

Lab Practical Two

Week 6: Lymphatic, Digestive

Lymphatic	3
Tonsils	3
Lymph Nodes	4
Thymus	6
Spleen	7
Questions	11
Digestive	12
Tongue	12
Esophagus	14
Gastroesophageal Junction	16
Stomach	17
Small Intestine	20
Large Intestine	21
Appendix	23
Rectum	26
Recto-Anal Junction	27
Parotid Gland	29
Liver	31
Gall Bladder	33
Exocrine Pancreas	34
Endocrine Pancreas	36

Week 7: Respiratory, Integument, Urinary

Respiratory	38
Nasal and Oral Cavities	38
Larynx	40
Trachea	43
Lung	45
Integument	47
Thick Skin	47
Thin Skin	50
Pigmented Skin	52
Questions	53
Meissner and Pacinian Corpuscles	54
Urinary	55
Kidney	55
Nephron	57
Ureter	59
Urinary Bladder	61

Week 8: Endocrine, Male Reproductive

Endocrine Glands	63
Pituitary Gland.....	63
Adrenal Gland.....	66
Questions.....	68
Thyroid	69
Male Reproductive System	71
Testis (Adult and Neonatal).....	71
Epididymis.....	75
Ductus Deferens.....	75
Seminal Vesicle.....	75
Prostate Gland.....	75
Penis With Penile Urethra.....	75
Questions.....	76
Week 9: Female Reproductive, Eye, Ear	
Female Reproductive System	77
Ovary	77
Oviduct	77
Uterus	77
Cervix.....	77
Questions.....	77
Placenta	78
Breast	78
Eye	78
Ear	78

Week 6: Lymphatic, Digestive

Lymphatic

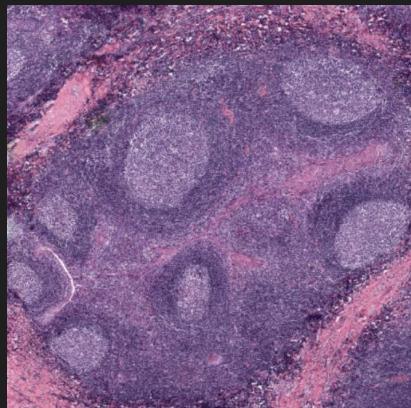
Tonsils

- Tonsils are examples of mucosa-associated lymphoid tissue (**MALT**). The lymphocytes are distributed as diffuse, non-encapsulated nodules in the underlying connective tissue.

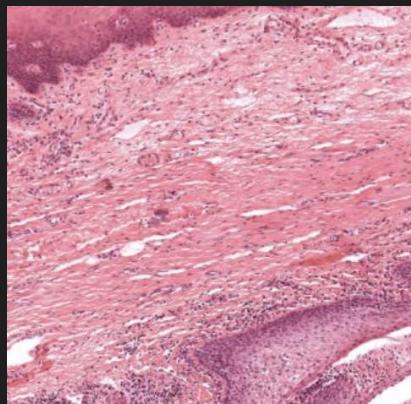
- **Stratified Squamous Non-Keratinized Epithelium:** covers the numerous nodules that comprise the palatine tonsil.



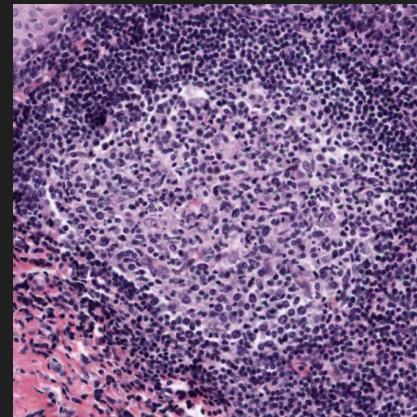
- **Lymph Nodules:** spherical aggregations of lymphocytes that usually have germinal centers.



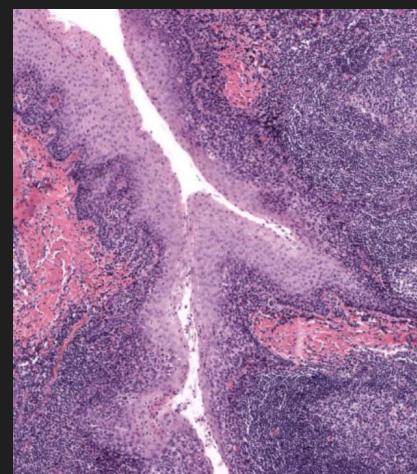
- **Submucosa**



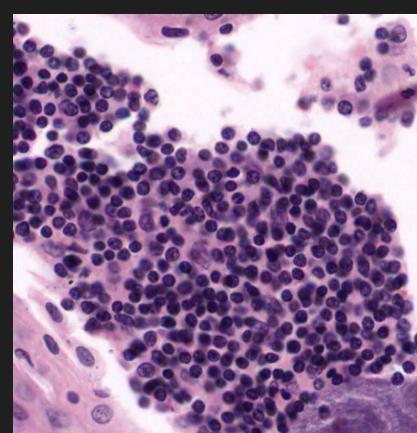
- **Germinal centers**



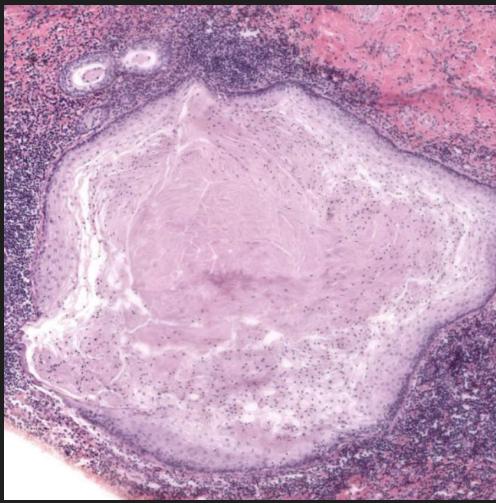
- **Crypts:** infoldings of the epithelium into the underlying connective tissue.



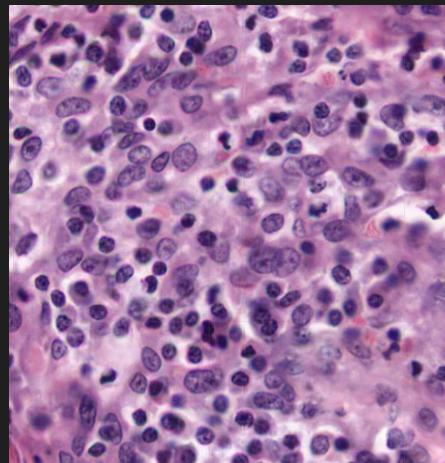
- **Lymphocytes**



- **Sequestered crypts:** usually inflamed and filled with debris and lymphocytes

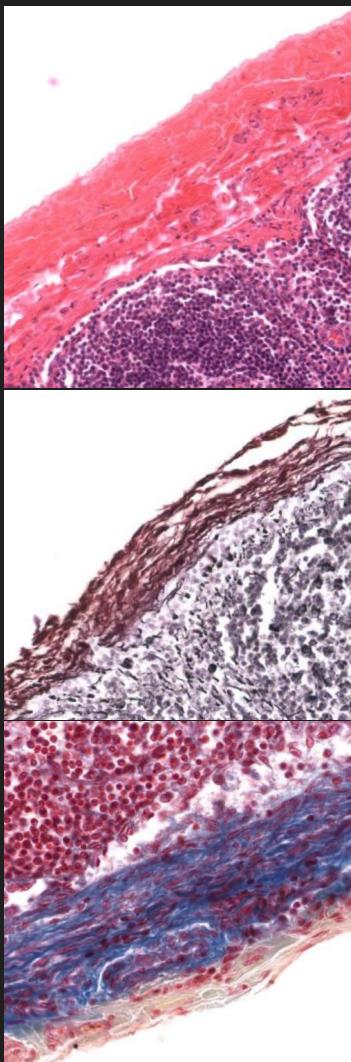


- **Plasma cells:** large numbers of plasma cells are usually seen in the underlying connective tissue near the epithelium.

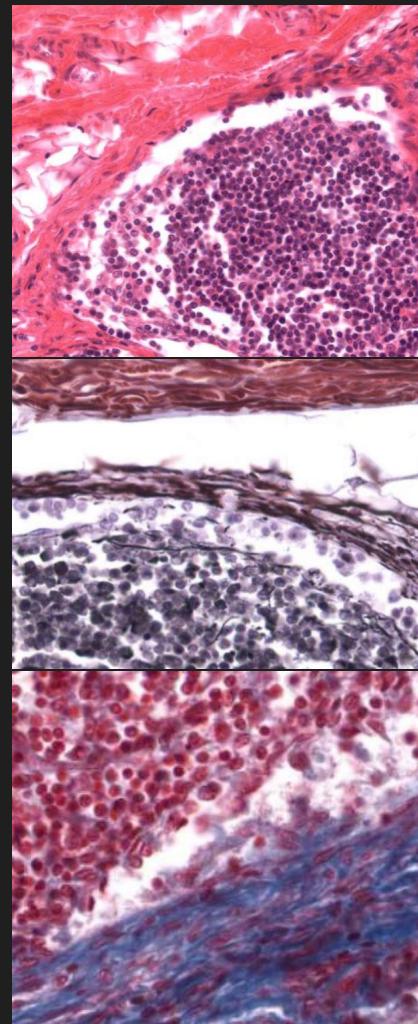


Lymph Nodes

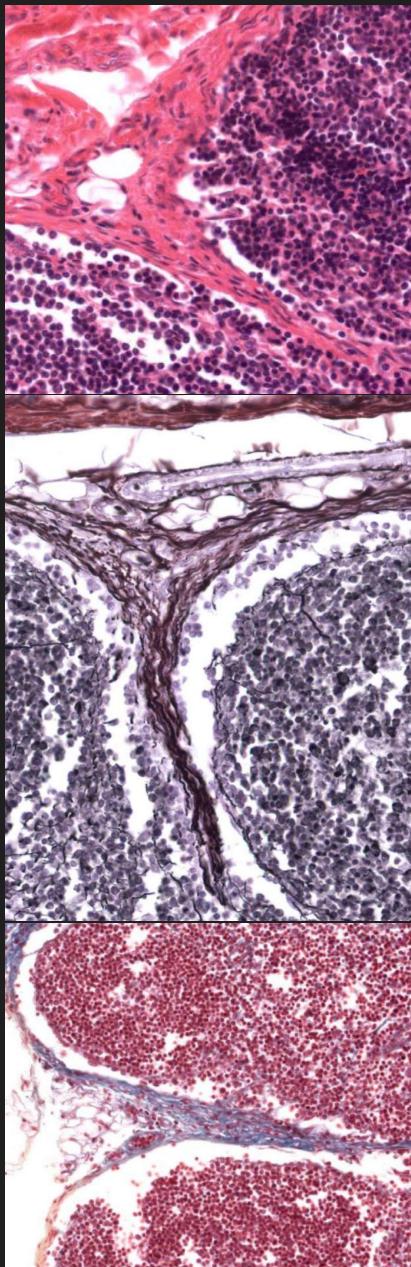
- **Capsule:** dense connective tissue enclosing the node.



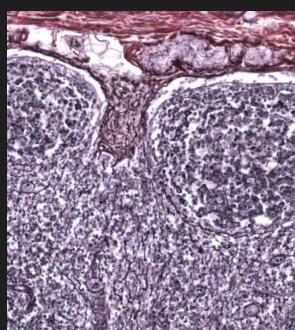
- **Subcapsular Sinus:** space underneath the capsule that receives lymph from afferent lymphatic vessels.



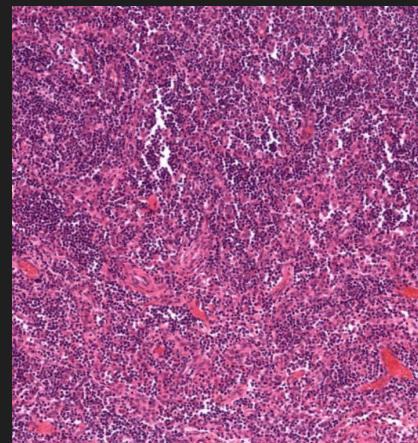
- **Trabeculae:** connective tissue that extends inward from the capsule.



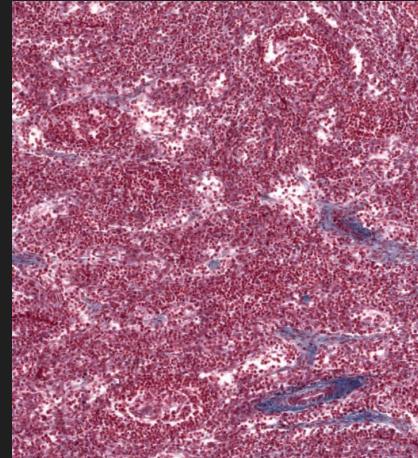
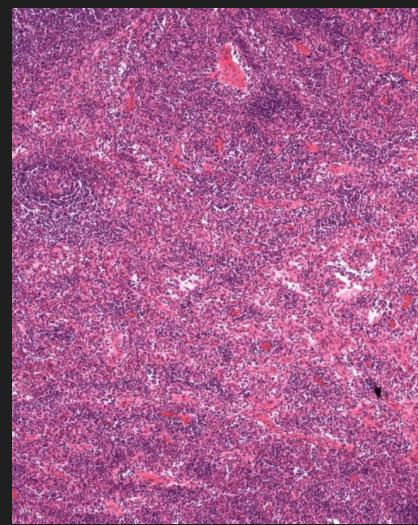
- **Cortex:** reticular fibers form an irregular, anastomosing network in the outer region of the node. Nodules are enclosed by reticular fibers.



- **Inner Cortex:** region between the outer cortex and the medulla that is free of nodules.

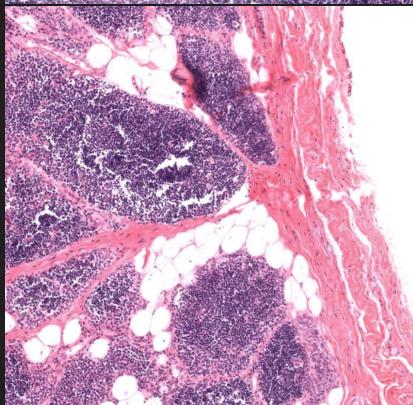
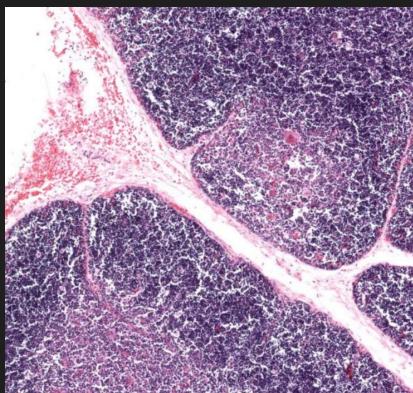


- **Medulla:** inner part of the node.

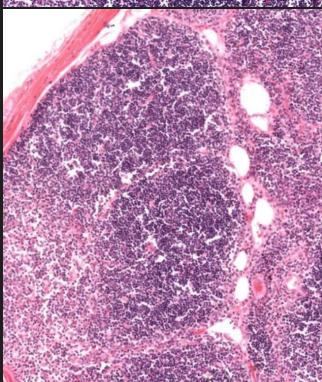
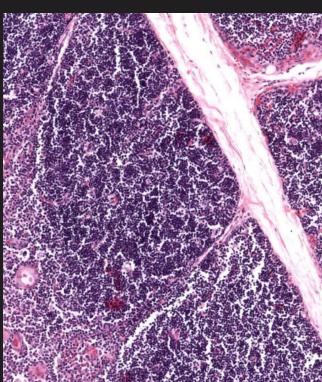


Thymus

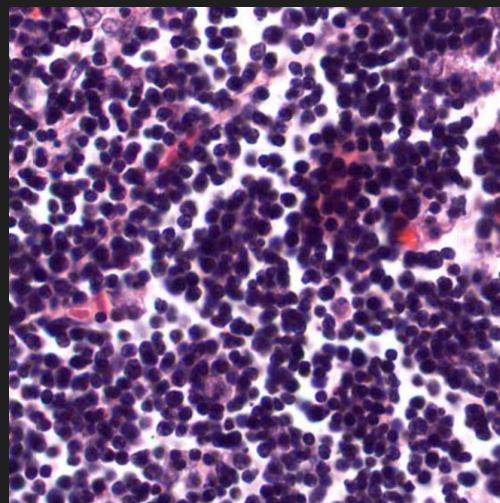
- **Capsule (neonatal/adult)**: thin connective tissue layer surrounding the thymus that extends inwards to form incomplete lobules.



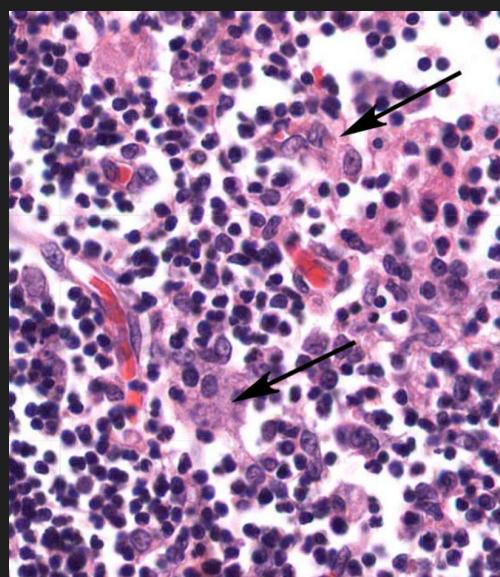
- **Cortex (neonatal/adult)**: outer darker, region of small lymphocytes.



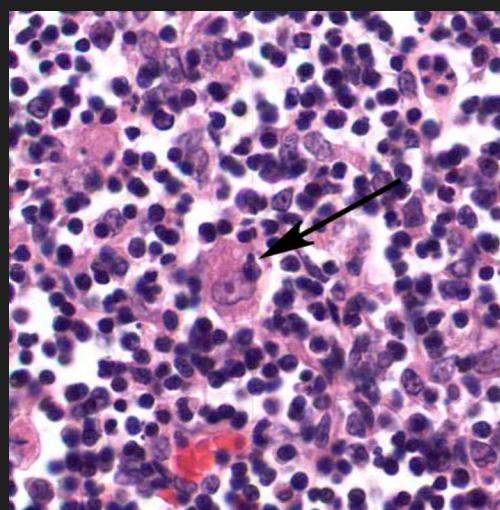
- **T Lymphocytes**: small nuclei of condensed chromatin.



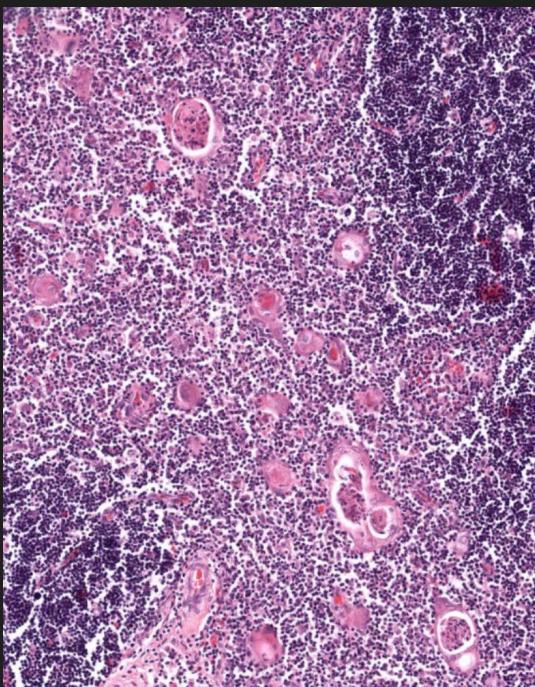
- **Epithelial Reticular Cells**



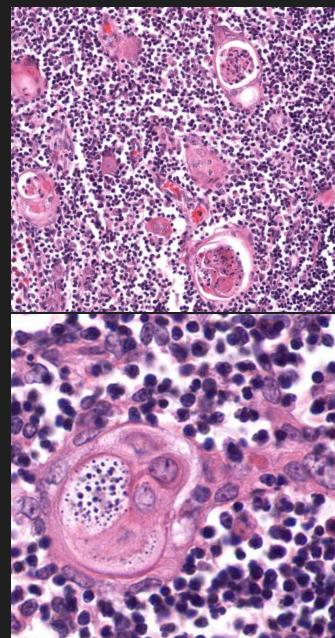
- **Macrophages**: large cells that phagocytize T cells marked for removal.



- **Medulla:** inner, lighter region of larger lymphocytes.

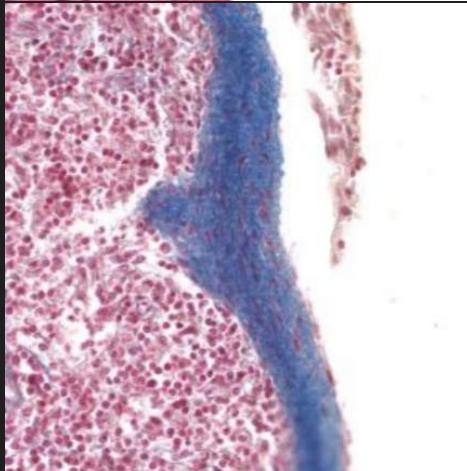
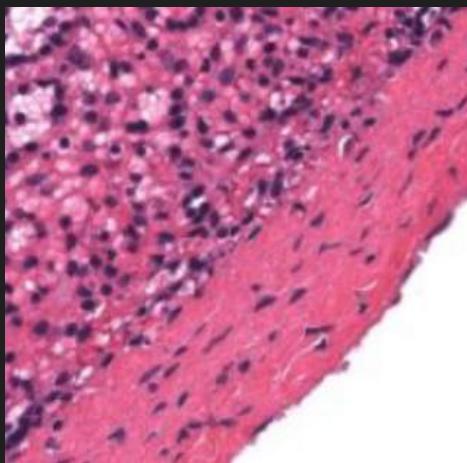


- **Hassal's Corpuscles:** closely packed, concentrically arranged epithelial reticular cells.

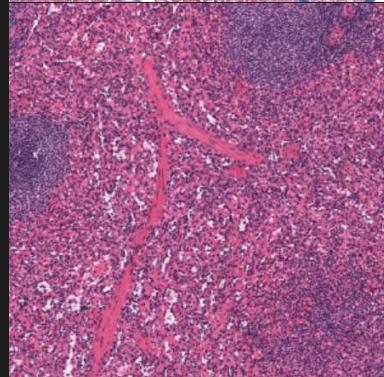
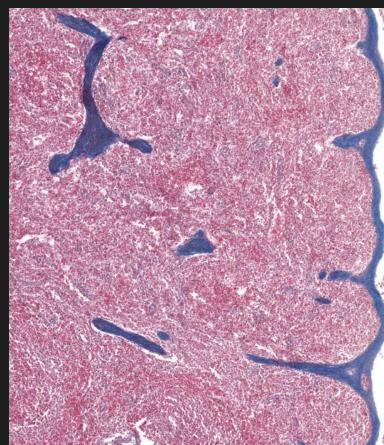


Spleen

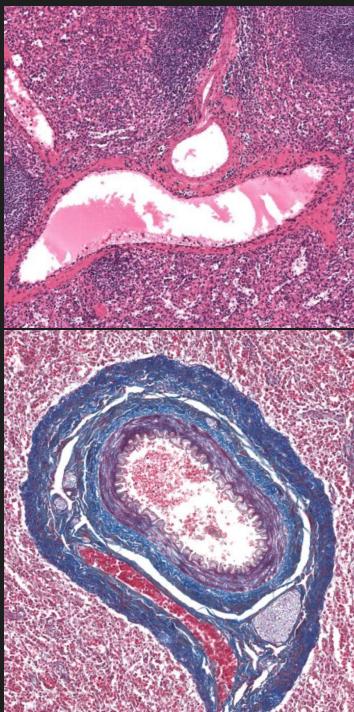
- **Capsule:** dense connective tissue enclosing the organ.



