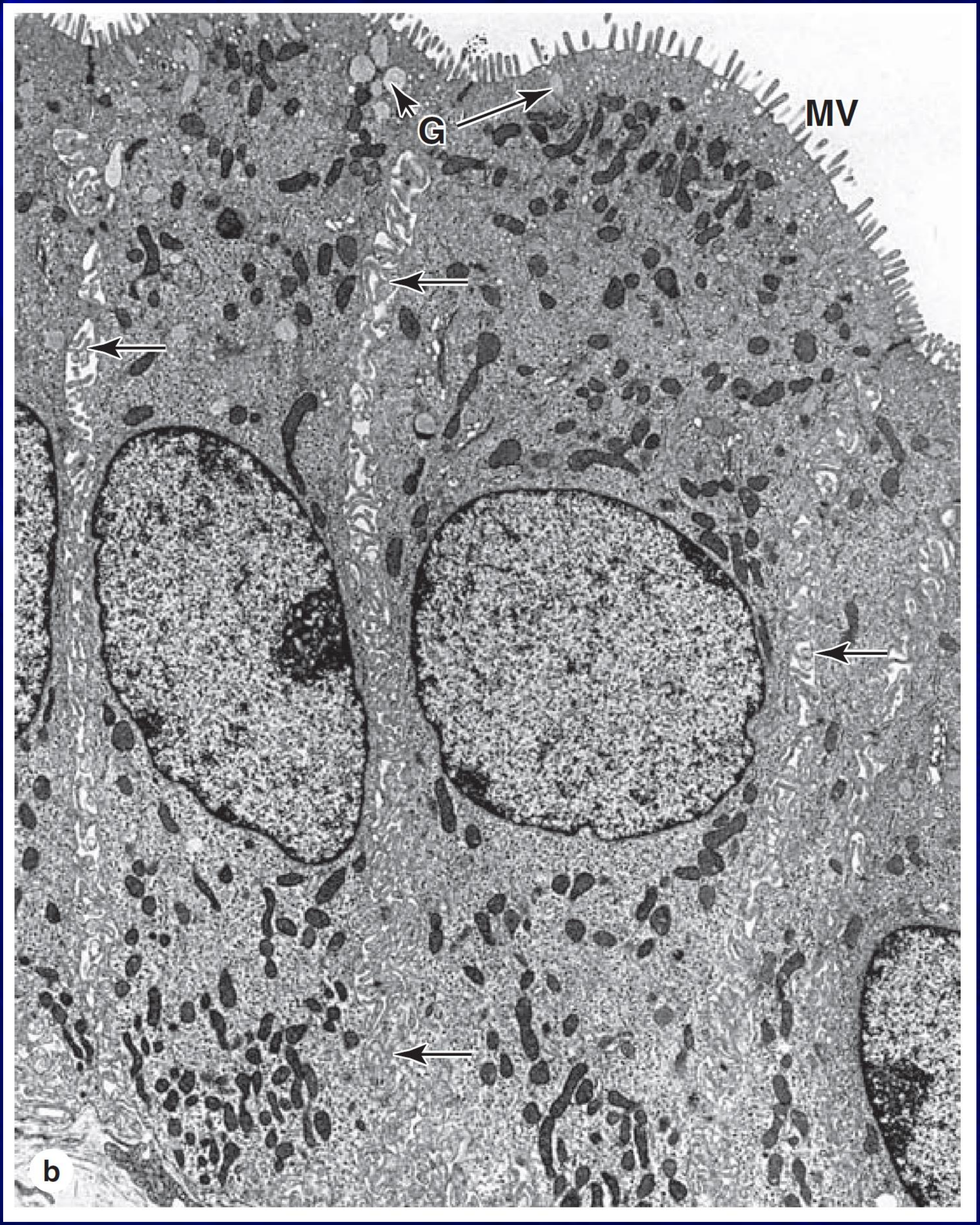


This muscle layer becomes thicker near the duodenum and finally, in the **duodenal papilla,** forms a sphincter that regulates bile flow into the small bowel.



- The wall of the gallbladder consists of a mucosa composed of **simple columnar epithelium** and lamina propria, a thin muscularis with bundles of muscle fibers oriented in several directions, and an external adventitia.
- **The mucosa has numerous folds** that are particularly evident when the gallbladder is empty.

(a) The gallbladder wall consists largely of a highly folded mucosa, with a simple columnar epithelium (arrows) overlying a typical lamina propria (LP); a muscularis (M) with bundles of muscle fibers oriented in all directions to facilitate emptying of the organ; and an external adventitia (A) where it is against the liver and a serosa where it is exposed. X60. H&E.



The **lining epithelial cells of the gallbladder** have prominent mitochondria, microvilli, and large intercellular spaces, all *indicative of cells actively transporting water,* in this case for concentrating bile.

(b) TEM of the epithelium shows cells specialized for water uptake across apical microvilli (MV) and release into the intercellular spaces (arrows) along the folded basolateral cell membranes. From these spaces water is quickly removed by capillaries in the lamina propria. Abundant mitochondria provide the energy for this pumping process. Scattered apical secretory granules (G) contain mucus. X5600.

Good Luck