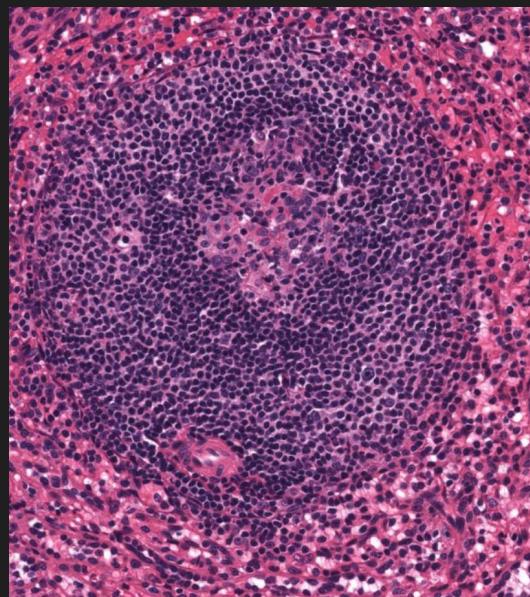
- **Trabeculae:** connective tissue that extends inward from the capsule through which blood vessels enter the pulp



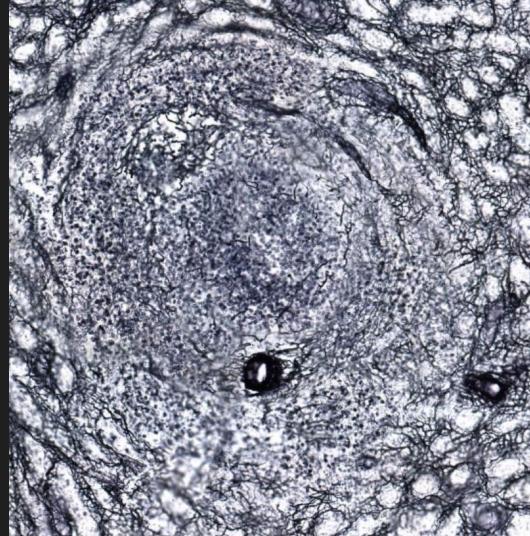
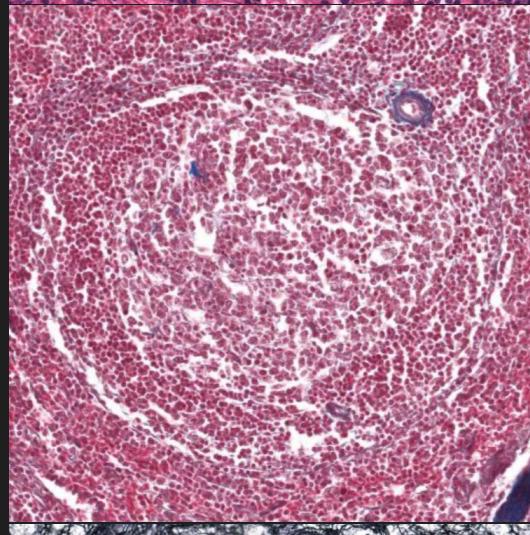
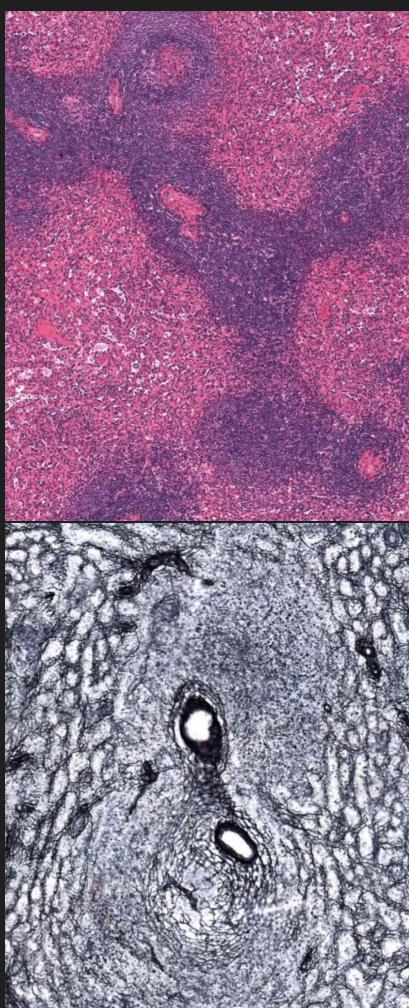
- **Blood vessels**



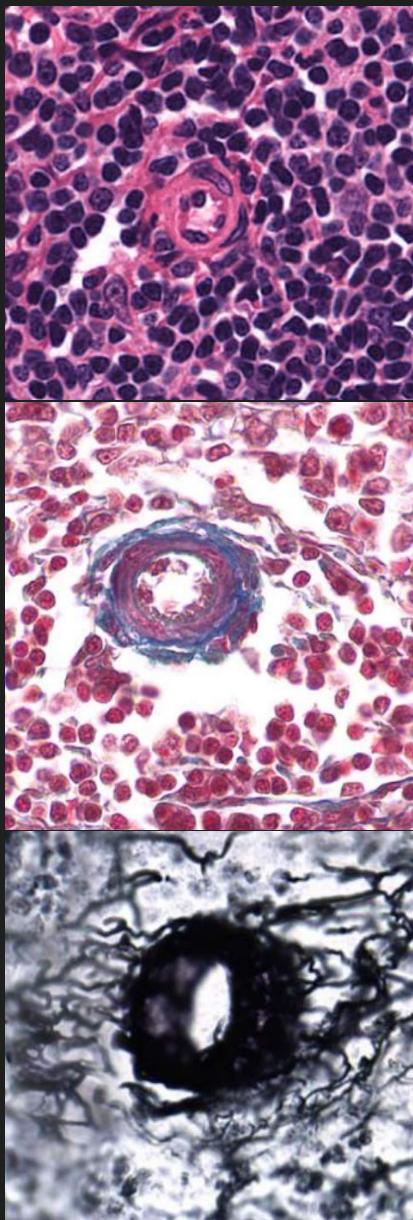
- **Splenic Nodules:** clusters of B lymphocytes located on central arterioles. They usually contain a germinal center of activated B lymphocytes.



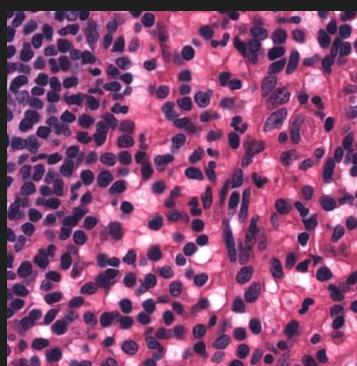
- **White Pulp:** composed of lymphatic tissue. It appears basophilic due to the large number of nuclei.



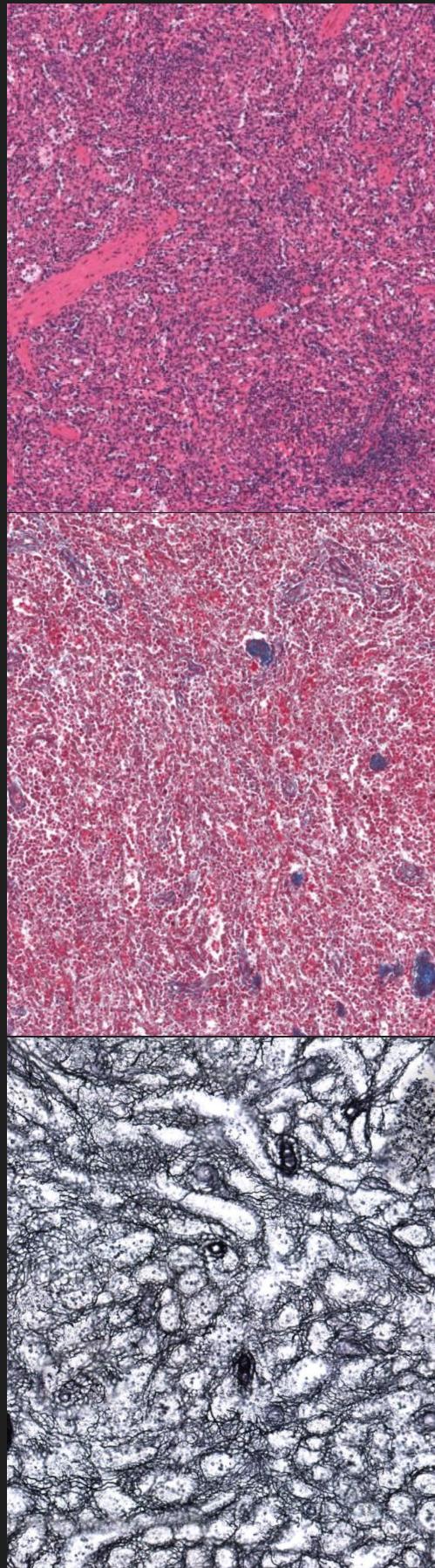
- **Central Arterioles** branches of trabecular arteries coated by PALS and adjacent to nodules.



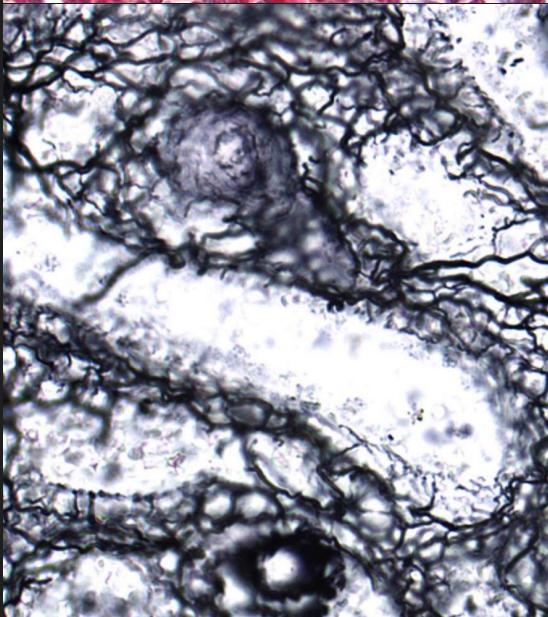
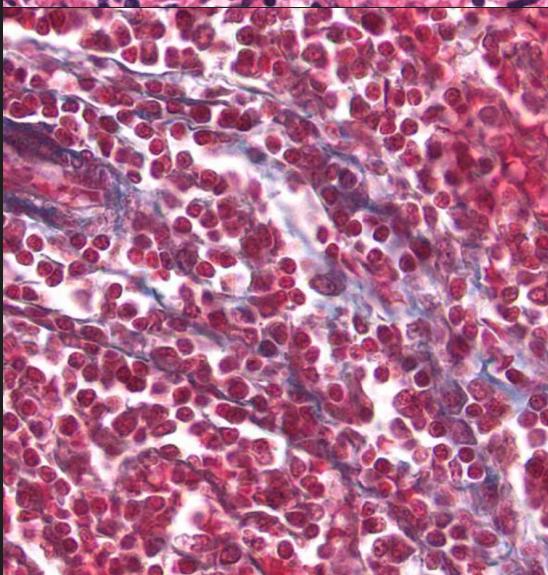
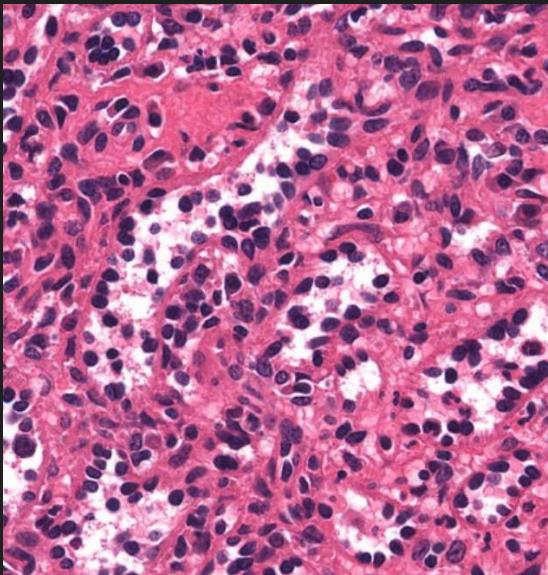
- **Marginal Zone:** region between white and red pulp where macrophages, dendritic cells, and lymphocytes interact.



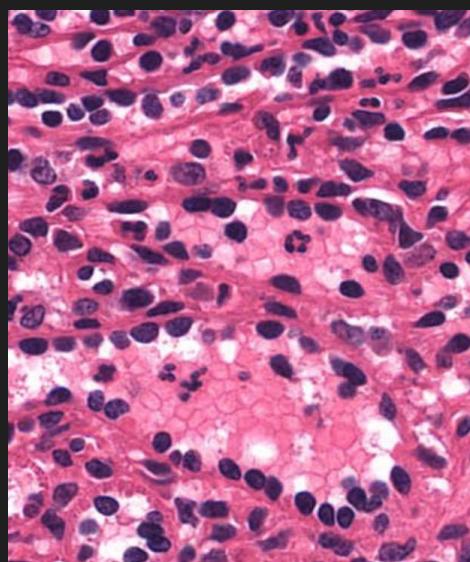
- **Red pulp:** filters and degrades red blood cells (RBCs). It appears eosinophilic due to the large number of RBCs.



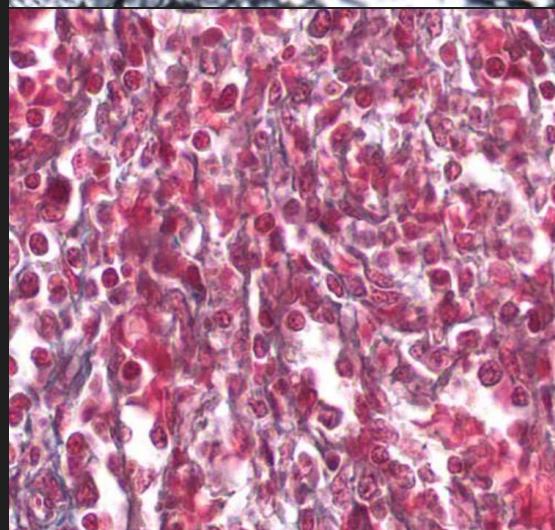
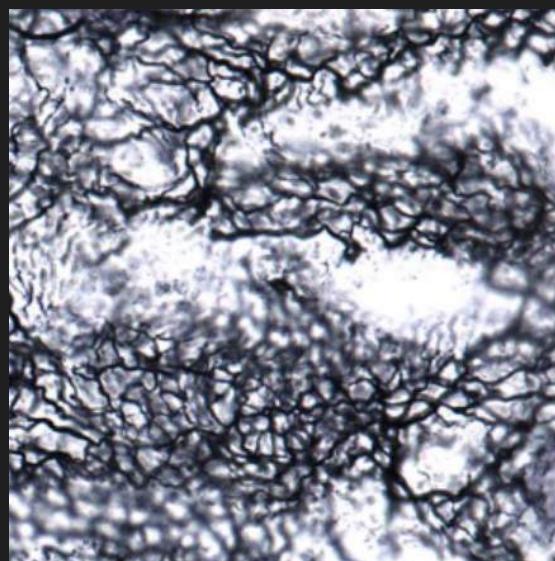
- **Splenic Sinusoids:** vascular spaces lined by specialized endothelial cells that filter RBCs.



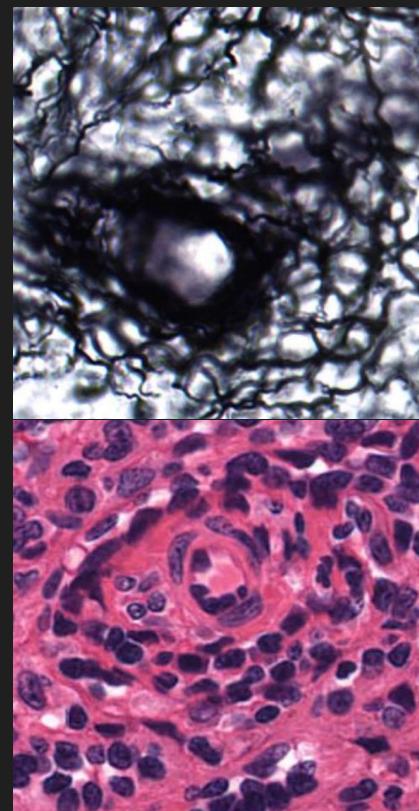
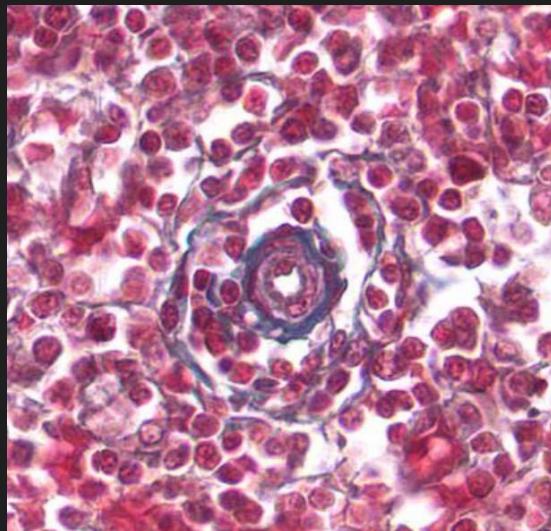
- **Specialized Endothelial Cells**



- **Splenic Cords:** loose connective tissue supported by a meshwork of reticular fibers, and contains loose connective tissue supported by a meshwork of reticular fibers.



- **Pulp Arterioles:** not surrounded by lymphocytes like central arterioles in white pulp and surrounded by layer of reticular fibers.

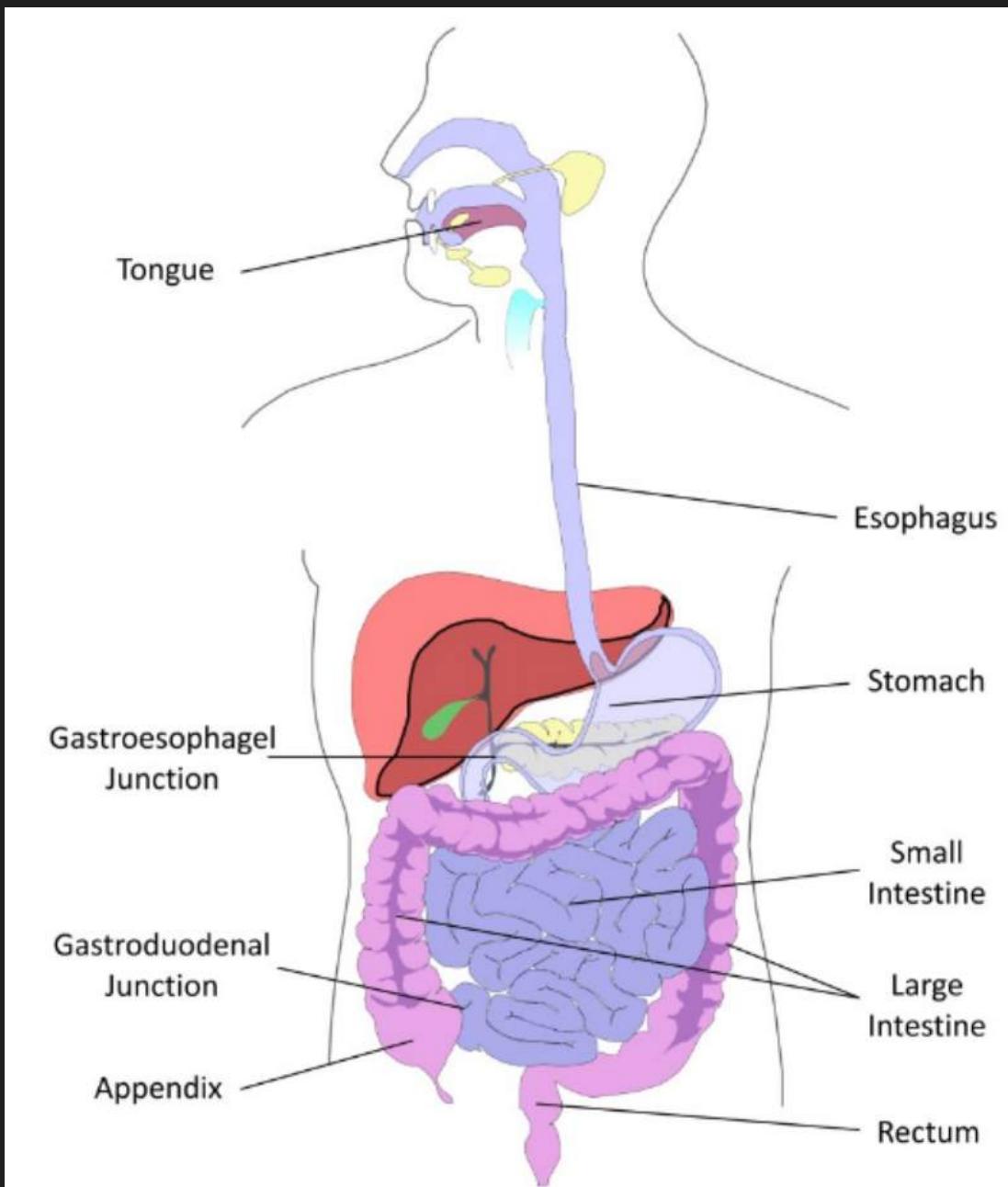


Questions

1. Which lymphatic organs have afferent lymphatic vessels?
 - Found only in lymph nodes; efferent are found in thymus and spleen.
2. How do lymphocytes enter:
 - (a) Lymph nodes?
 - Via blood vessel walls or afferent lymphatic vessels.
 - (b) MALT?
 - Via efferent lymphatic vessels.
3. What are the components of the blood thymic barrier?
 - Epithelial reticular cells, basal laminae, and endothelial cells joined by tight junctions.
4. Which of the lymphatic organs filters blood?
 - Spleen.

Digestive

- Gastrointestinal Tract



Tongue

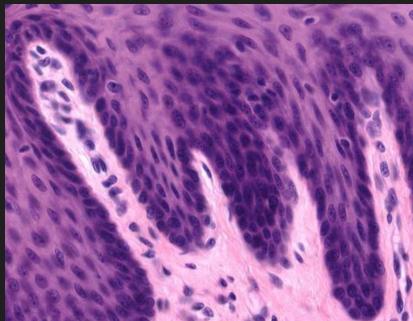
- Overview of the Tongue



- Stratified Squamous Non-Keratinized Epithelium



- **Dermal Papillae:** ridges of connective tissue that project into the epithelium that reduce its mobility and brings blood vessels in close contact with the epithelial cells.



- **Foliate Papillae:** parallel ridges on the lateral edges of the tongue separated by deep mucosal furrows.



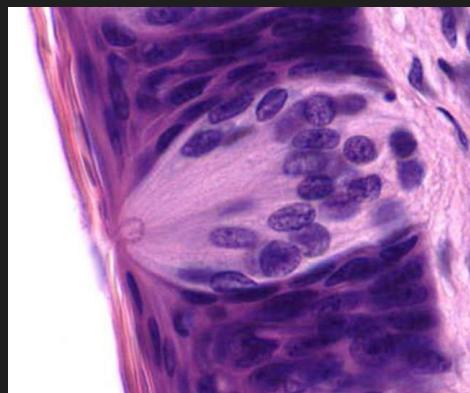
- **Furrows:** separate each papillae and receive saliva from the minor lingual glands.



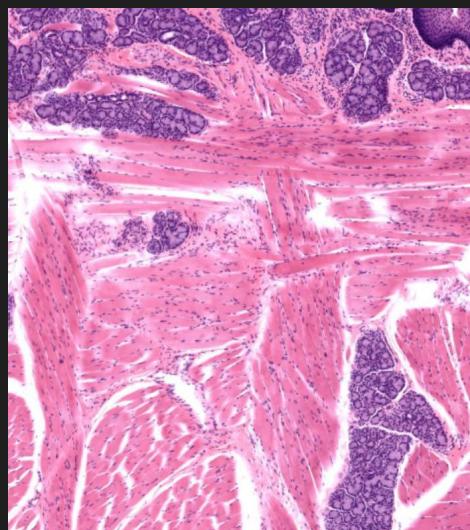
- **Taste Buds:** elliptical structures found in the epithelium of the furrows that contain cells with taste receptors. The circular opening at its apex is the taste pore.



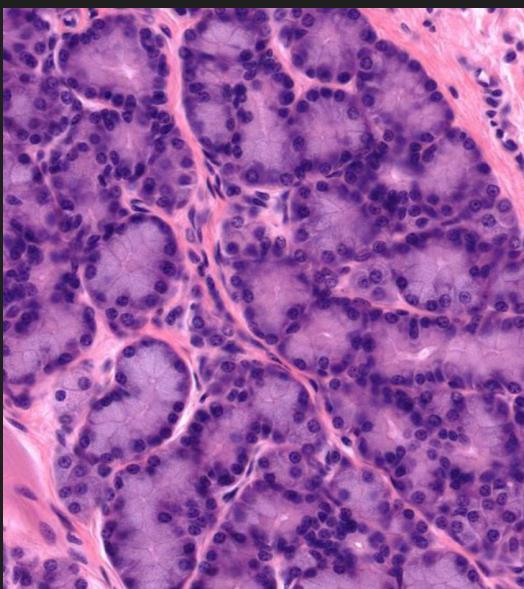
- **Taste Pore**



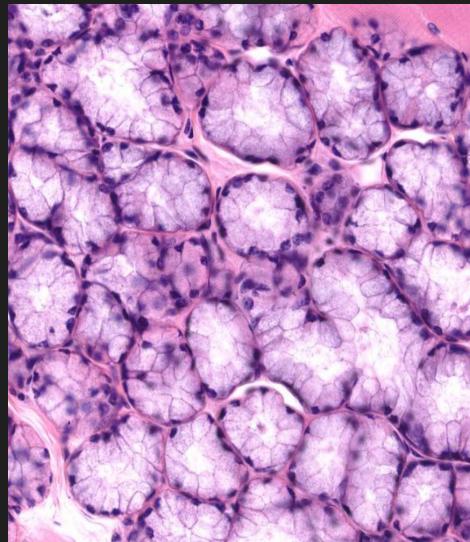
- **Skeletal Muscle:** arranged in three bundles at right angles to each other to allow flexibility and precision in movements of the tongue.



- **Serous Glands:** secrete a fluid that contains digestive enzymes.



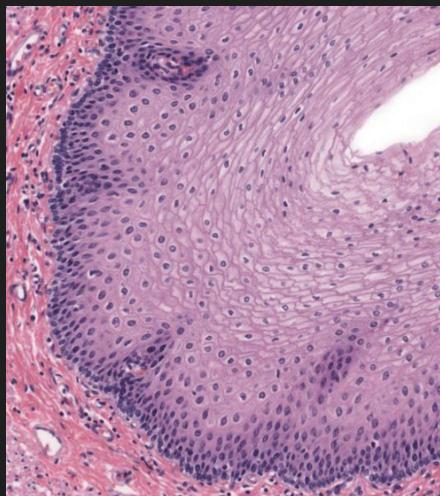
- **Mucous Glands:** secrete a fluid that contains mucus (glycoproteins known as mucins).



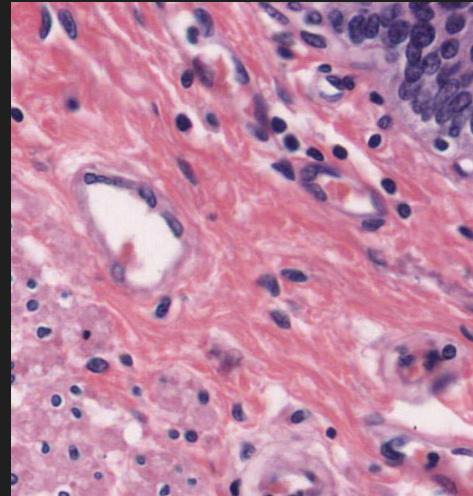
Esophagus



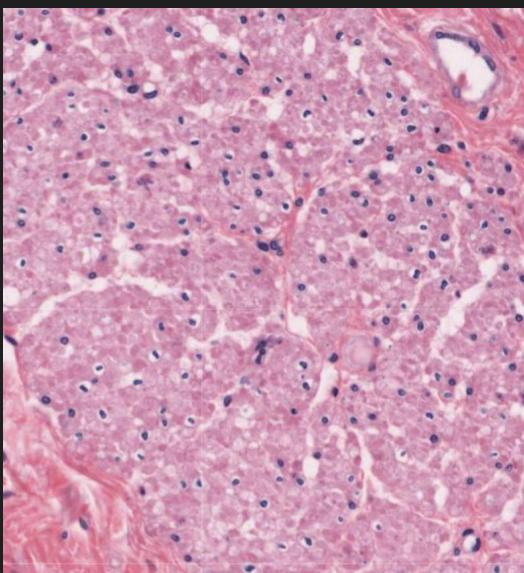
- **Stratified Squamous Non-Keratinized Epithelium:**



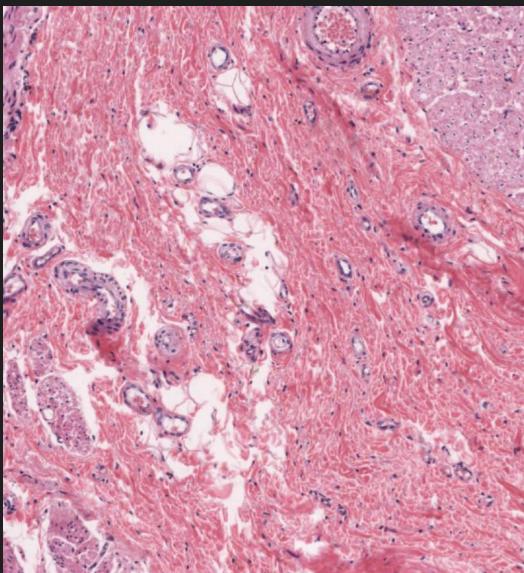
- **Lamina Propria:** dense irregular connective tissue.



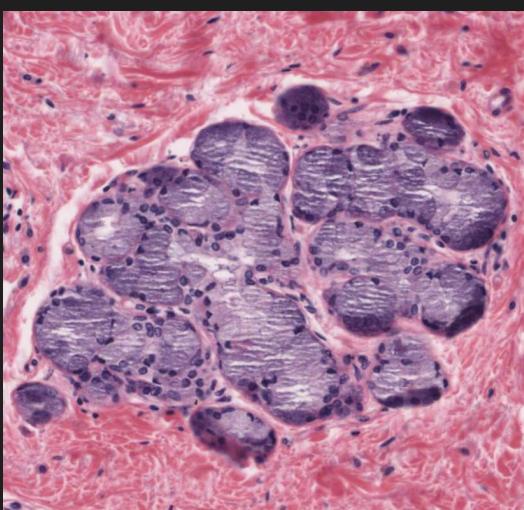
- **Muscularis Mucosae:** smooth muscle.



- **Submucosa:** dense irregular connective tissue.



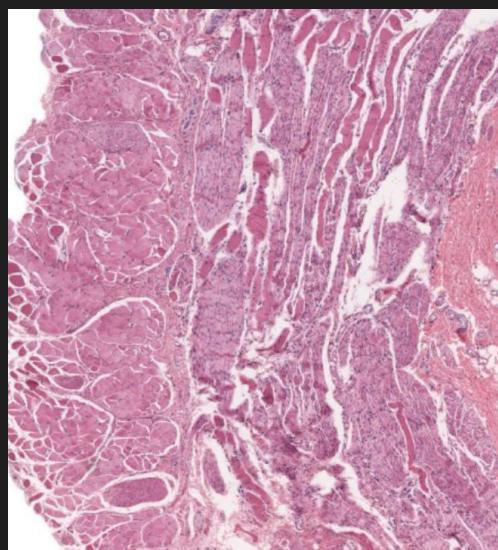
- **Mucus Glands:** only the esophagus and the duodenum have glands in the submucosa.



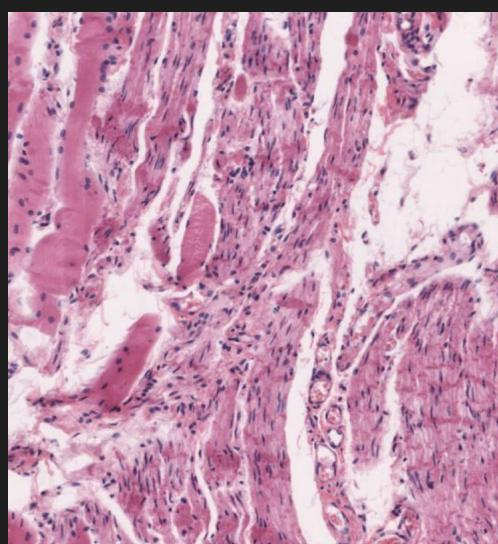
- **Ducts:** usually have cuboidal or stratified cuboidal epithelium.



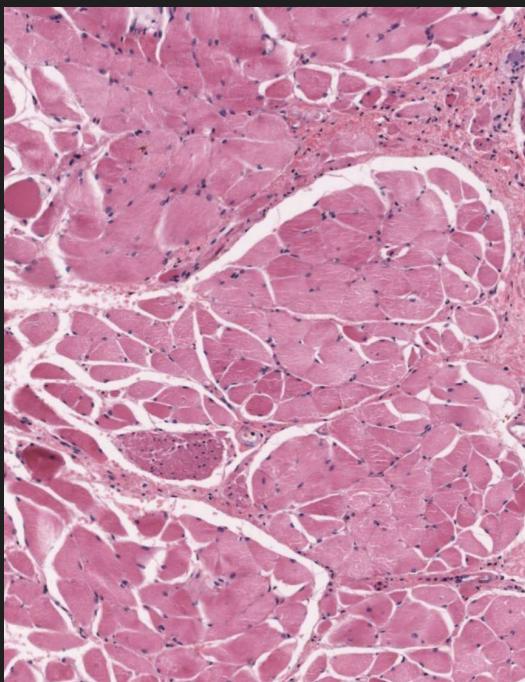
- **Muscularis Externa:** contains both smooth and skeletal muscle because this specimen is from the middle third of the esophagus.



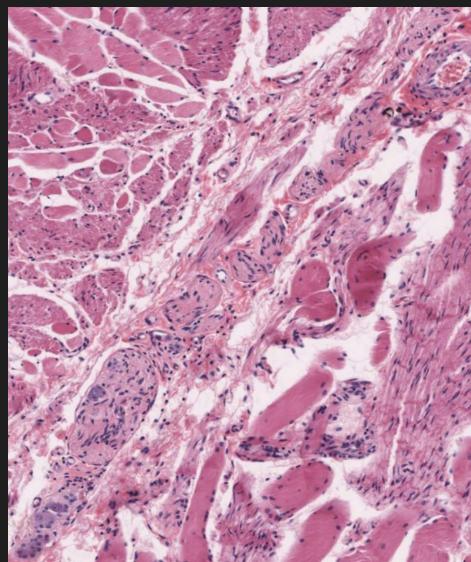
- **Inner Layer**



- **Outer Layer**

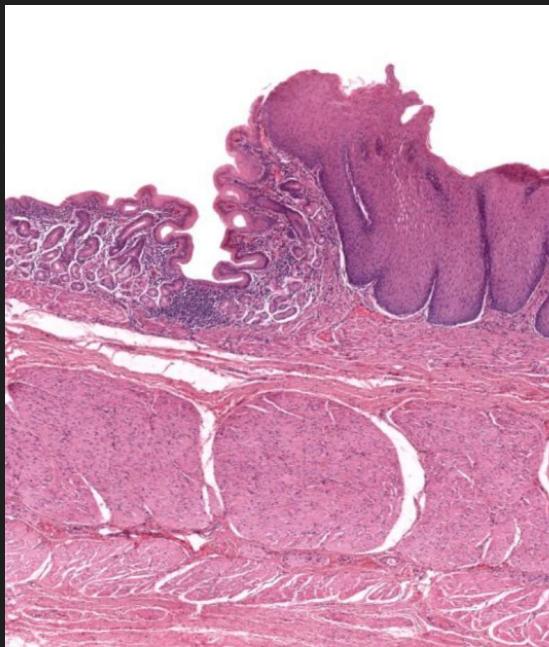


- **Auerbach's plexus:** is found between the inner and outer layers of the muscularis externa. Ganglia with prominent capsule cells can be seen.

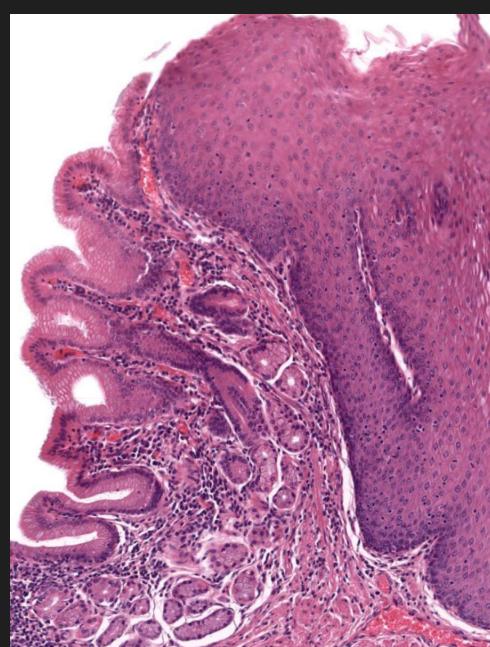


Gastroesophageal Junction

- **Gastroesophageal Junction**



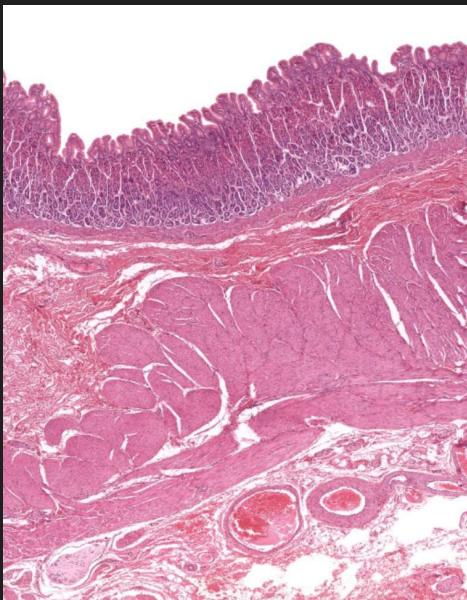
- **Change in Epithelium**



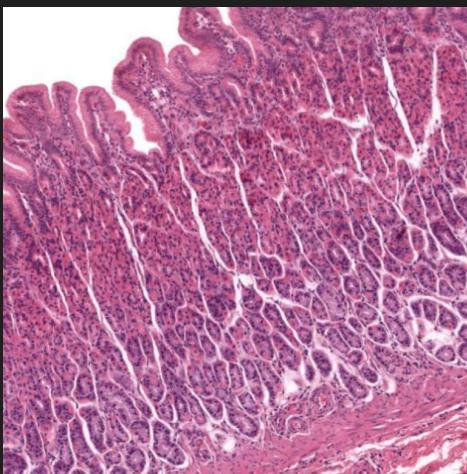
- How can you diagnose whether you are looking at the upper or lower portion of the esophagus?
 - The best way to tell is to look at the epithelium; the upper portion of the esophagus has stratified squamous while the lower portion (stomach) has simple columnar epithelium with long linear or coiled glands.

Stomach

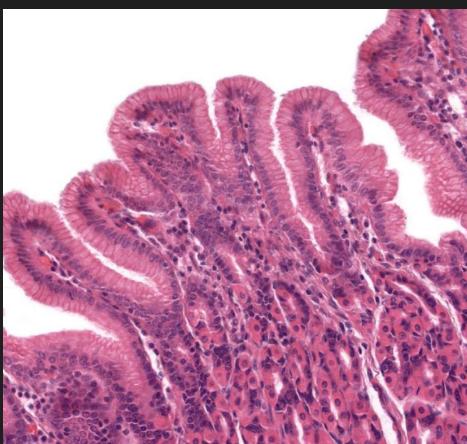
- **Stomach**



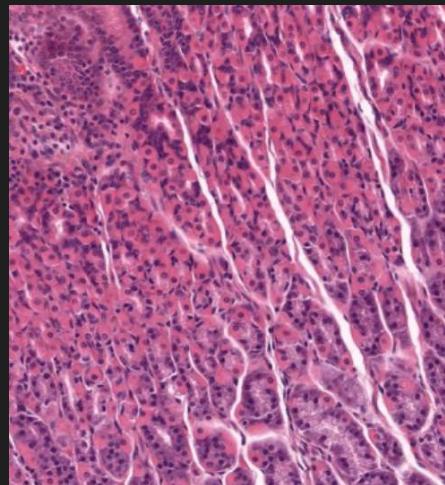
- **Mucosa:** composed of the epithelium, lamina propria, and muscularis mucosae.



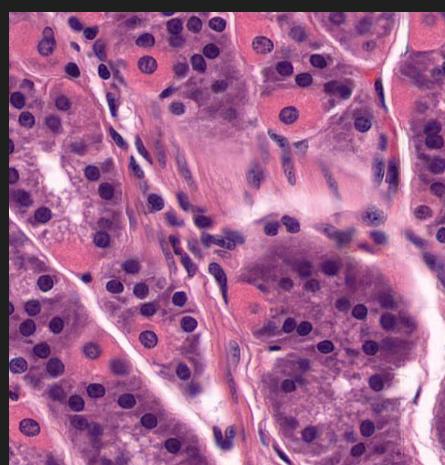
- **Gastric Pits:** invaginations of the surface epithelium.



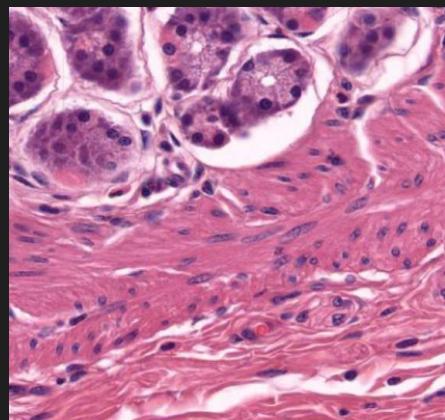
- **Gastric Glands:** tubular glands that extend from the base of the gastric pits to the muscularis mucosae.



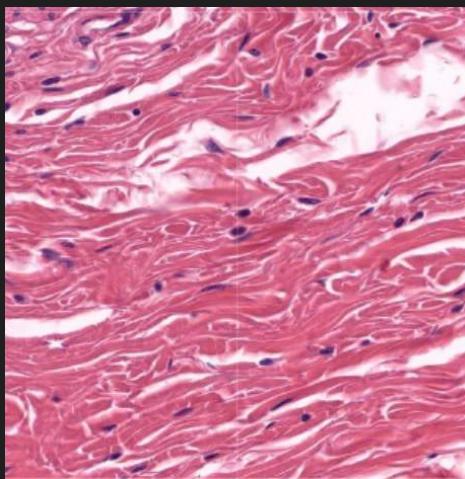
- **Lamina Propria:** reduced to small amounts of connective tissue found between gastric pits and glands.



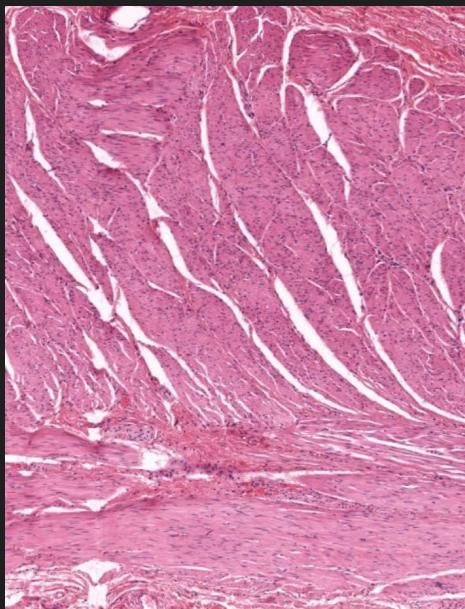
- **Muscularis Mucosae:** narrow layer of smooth muscle cells at the base of the mucosa.



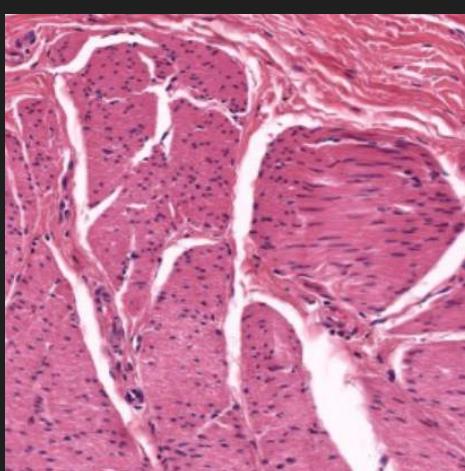
- **Submucosa:** dense irregular connective tissue.



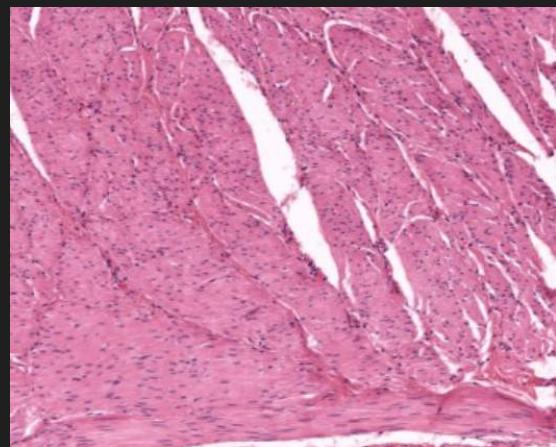
- **Muscularis Externa:** three layers of muscle cells rather than two layers found elsewhere in the GI tract.



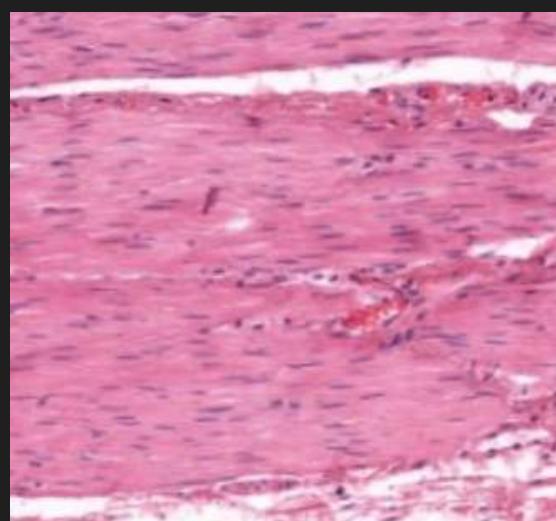
- **Inner Oblique Layer:** this layer is unique to the stomach and is found near the boundary with the submucosa.



- **Middle Circular Layer:**



- **Outer Longitudinal Layer:**

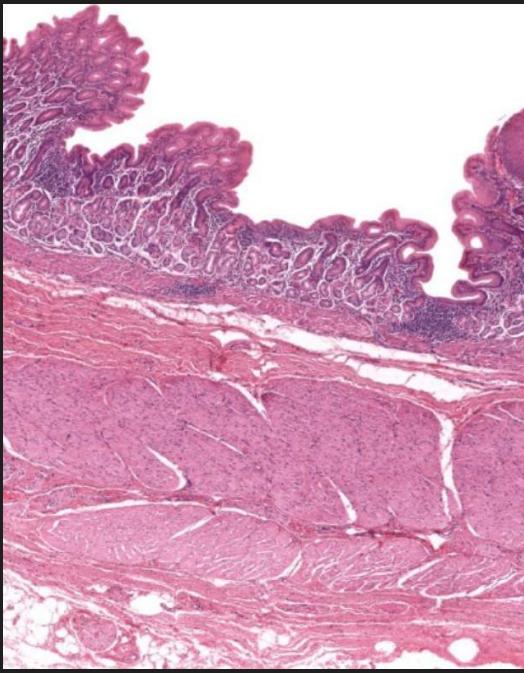


- **Adventitia:** loose irregular connective tissue.

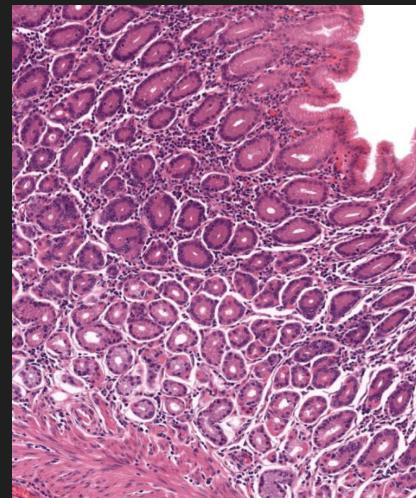


- **Cardiac Stomach:** the narrow region surrounding the opening of the esophagus that contains cardiac

glands in the mucosa.



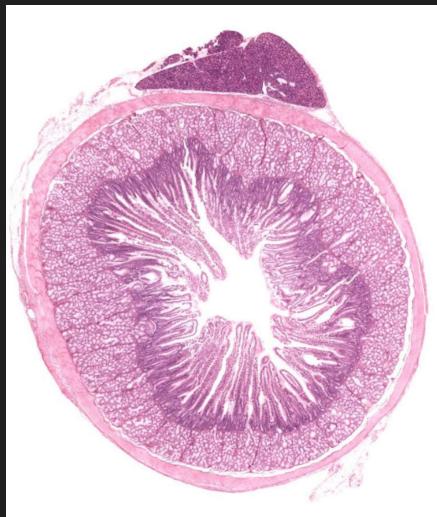
- **Cardiac Glands:** appear as cross-sections of the coiled tubular glands of mostly mucus secreting cells that empty into the bottom of gastric pits.



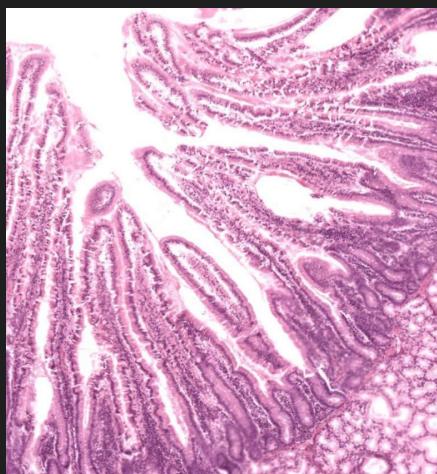
- To what ultrastructural feature does the brush border correspond?
 - The presence of mucous-secreting duodenal glands in its submucosa.

Small Intestine

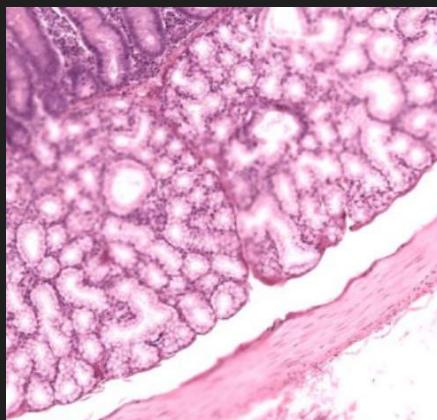
- **Duodenum:** proximal portion adjacent to the stomach.
- **Jejunum:** middle portion.

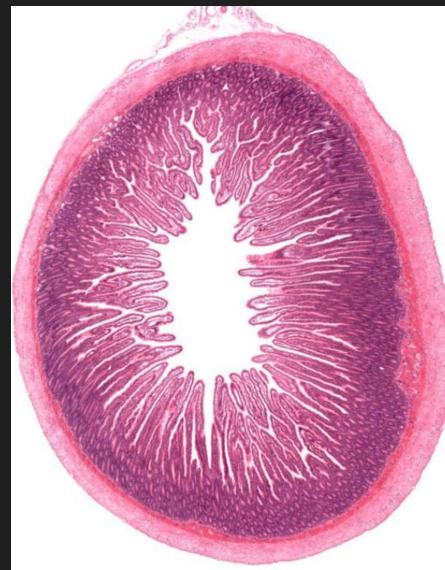


- **Villi (Duodenum):** tall, slender finger-like projections that extend into the lumen.

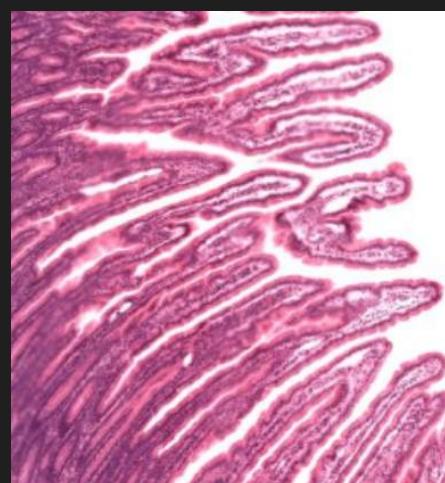


- **Brunner's Glands:** only region of the gastrointestinal tract (along with the esophagus) with glands in the submucosa.





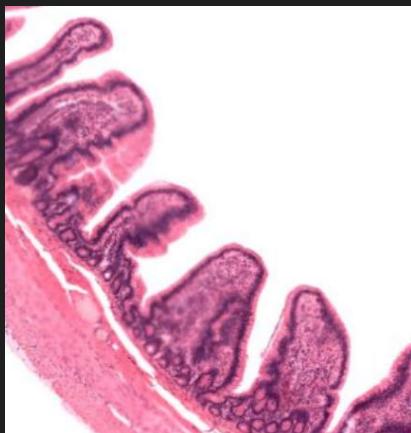
- **Villi (Jejunum)**



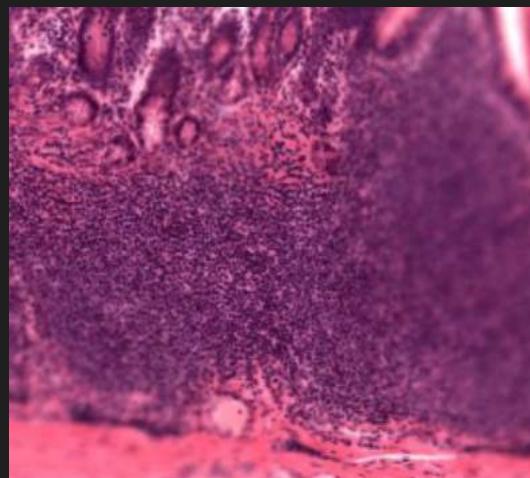
- **Ileum:** distal portion adjacent to the large intestine.



- **Villi (Ileum)**: short, broad finger-like projections with blunt ends that extend into the lumen.



- **Peyer's Patches**: diffuse aggregations of lymphoid cells in the lamina propria.

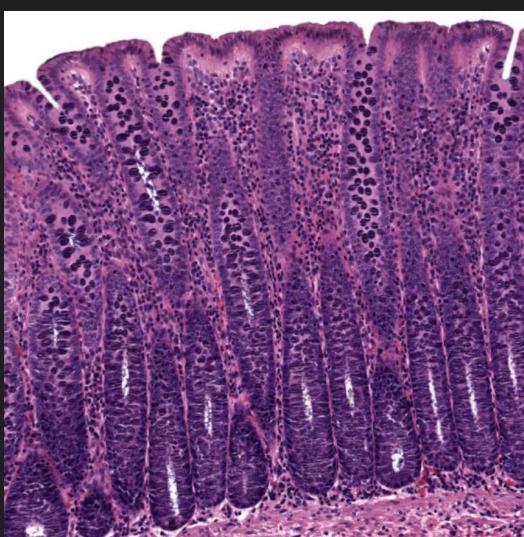


Large Intestine

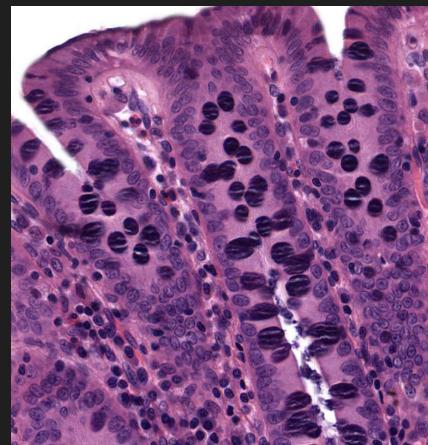
- **Colon**: The colon is composed of the four layers characteristic of the gastrointestinal tract. However, neither villi nor plicae circulares are present and goblet cells become more frequent.



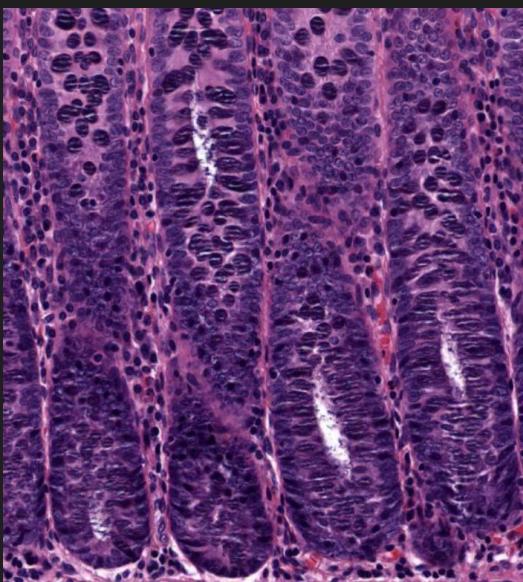
- **Mucosa**: mucous membrane.



- **Epithelium**: with enterocytes (simple columnar cells with microvilli; i.e., the brush border) and goblet cells.



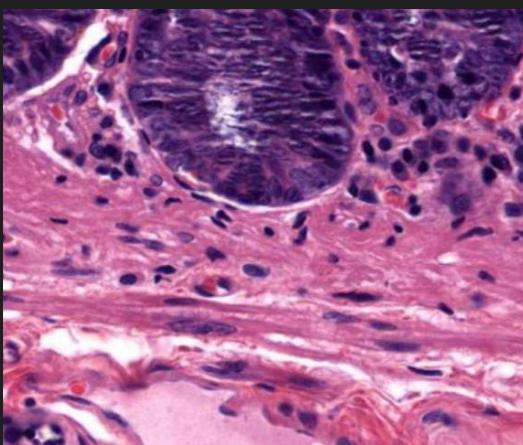
- **Intestinal Crypts of Lieberkuhn:** straight, unbranched, tubular glands.



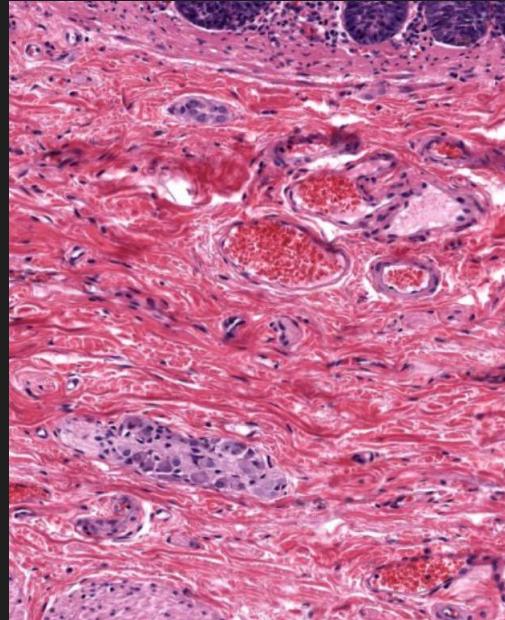
- **Lamina Propria:** abundant between cross-sections of the crypts. Many including cell types plasma cells, lymphocytes, eosinophils and macrophages can be seen.



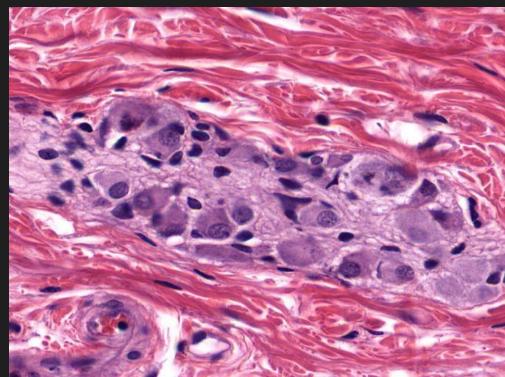
- **Muscularis Mucosae:** layer of smooth muscle.



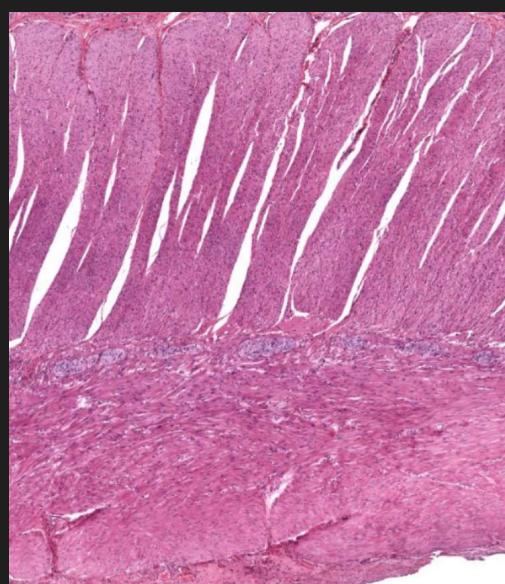
- **Submucosa:** dense irregular connective tissue.



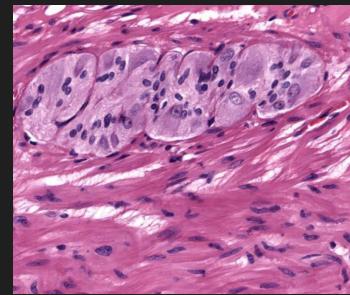
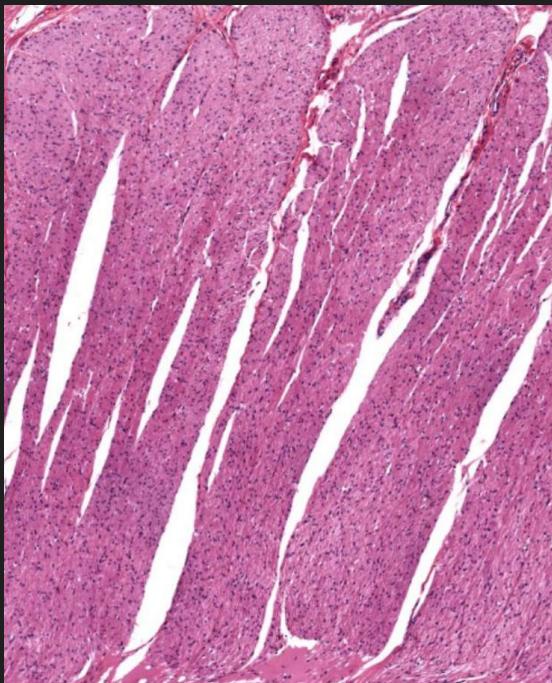
- **Meissner's Plexus:** provides secretory innervation of goblet cells and motor innervation of the muscularis mucosae.



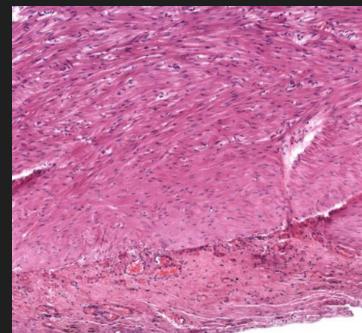
- **Muscularis Externa:** two orthogonal layers of smooth muscle.



- **Inner Circular Layer:** smooth muscle.
- **Auerbach's Plexus:** provides motor innervation of the muscularis externa.

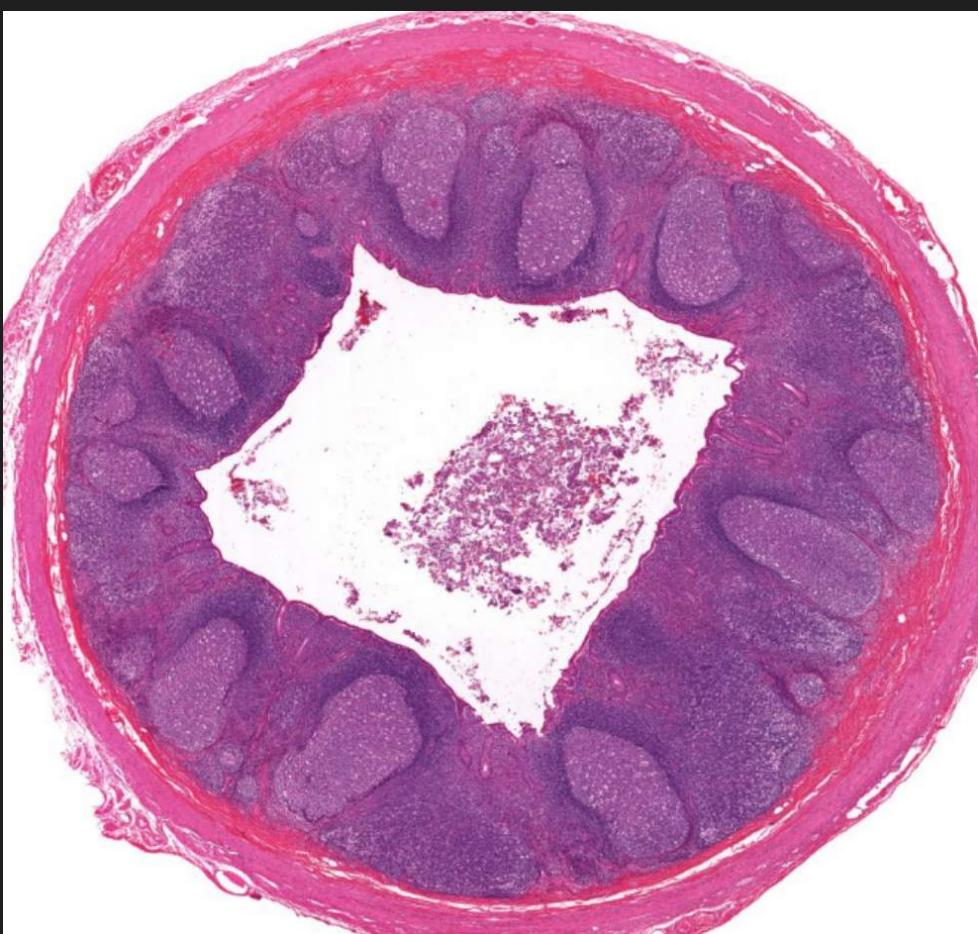


- **Outer Longitudinal Layer:** smooth muscle.

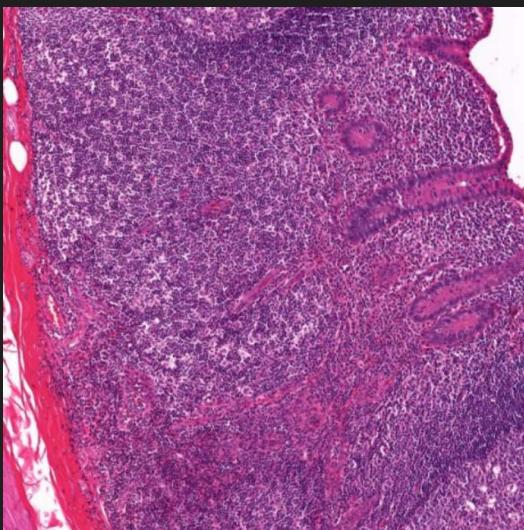


Appendix

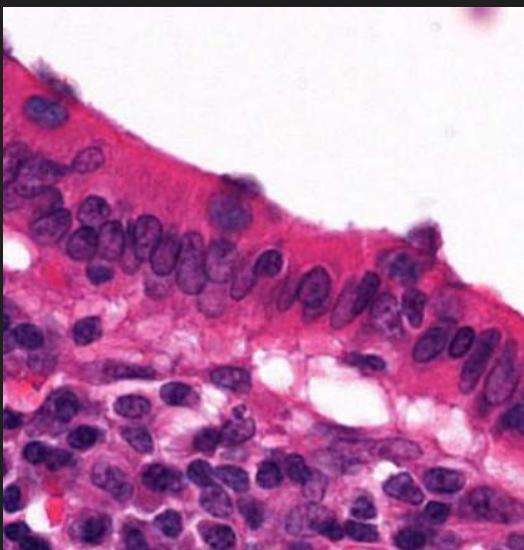
- **Appendix:** the appendix is composed of the four layers characteristic of the gastrointestinal tract.



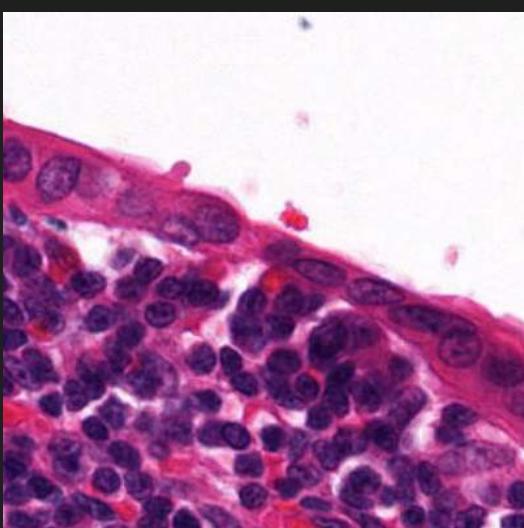
- **Mucosa**



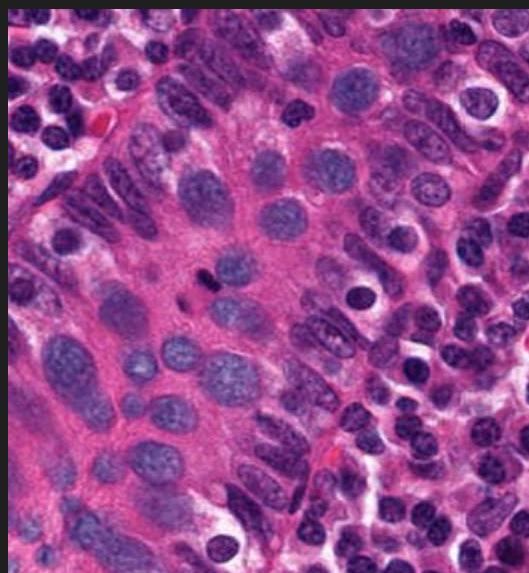
- **Enterocytes**: simple columnar cells with microvilli (or brush border).



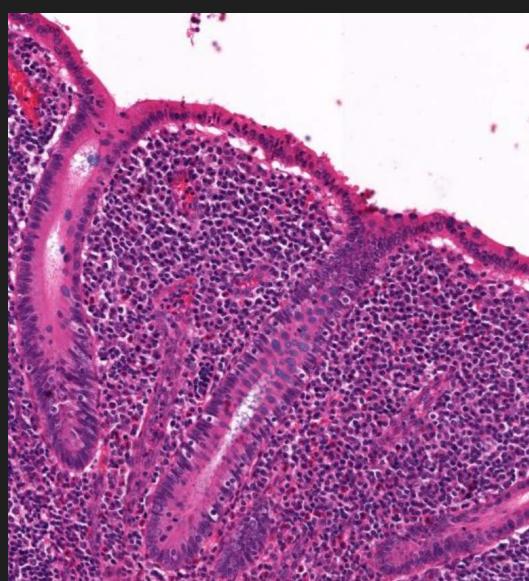
- **M-Cells**: cover nodules and have a lower profile than absorptive cells (small folds on their surface versus microvilli on absorptive cells).



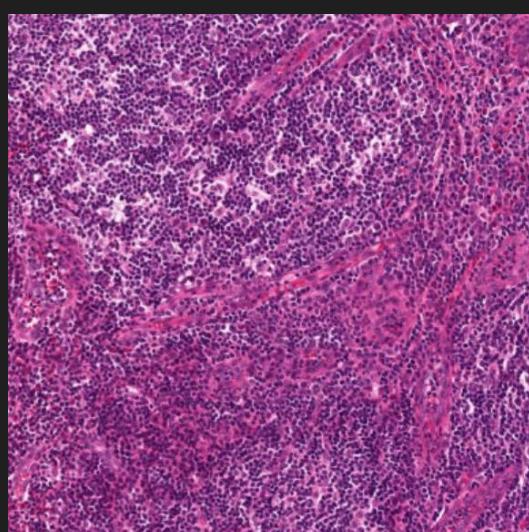
- **Goblet Cells**: secrete mucus for lubrication



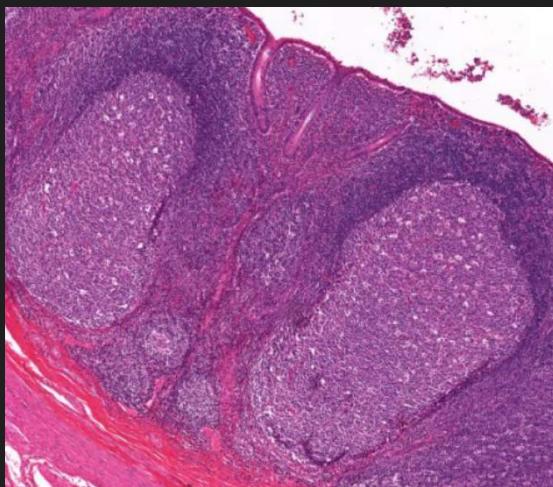
- **Crypts**: very few.



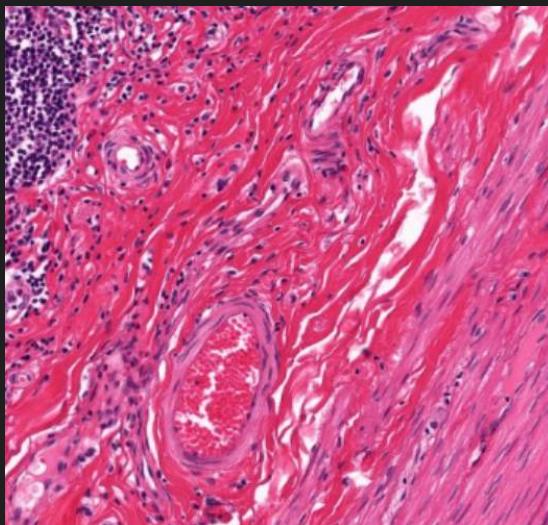
- **Lamina Propria**: comprises almost the entire mucosa.



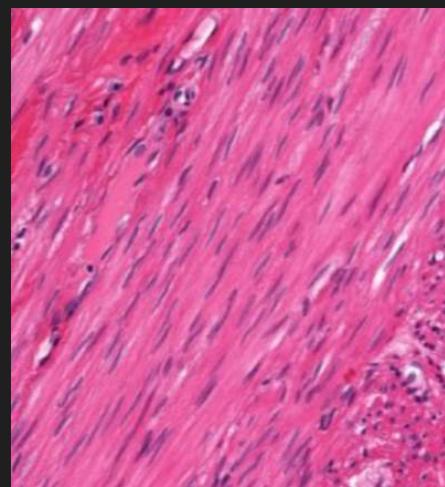
- **Nodules:** fill the lamina propria.



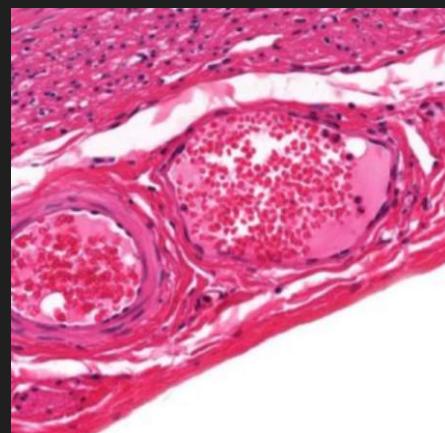
- **Submucosa:** nodules may extend into the submucosa



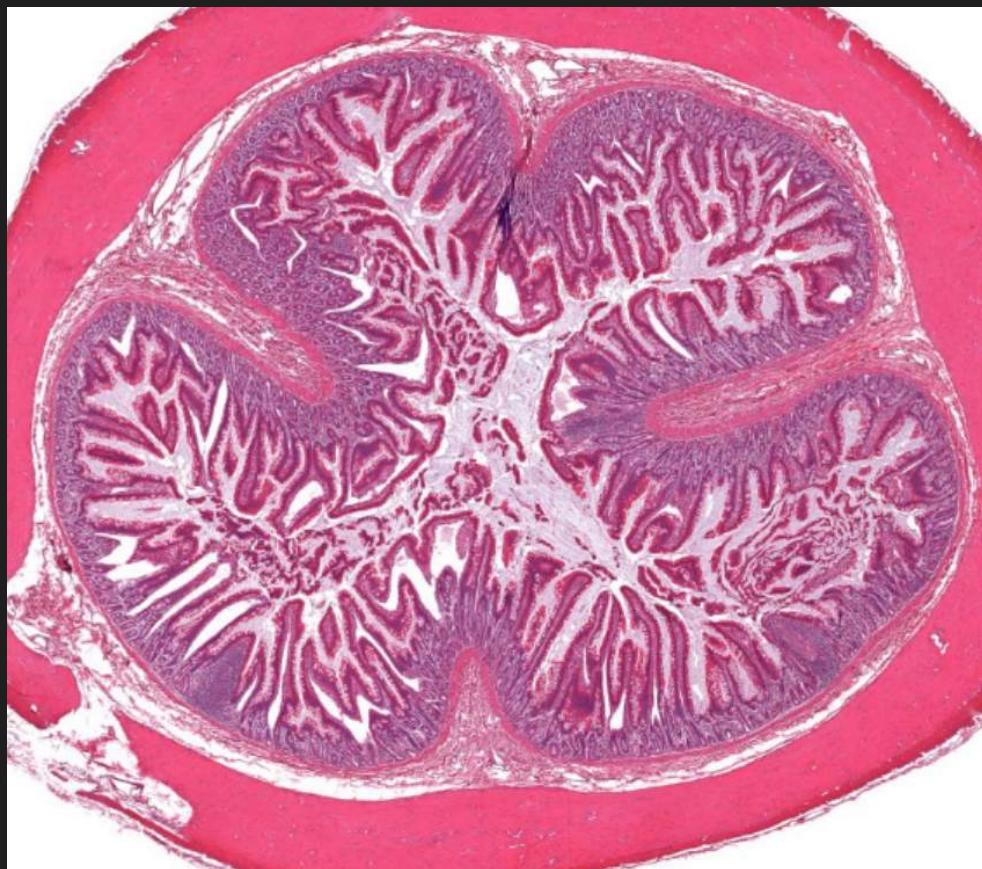
- **Muscularis Externa:** two orthogonal layers of smooth muscle (inner circular and outer longitudinal).



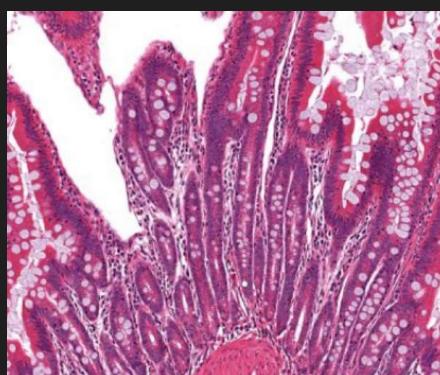
- **Serosa:** covers the outer surface of the appendix.



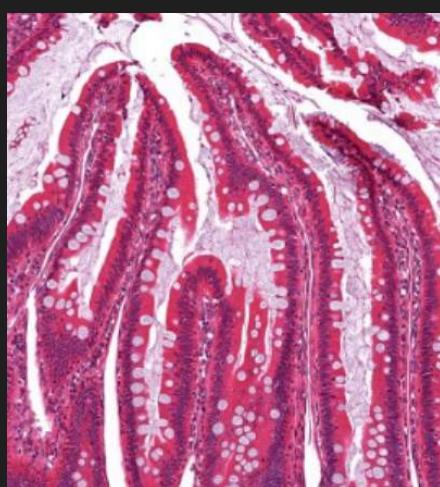
Rectum



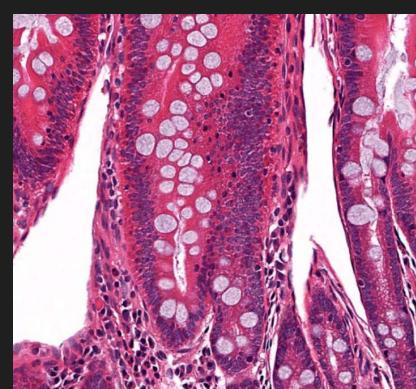
- **Mucosa:**



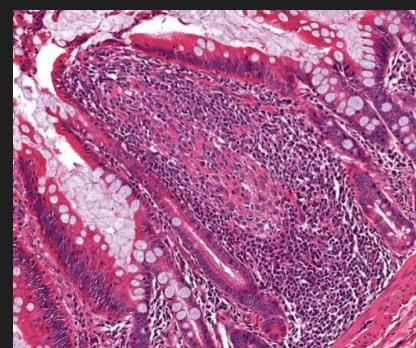
- **Villi:** cover the surface of the mucosa.



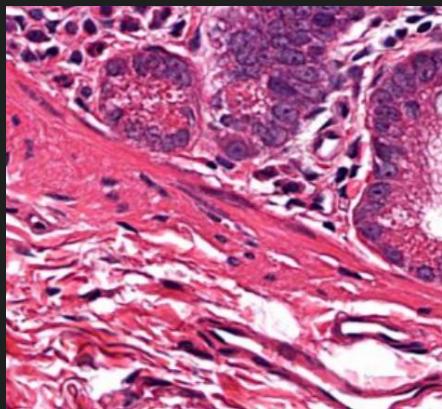
- **Crypts:**



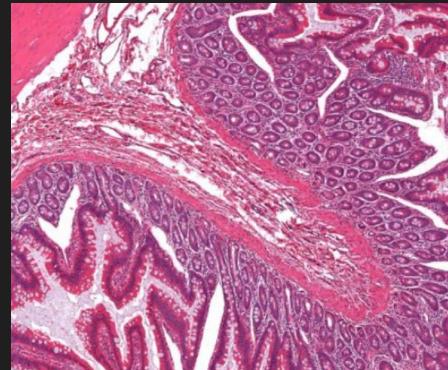
- **Lamina Propria:** loose connective tissue that supports the epithelium and forms the core of villi.



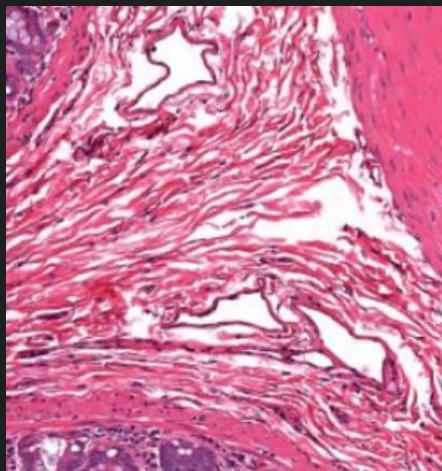
- **Muscularis Mucosae:** layer of smooth muscle



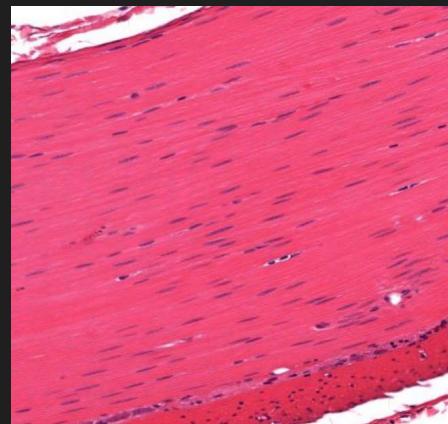
- **Anal Columns:** vertical folds of the mucosa and submucosa that project into the lumen.



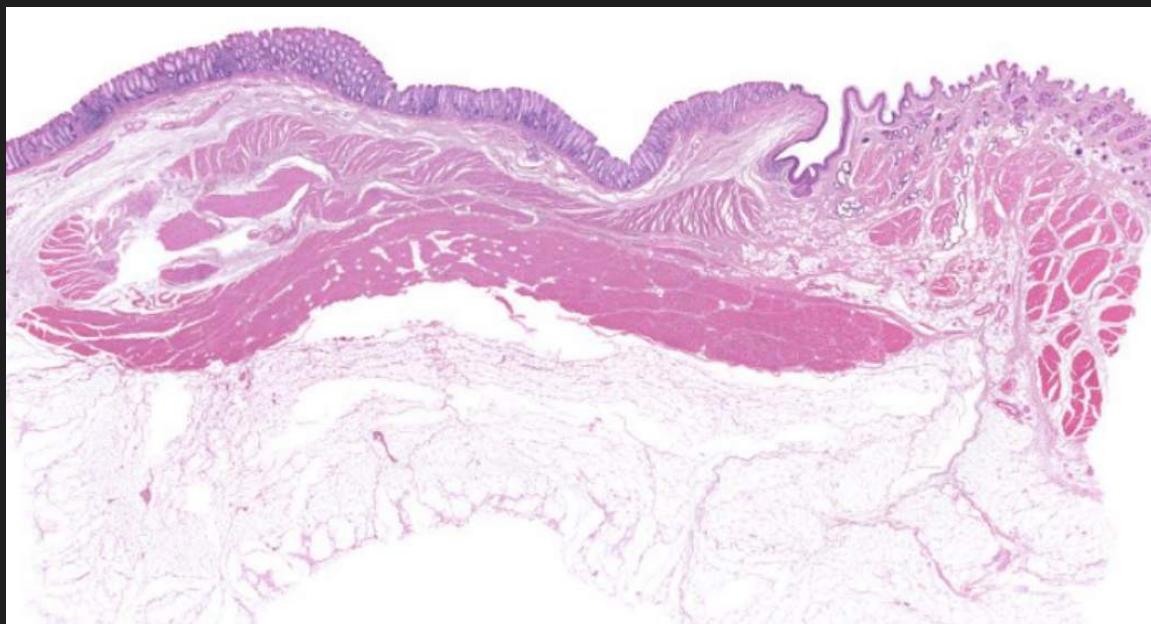
- **Submucosa:** dense irregular connective tissue.



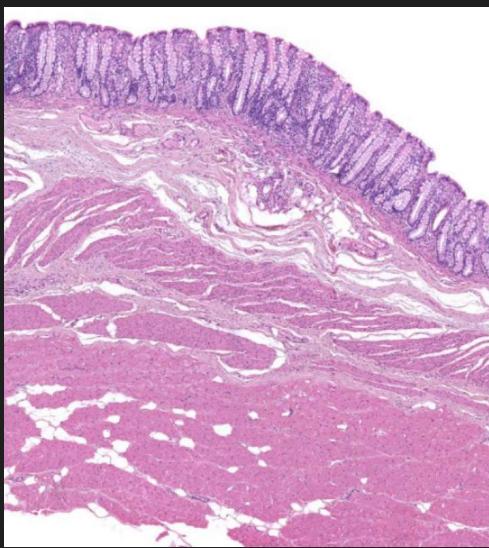
- **Muscularis Externa:** two orthogonal layers of smooth muscle (inner circular and outer longitudinal).



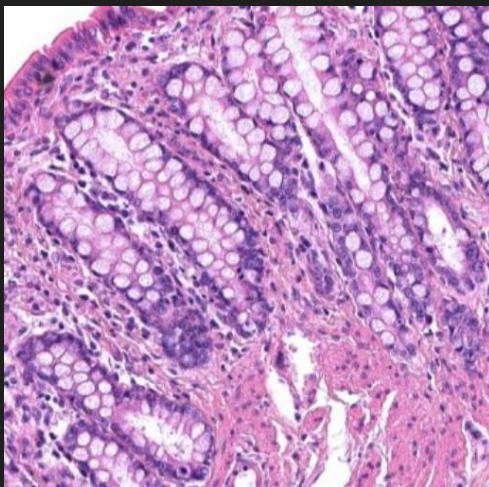
Recto-Anal Junction



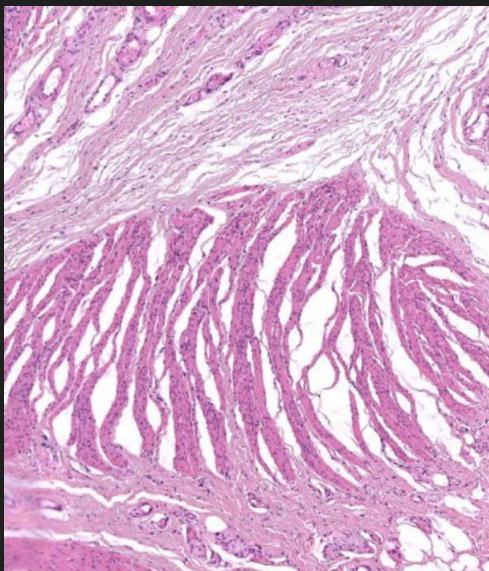
- **Colorectal Zone:** left side of the specimen



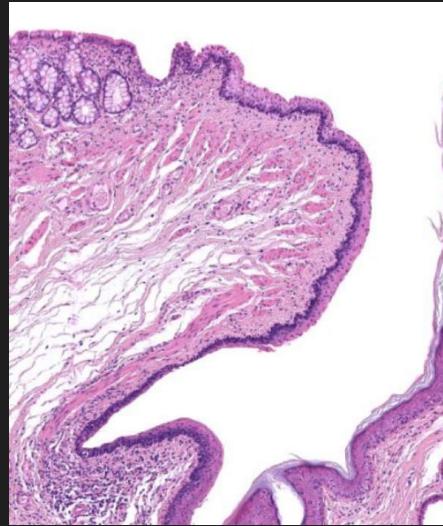
- **Anal Glands:** secrete mucus into the anal canal



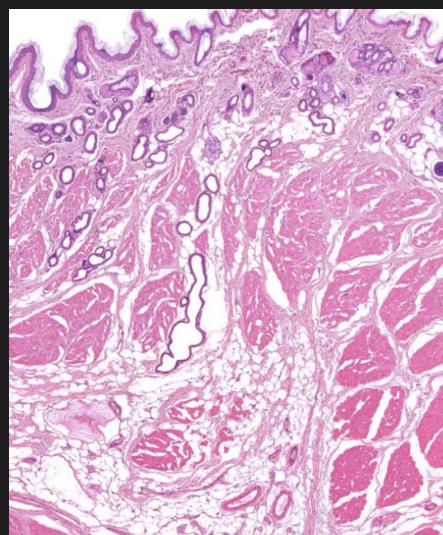
- **Internal Anal Sphincter:** an expansion of the inner circular layer of the muscularis externa



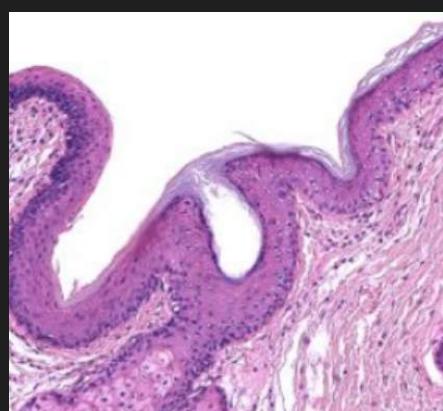
- **Pectinate Line:** junction between the simple columnar epithelium of the colon and the stratified squamous epithelium of the skin



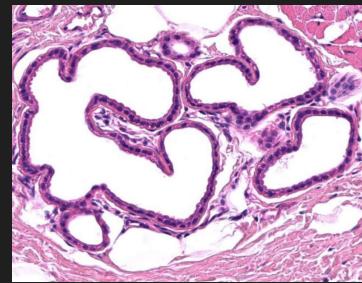
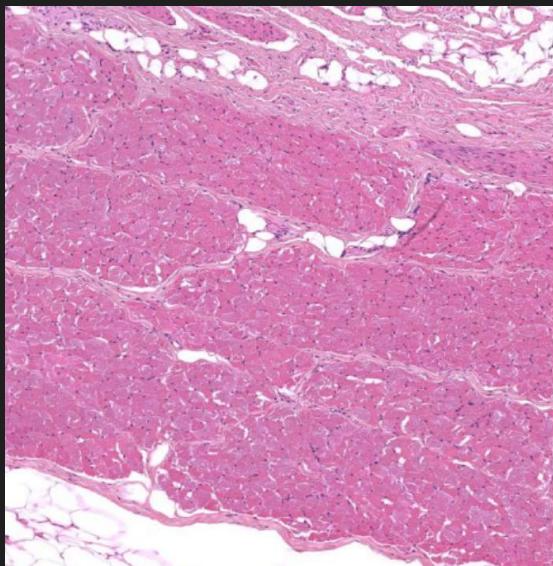
- **Squamous Zone of the Anal Canal:** right side of the specimen.



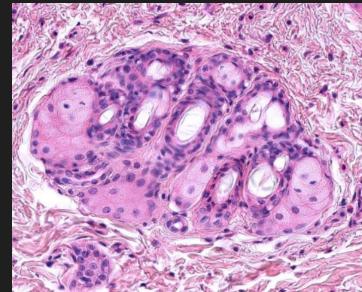
- **Stratified Squamous Epithelium:** initially is non-keratinized but becomes keratinized within a few millimeters.



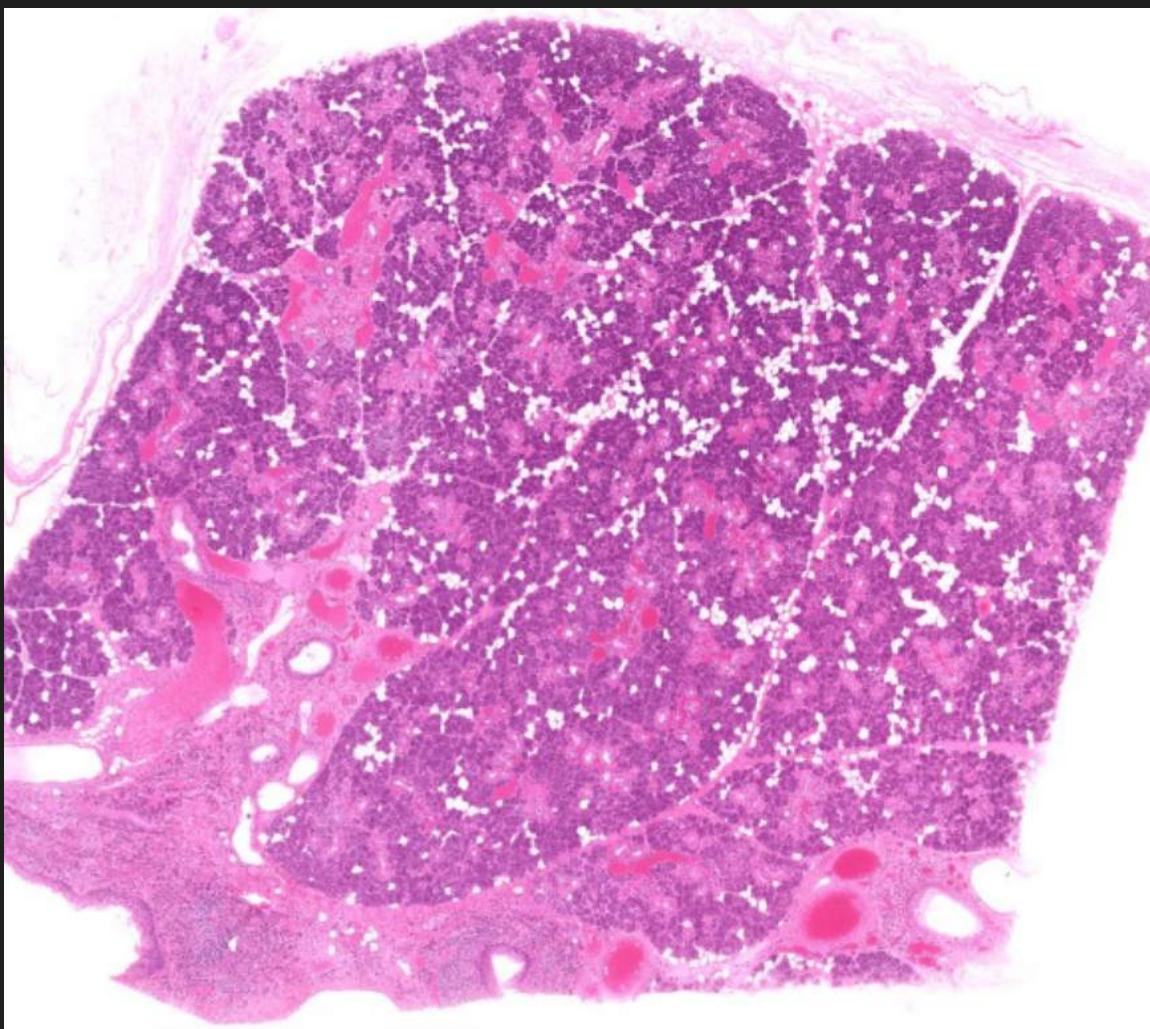
- **External Sphincter:** skeletal muscle that is part of the pelvic floor.
- **Circumanal Glands:** apocrine glands.



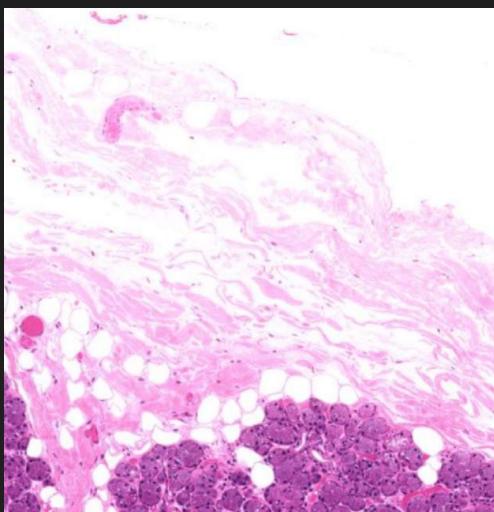
- **Sebaceous Glands:**



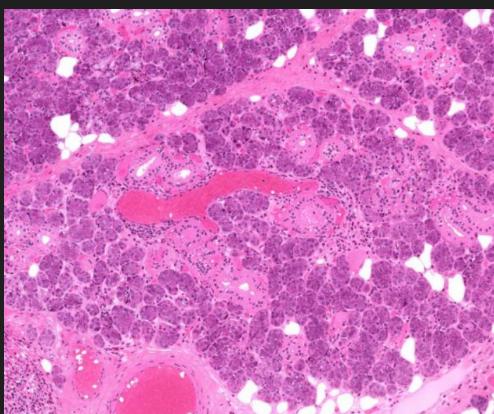
Parotid Gland



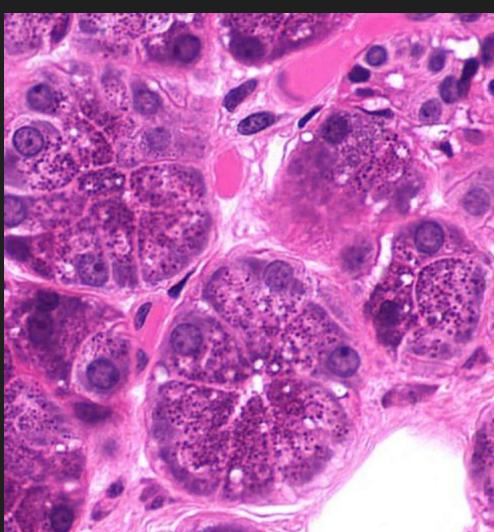
- **Capsule:** connective tissue that encapsulates the gland.



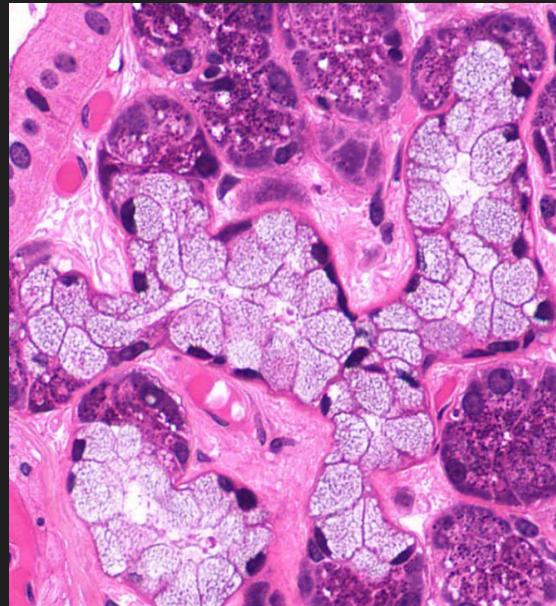
- **Lobules:** connective tissue further divides lobes into lobules the smallest functional unit.



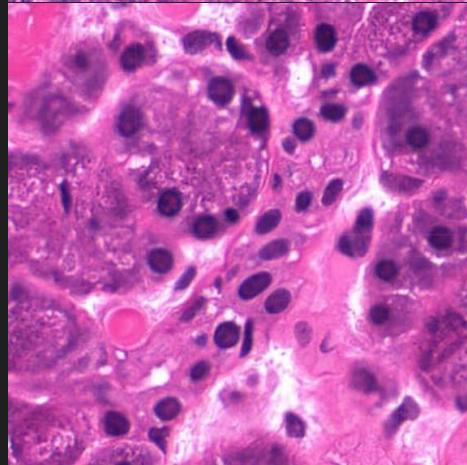
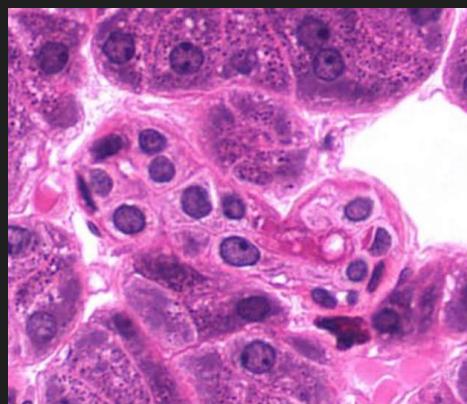
- **Serous Cells:** arranged in acini of pyramidal serous cells. These polarized cells have rough endoplasmic reticulum at their base (basophilic) and secretion granules (eosinophilic) at their apex.



- **Mucous Cells:** polarized cells with flattened nuclei at the bottom of the cells. They are very lightly stained with a "foamy" appearance (mucous has been extracted).



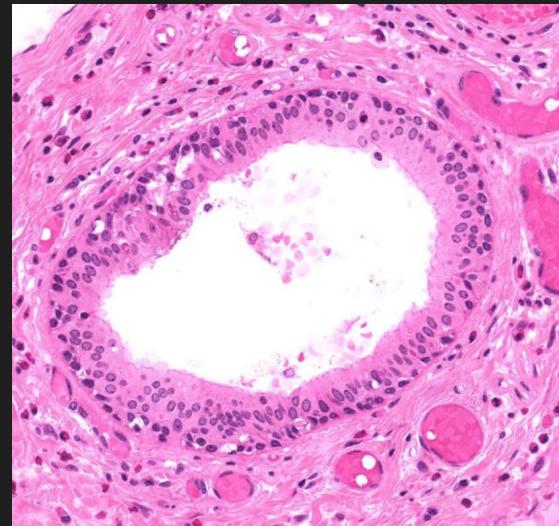
- **Intercalated Ducts:** the smallest ducts that insert into and drain individual acini. They are more lightly stained than acini cells and are low cuboidal.



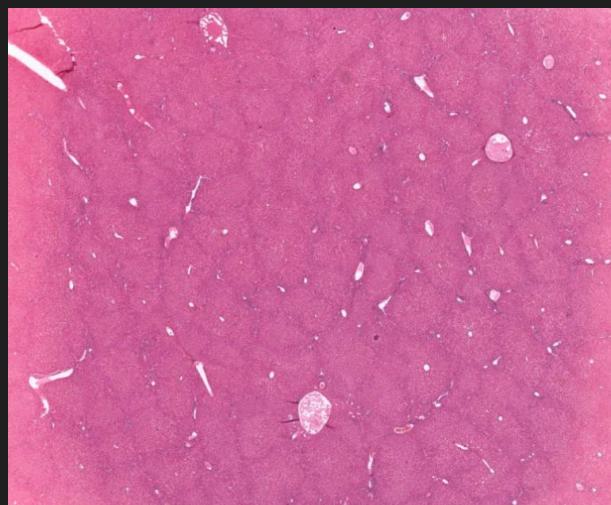
- **Striate Ducts:** arise from intercalated ducts. They are columnar with basal striations and are surrounded by capillaries.



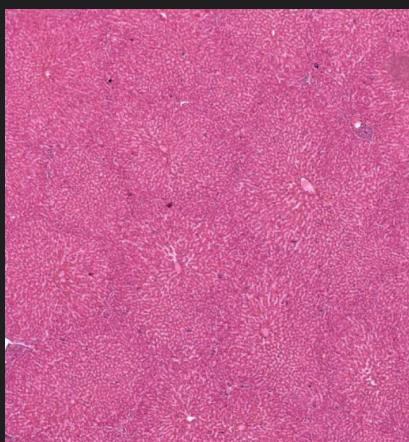
- **Interlobular Ducts:** found outside of lobules.



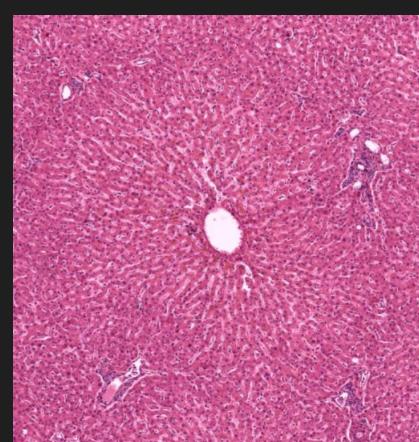
Liver



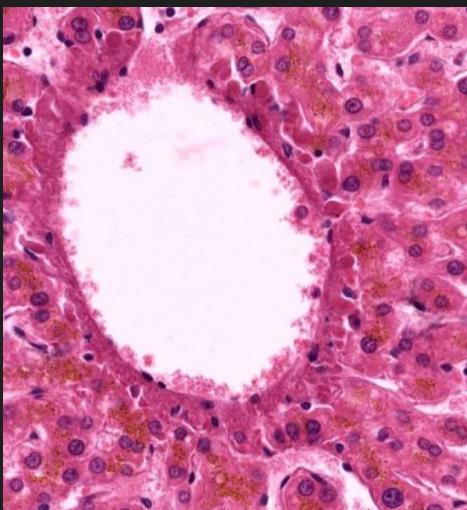
- **Lobules:** individual lobules are seen as lighter areas with darker edges at low magnification



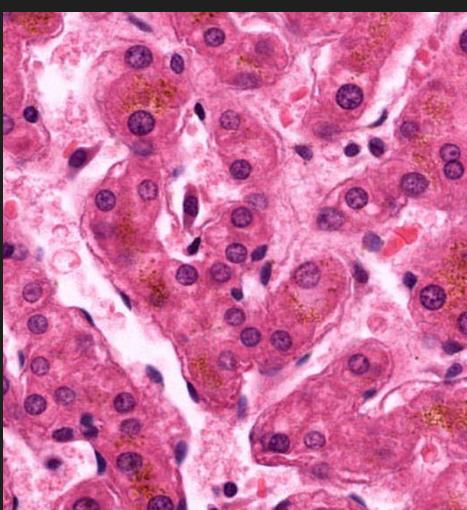
- **Lobule Structure:** roughly hexagonal structure with a central vein at its center and six portal triads at its periphery.



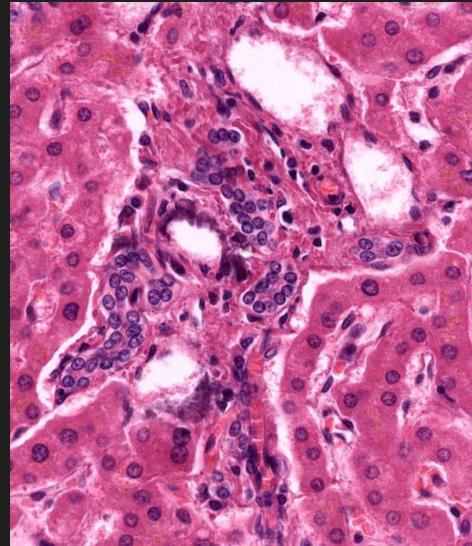
- **Central Vein:** large venule at the center of the lobule.



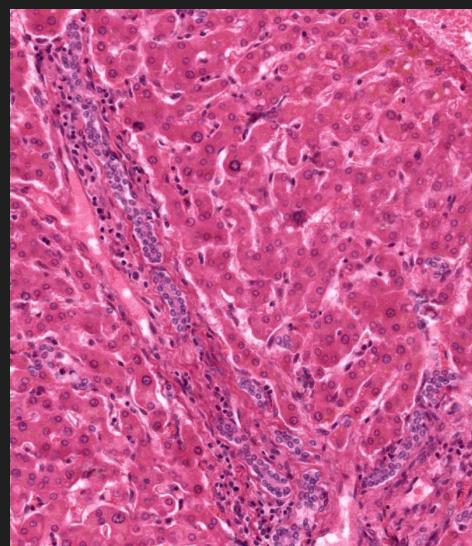
- **Hepatocytes:** anastomosing plates, one cell thick, radiate outward from the central vein separated by sinusoidal capillaries and supported by reticular fibers.



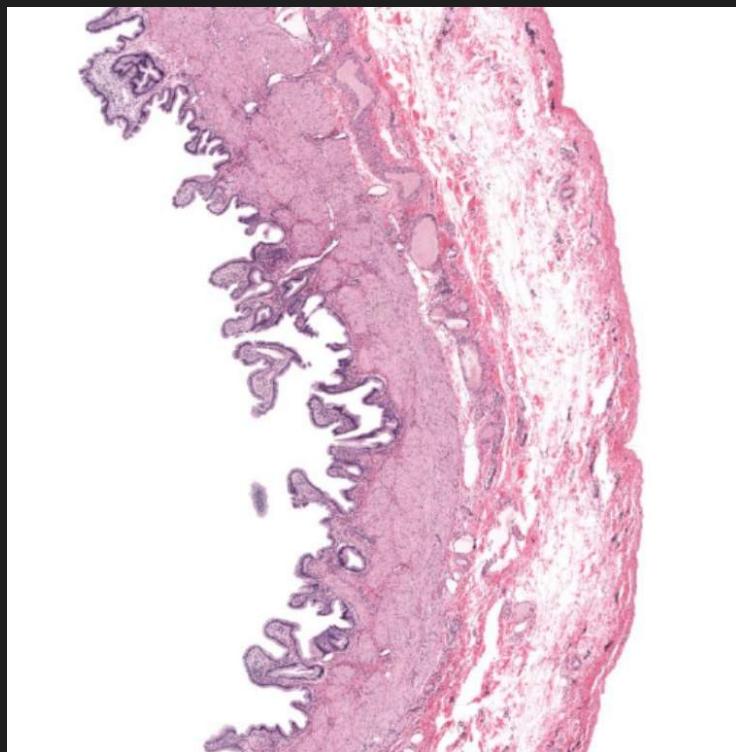
- **Portal Triads:** at the corners of each lobule.



- **Bile Ducts:** lined with a simple cuboidal epithelium.



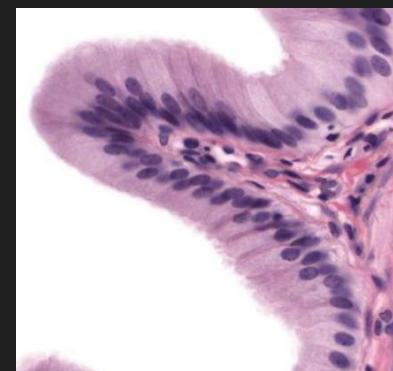
Gall Bladder



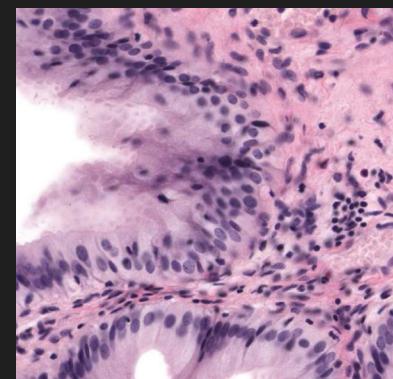
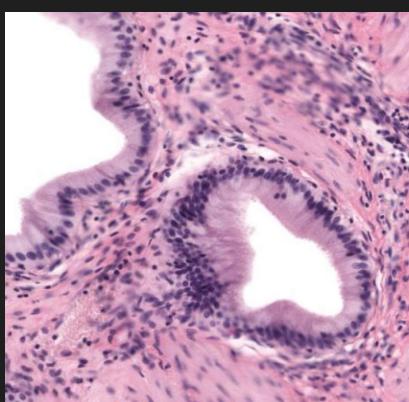
- **Mucosa:** the empty bladder has numerous deep folds (or rugae) often resulting in the appearance of cross bridges.
- **Simple Columnar Epithelium:** similar in appearance to absorptive cells in the intestines.



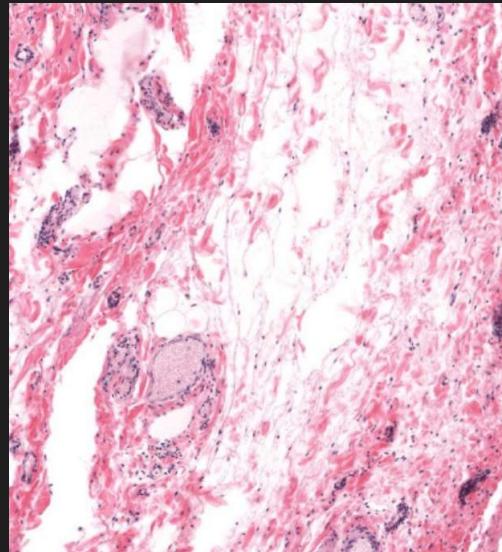
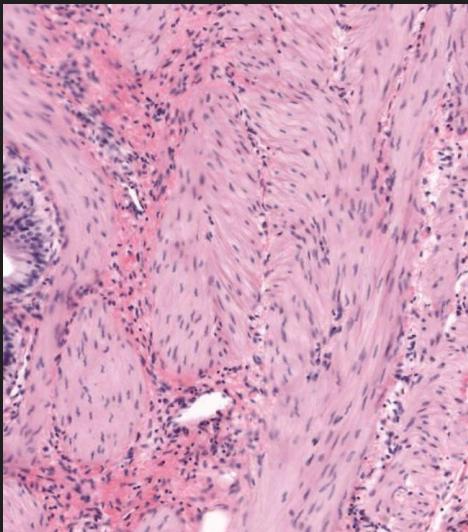
- **Cross Bridges**



- **Lamina Propria:** dense irregular connective tissue that supports the epithelium. It is rich in fenestrated capillaries and small venules.



- **Tunica Muscularis:** randomly oriented bundles of smooth muscle containing numerous collagen and elastic fibers. Its contraction results in emptying of the gallbladder.
- **Serosa:** where the gallbladder is unattached to the liver. It is composed of a surface layer of mesothelium supported by loose connective tissue.

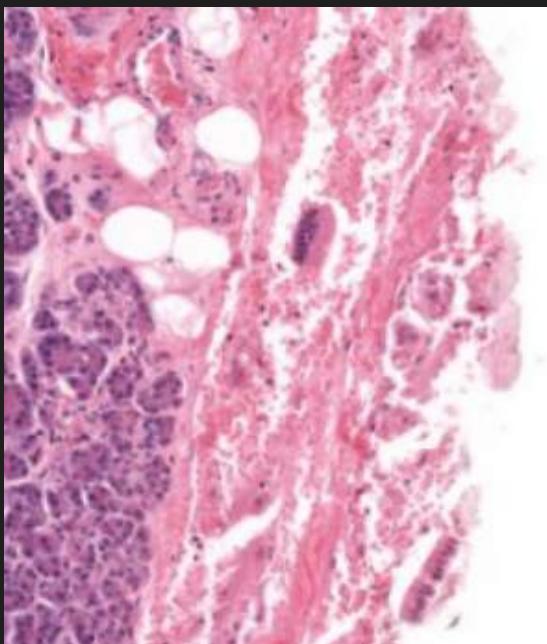


Exocrine Pancreas

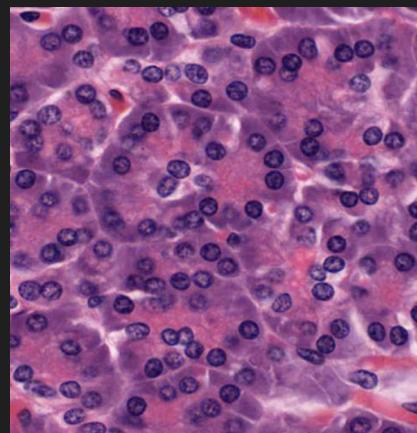
- The pancreas is the largest exocrine gland and is 95% exocrine tissue and 1–2% endocrine tissue. The exocrine portion is a purely serous gland which produces digestive enzymes that are released into the duodenum. The duct cells also secrete bicarbonate to neutralize acid from the stomach.
- The exocrine pancreas is compound tubuloacinar in structure. Centroacinar cells are epithelial cells from the beginning of ducts that protrude into the acinar lumen.



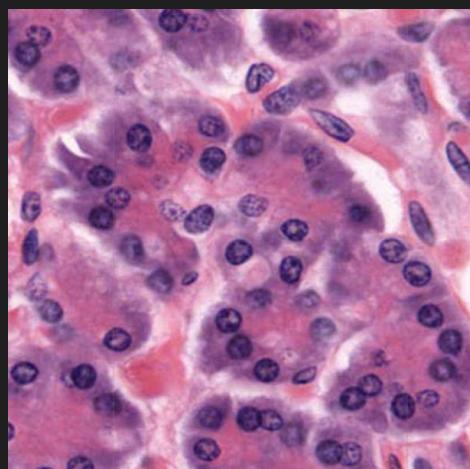
- **Capsule:** connective tissue covers the exterior surface.



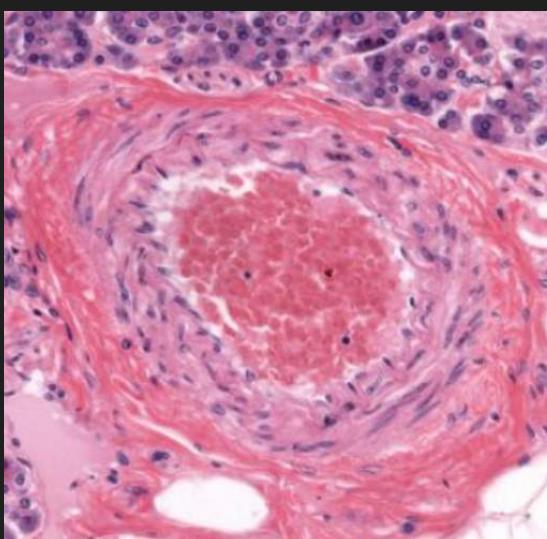
pyramidal serous cells.



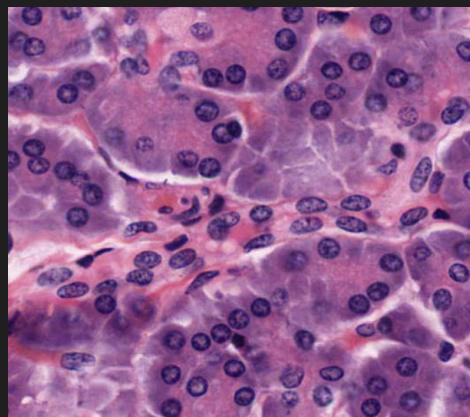
- **Acini**



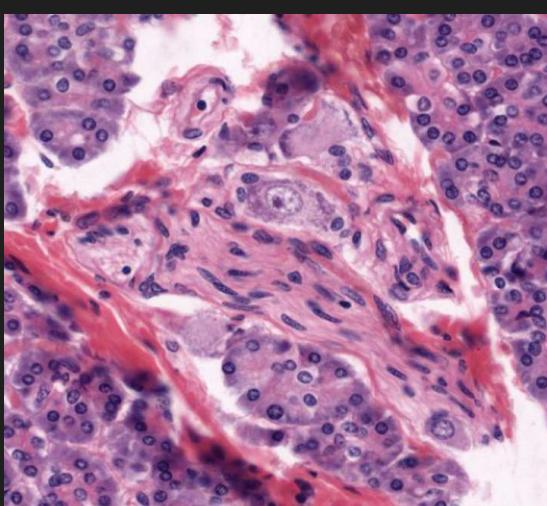
- **Blood Vessels**



- **Intercalated Ducts**



- **Nerves**

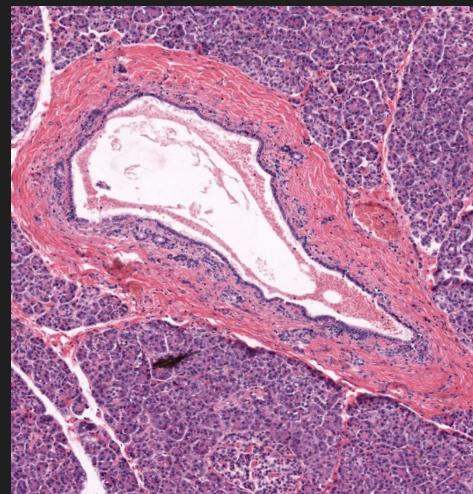
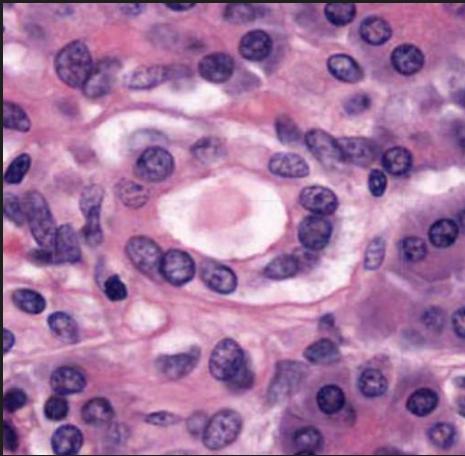


- **Centroacinar Cells:** duct cells located within an acinus.



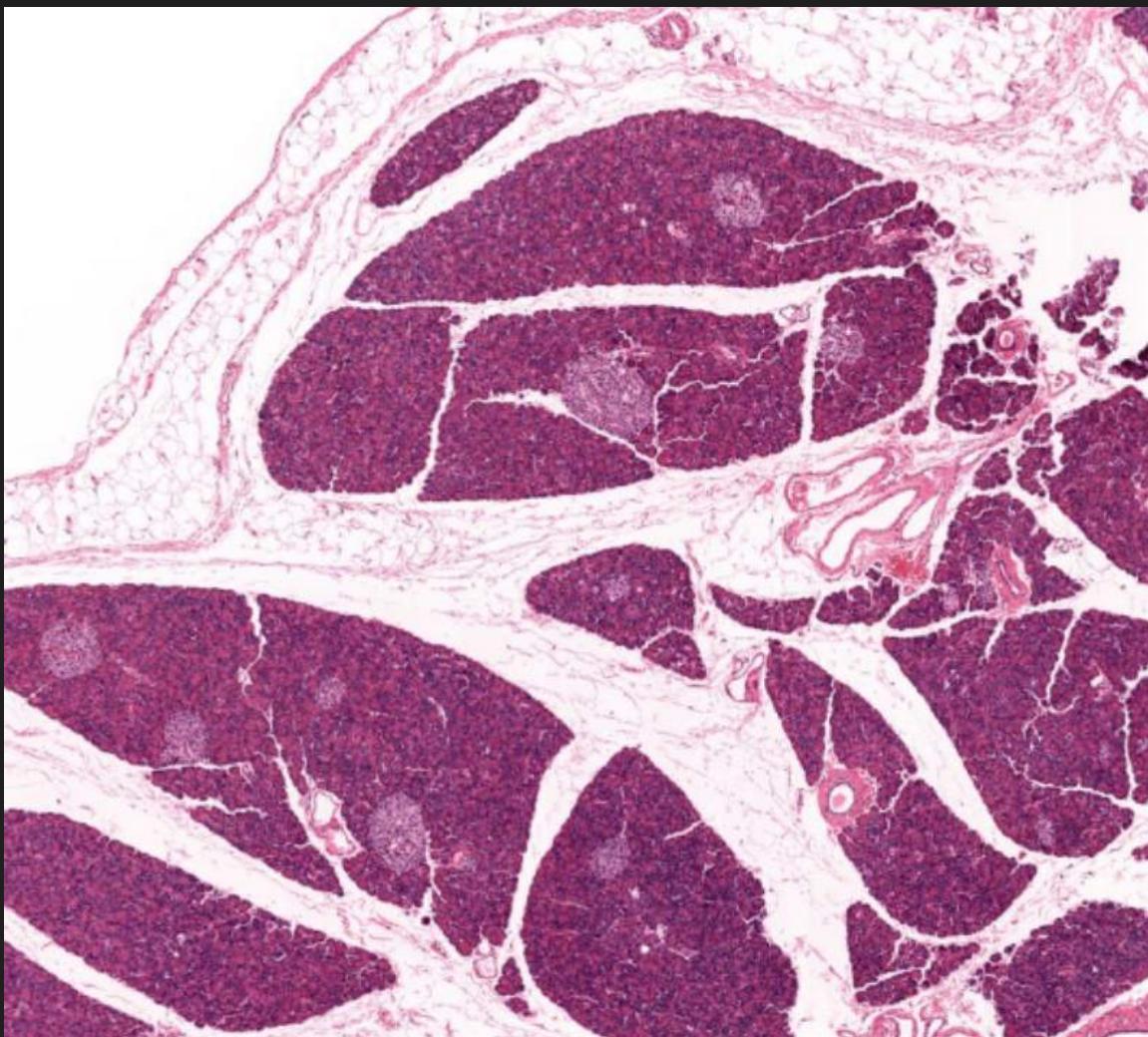
- **Exocrine Cells:** arranged as acini of

- **Interlobular Ducts:** leave the lobule and drain into interlobular ducts.
- **Interlobular Ducts:** ducts located outside a lobule.

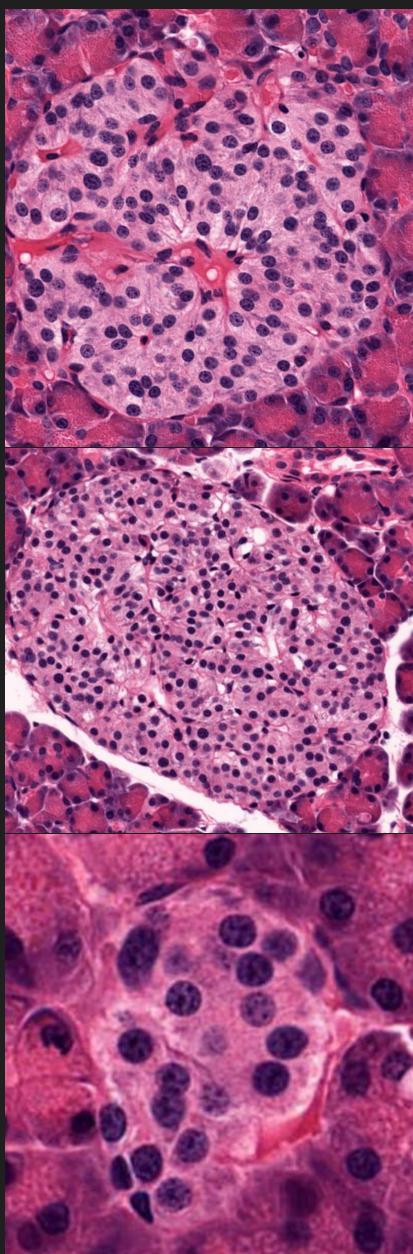


Endocrine Pancreas

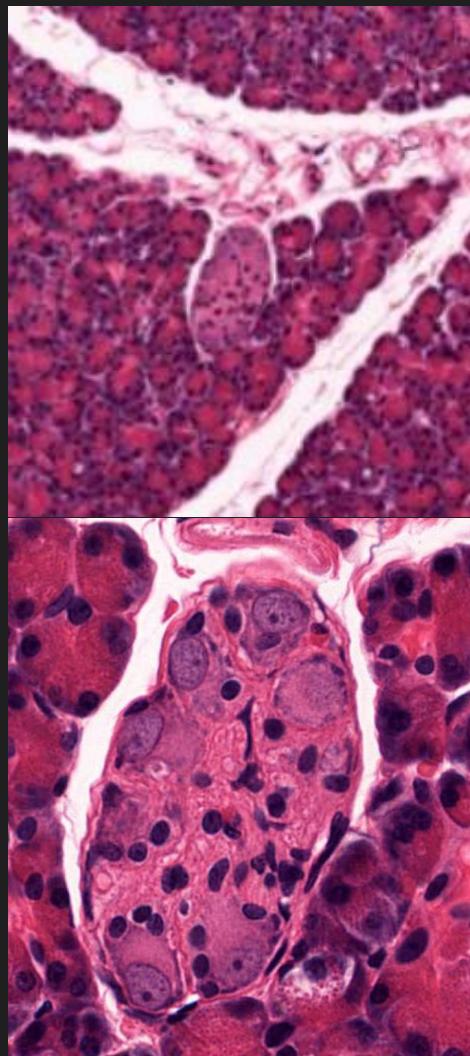
- Pancreatic islets (or islets of Langerhans) are “islands” of endocrine cells located within the pancreas. They secrete hormones (insulin and glucagon) important in the regulation of glucose in blood.



- **Islets of Langerhans:**



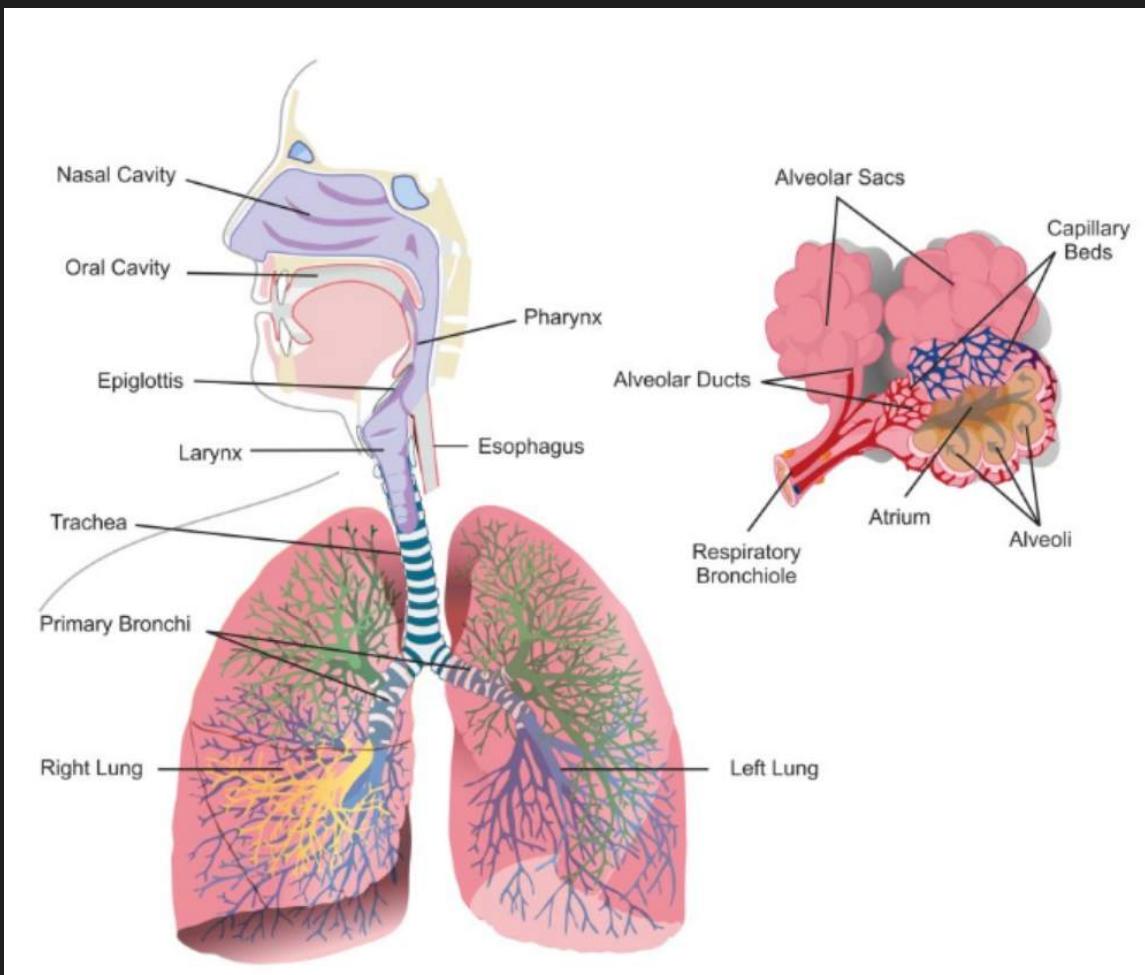
- **Parasympathetic Ganglion:** that is easily confused with small islets at low magnification, however at higher magnification shows typical structure of automatic ganglia.



1. Why can the liver be characterized as both an exocrine and endocrine organ?
 - Exocrine, since it primarily produces digestive bile for the small intestine, but is also endocrine since it releases hormones into the blood.
2. What are the secretory products of the exocrine pancreas?
 - Digestive enzymes: trypsinogen, lipase, amylase, etc., in inactive state
3. What is the major factor controlling insulin secretion?
 - Modulating blood glucose levels.

Week 7: Respiratory, Integument, Urinary

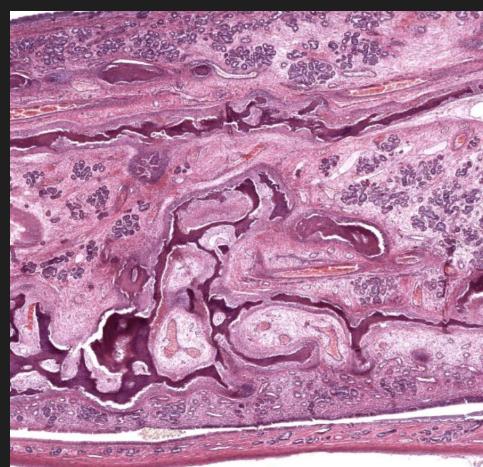
Respiratory



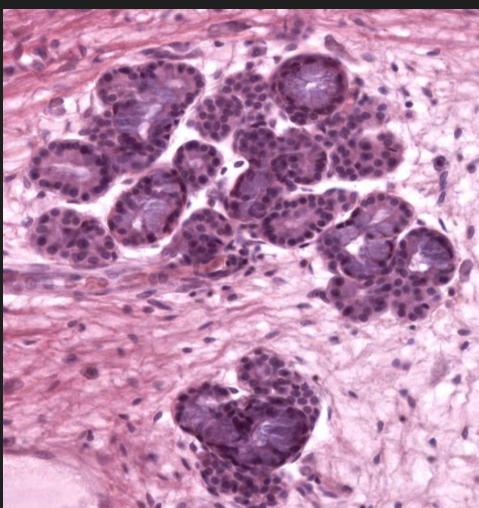
Nasal and Oral Cavities

The nasal cavities provide an extensive surface area for removing debris, warming, and humidifying the air. The nasal and oral cavities are separated by the hard and soft palate.

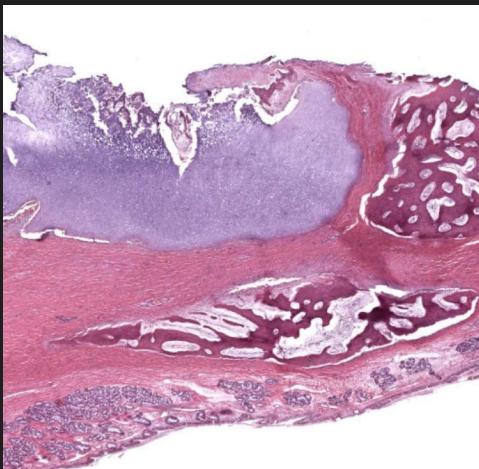
- **Respiratory epithelium:** pseudostratified epithelium with cilia and goblet cells lines the nasal cavity.
- **Nasal concha:** long, narrow and curled bone that protrudes into the nasal cavity.



- **Nasal Sero-Mucous glands:**



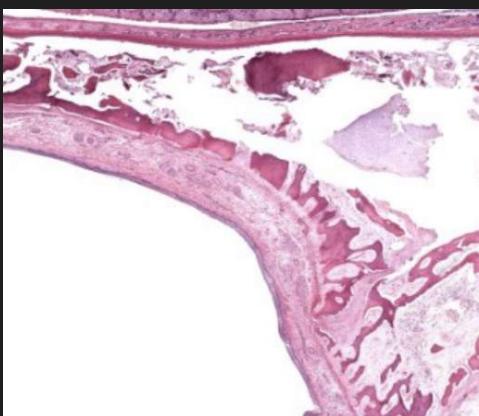
- **Nasal pharynx:** nasal portion of the pharynx.



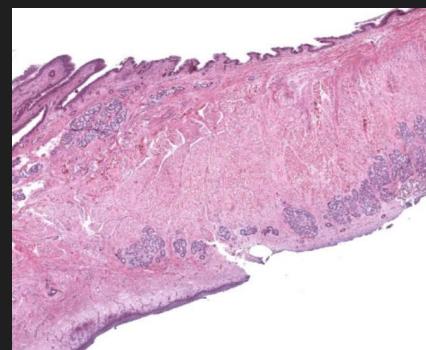
- **Palate:** roof of the mouth that separates the oral cavity from the nasal cavity.



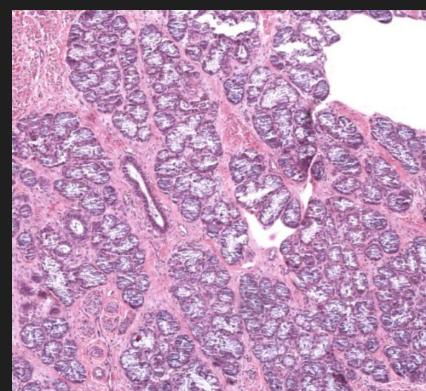
- **Hard palate:** anterior, bony (rigid) portion.



- **Soft palate:** anterior, bony (rigid) portion.



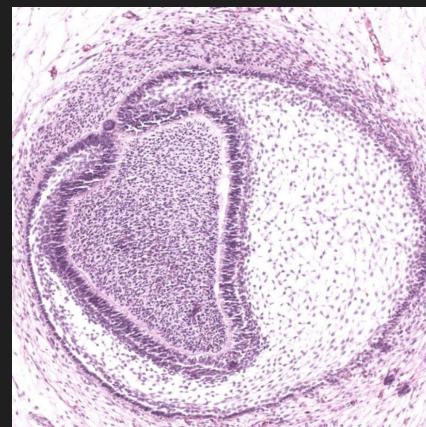
- **Palatine mucous glands:**



- **Tooth:**



- **Tooth Bud:**

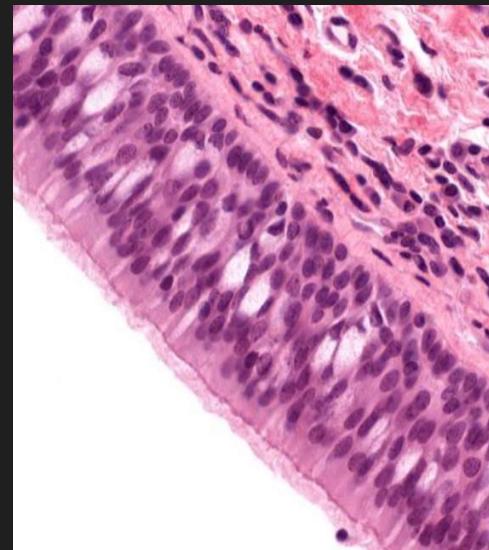
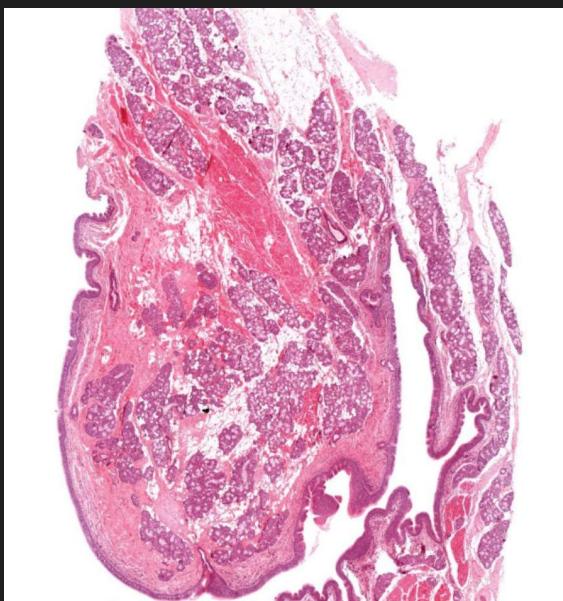


Larynx

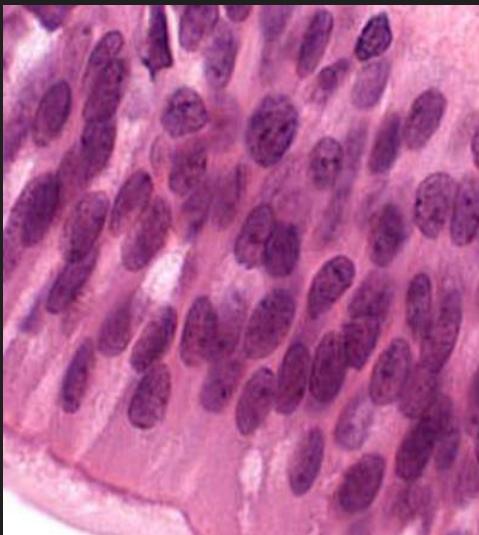
The larynx plays a critical role in speech.



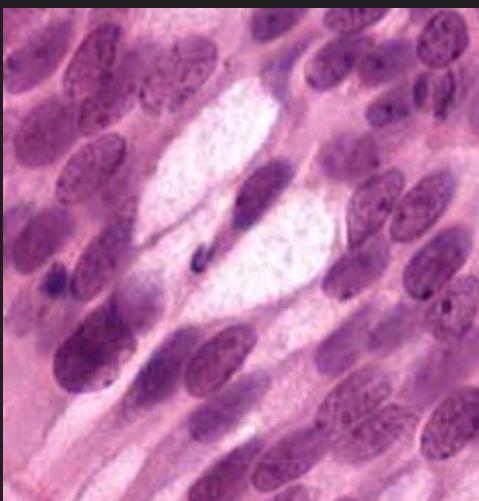
- **False vocal (ventricular) fold:**
- **Respiratory epithelium:** pseudostratified columnar epithelium with cilia and goblet cells.



- **Pseudostratified columnar cells:** basal bodies visible as a dark line at the base of the cilia.



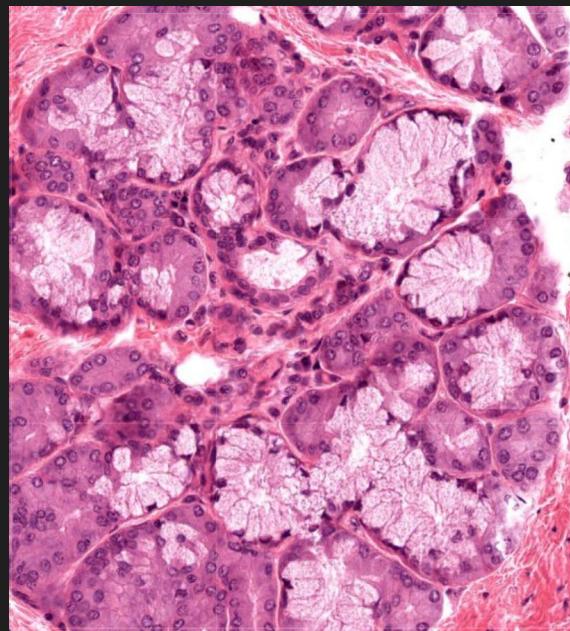
- **Goblet cells:** basal bodies visible as a dark line at the base of the cilia.



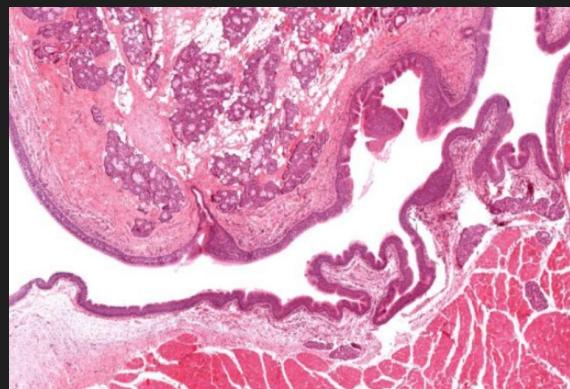
- **Basement membrane:** basal bodies visible as a dark line at the base of the cilia.



- **Sero-Mucous glands:** add moisture to air and aid in trapping contaminants.



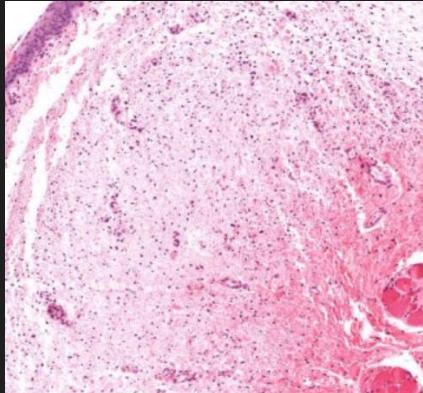
- **Laryngeal ventricle:** a lateral diverticulum that separates false folds above from true vocal cords below.



- **True vocal cord:**



- **Vocal ligament:** thick band of connective tissue within the lamina propria near the surface of the vocal cord.



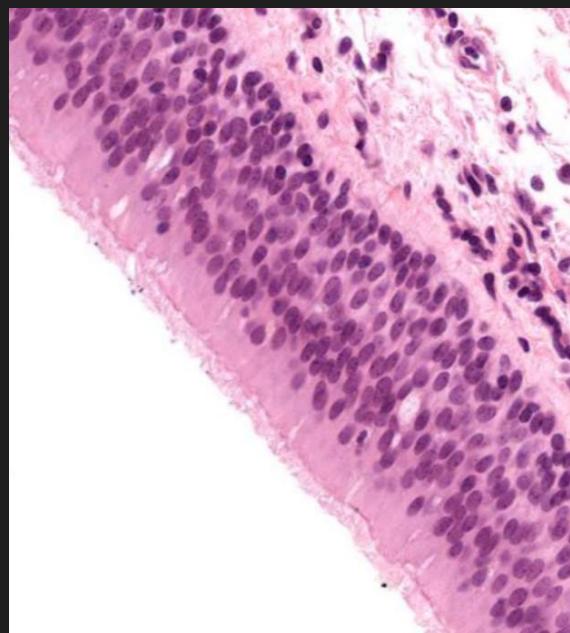
- **Stratified squamous non-keratinized epithelium:** covers this region of the larynx because it is subject to mechanical stress.



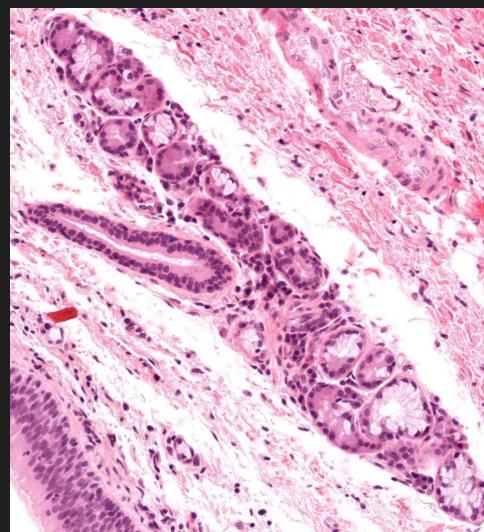
- **Vocalis muscle:** skeletal muscle that underlies and regulates the tension of the vocal ligament.



- **Respiratory epithelium:** covers the true vocal cord except for the region that covers the vocal ligament.



- **Sero-Mucous glands:** add moisture to air and aid in trapping contaminants.



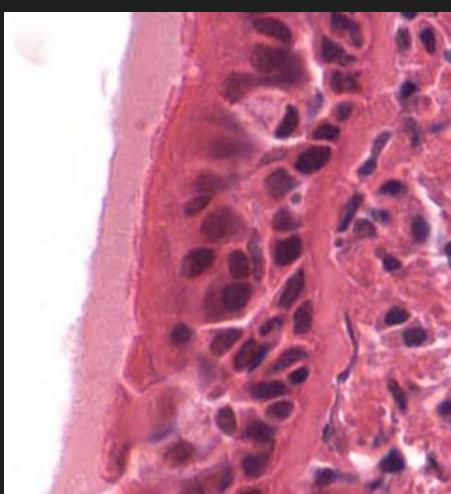
Trachea

The trachea (windpipe) is a fibromuscular tube supported by C-shaped rings of hyaline cartilage. It extends from the larynx toward the lungs.



- **Respiratory epithelium:** the trachea is lined with a pseudostratified columnar epithelium with cilia and goblet cells.

- **Cilia:** extend 5 to 7 μm from the surface of the columnar epithelial cells. The dark line at their base is from their basal bodies.



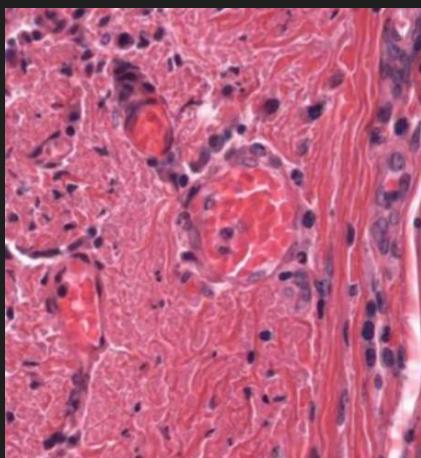
- **Goblet cells:** secrete mucus. They are difficult to identify in this specimen, but a thick layer of mucus (20 to 30 µm) is seen on the surface of the epithelium.



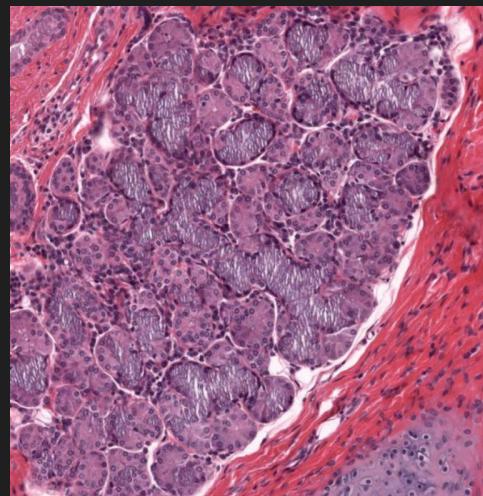
- **Basement membrane:** separates the epithelium from the underlying connective tissue. It is seen as a thick, eosinophilic band beneath the epithelium.



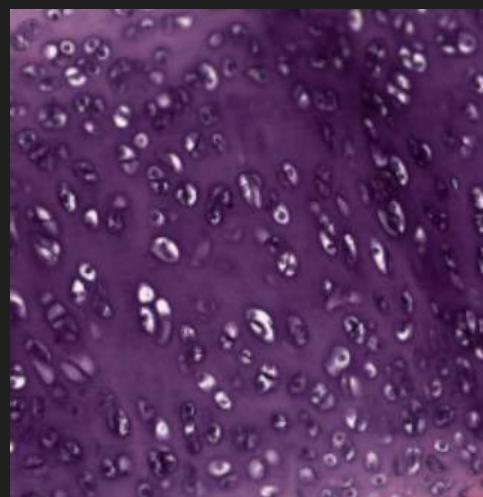
- **Lamina propria:** dense irregular connective tissue supports the epithelium.



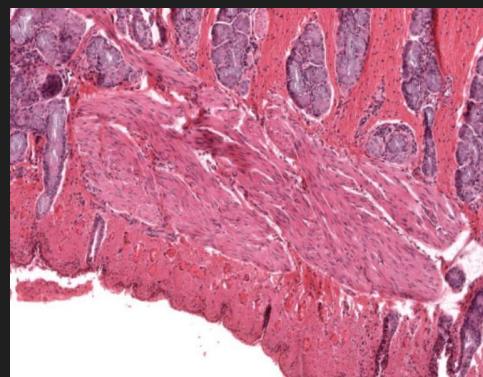
- **Sero-Mucous glands:** add moisture to air and aid in trapping contaminants. The cilia propel mucus towards the esophagus where it is swallowed.



- **Hyaline cartilage:** "C"-shaped cartilage that is open in its posterior aspect.



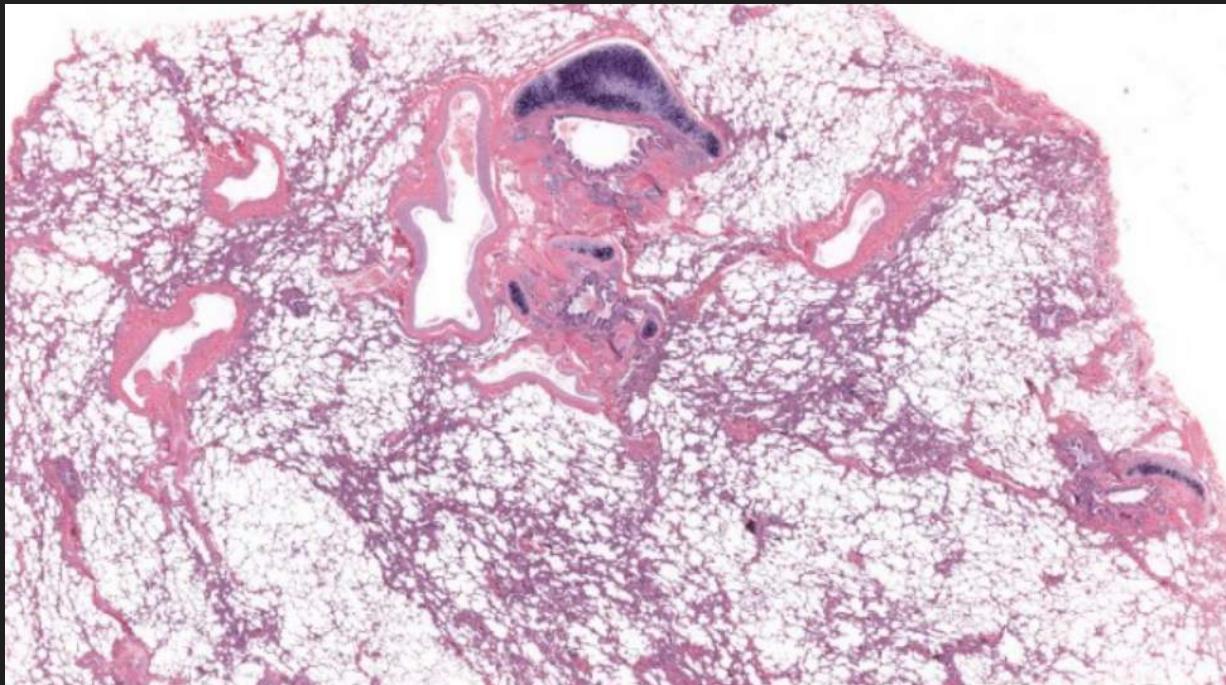
- **Trachealis muscle:** smooth muscle that spans the ends of tracheal cartilages. They control the diameter of the trachea.



Lung

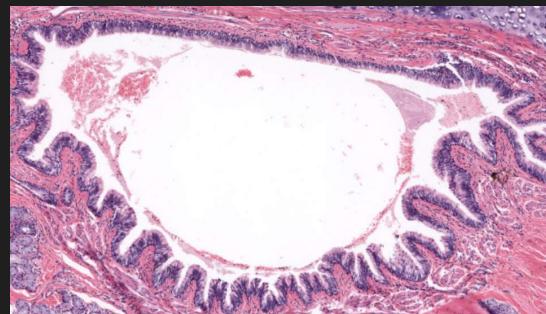
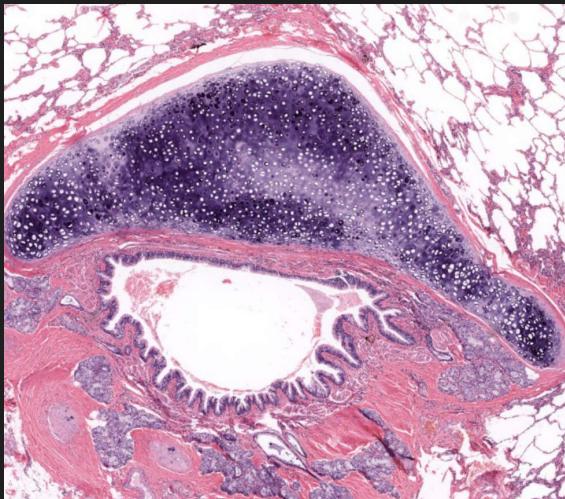
The lung consists of airways and structures for gas exchange.

The trachea divides into primary bronchi for each lung. They divide into secondary (lobar) bronchi and then into segmental (terminal) bronchi.

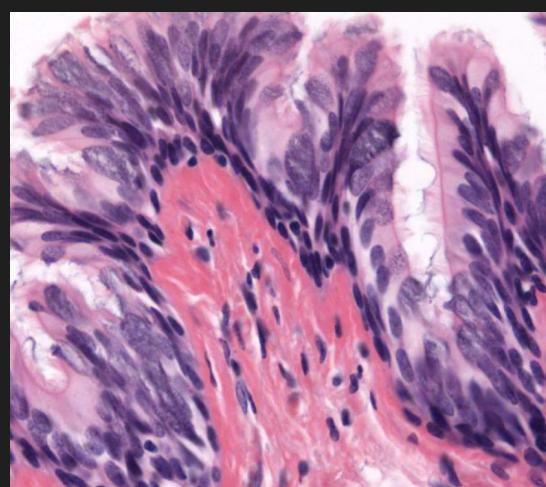
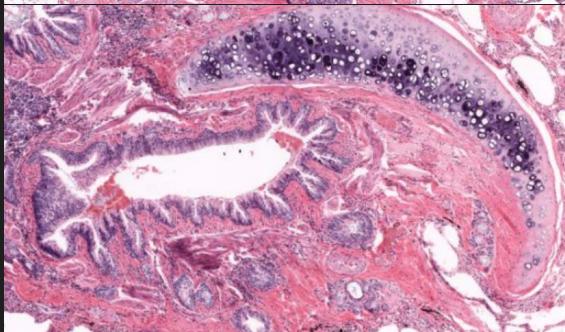


- **Primary bronchi:**

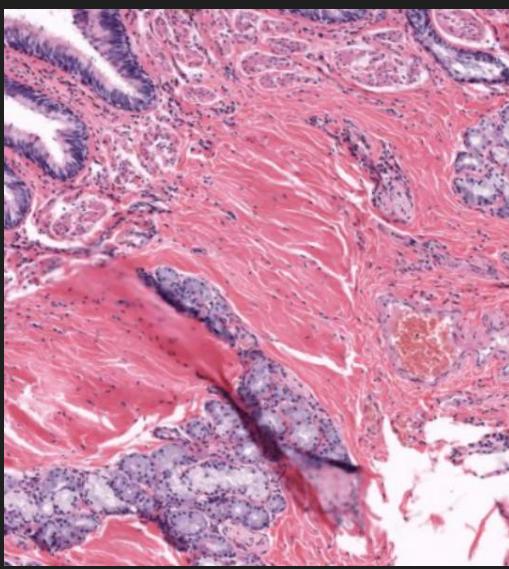
- **Respiratory epithelium:** composed of pseudostratified columnar epithelium.



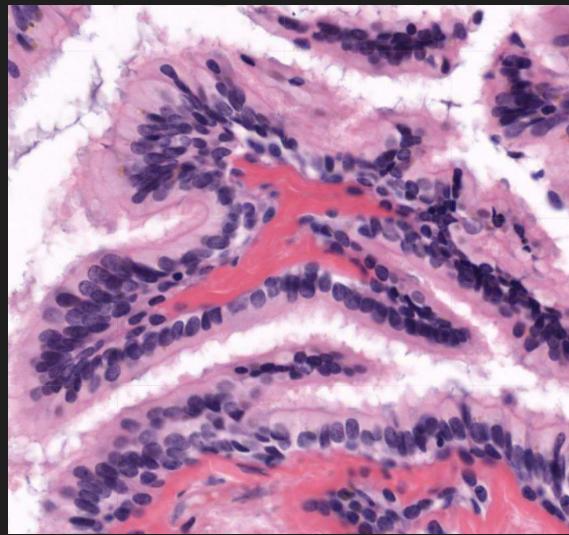
- **Pseudostratified columnar epithelium:**



- **Lamina propria:**



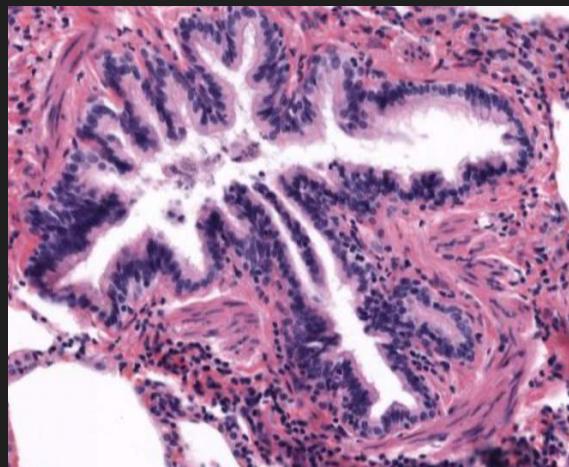
- **Epithelium:** changes from pseudostratified columnar to simple, ciliated columnar epithelium as they decrease in diameter.



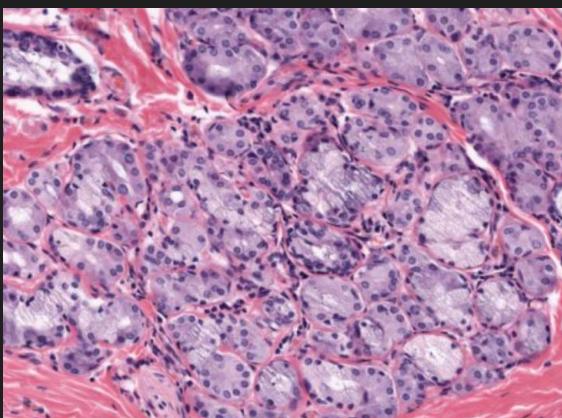
- **Bronchial cartilage:**



- **Terminal bronchioles:** conducting airways.

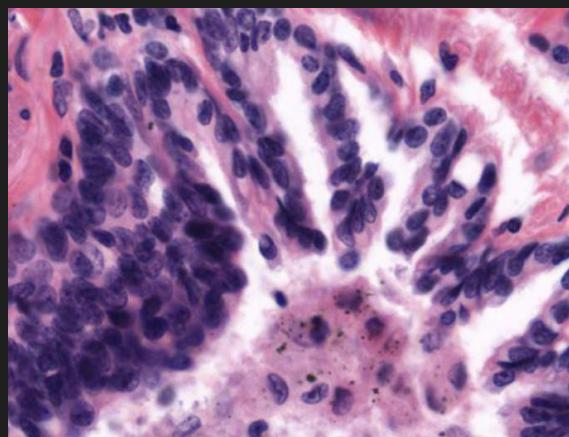
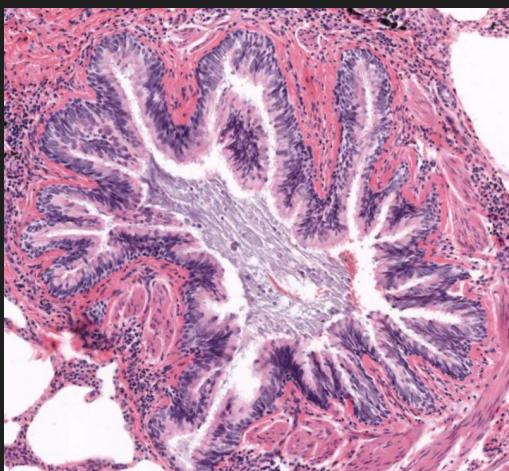


- **Sero-Mucous glands:**



- **Epithelium:** changes from simple, ciliated columnar epithelium to cuboidal epithelium.

- **Primary muscular bronchioles:**



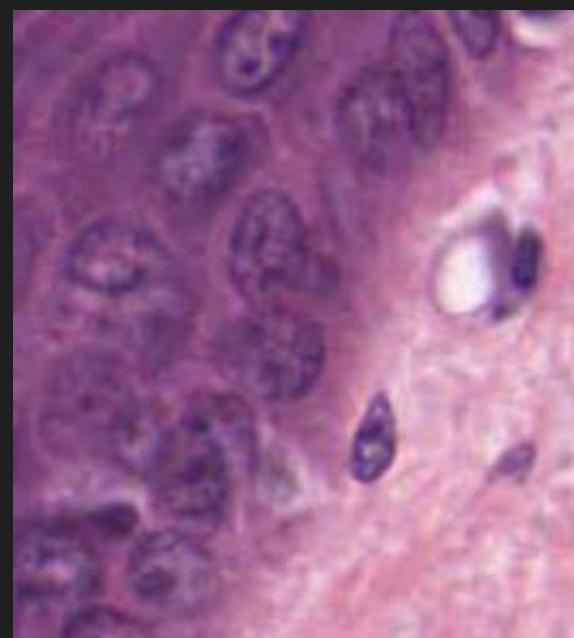
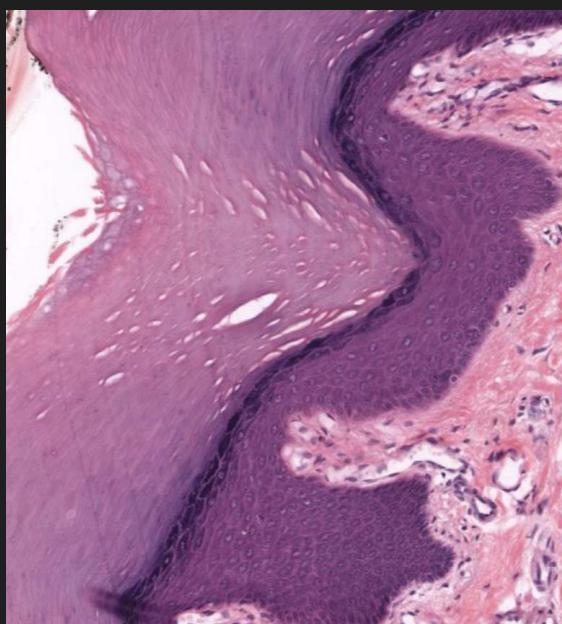
Integument

Thick Skin

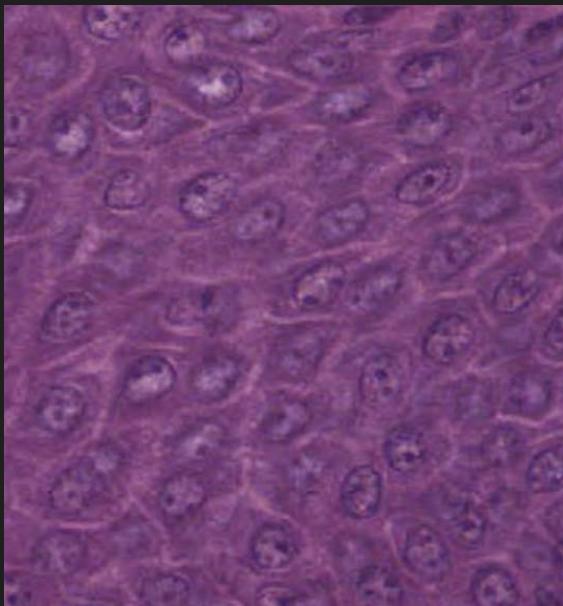
Thick skin is only found on the palms of the hands, and the soles of the feet, locations subjected to considerable abrasion. It has a thick epidermis and contains sweat glands, but lacks hair follicles and sebaceous glands.



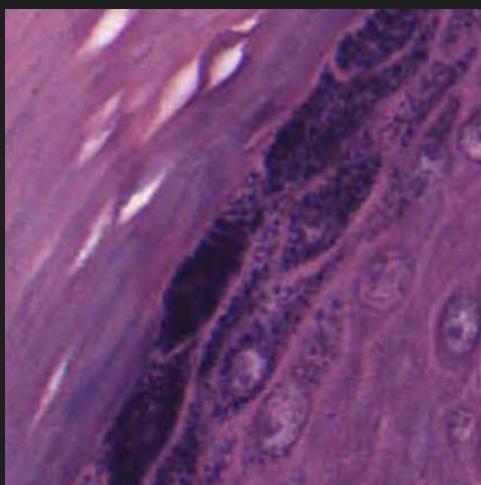
- **Epidermis:** stratified squamous keratinized epithelium divided into five strata (or layers).
- **Stratum basale:** single layer of germinative cells resting on the basement membrane which is attached to the dermis.



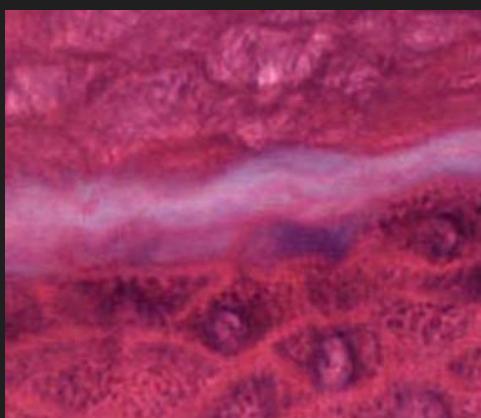
- **Stratum spinosum:** keratinocytes attached to each other by desmosomes on spiny processes.



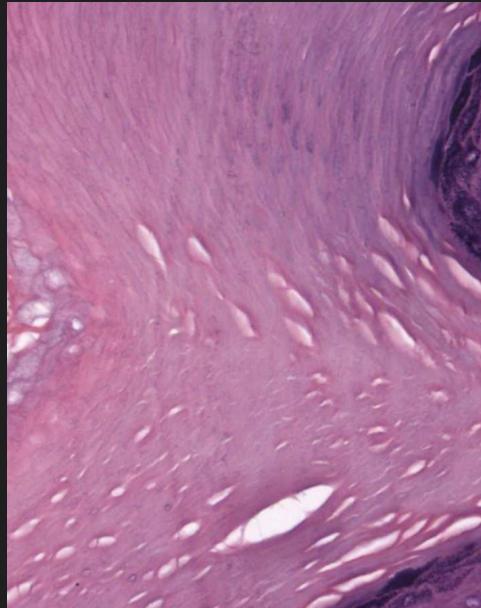
- **Stratus granulosum:** keratinocytes with numerous basophilic, keratohyalin granules in their cytoplasm.



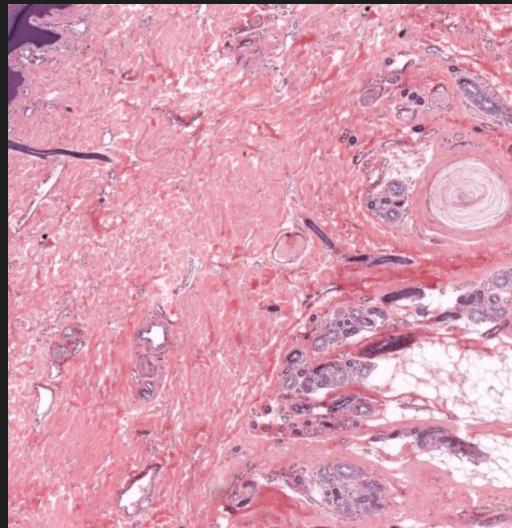
- **Stratum lucidum:** highly refractive zone only seen in very thick skin.



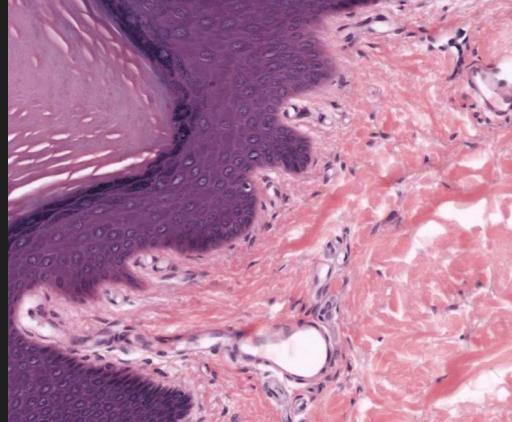
- **Stratum Corneum:** - thick layer of dead cells (squames) devoid of nuclei and organelles.



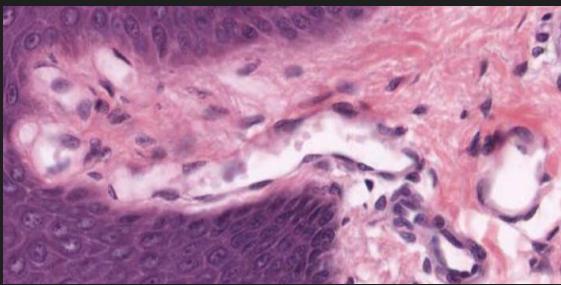
- **Dermis:** dense irregular connective tissue that supports the epidermis.



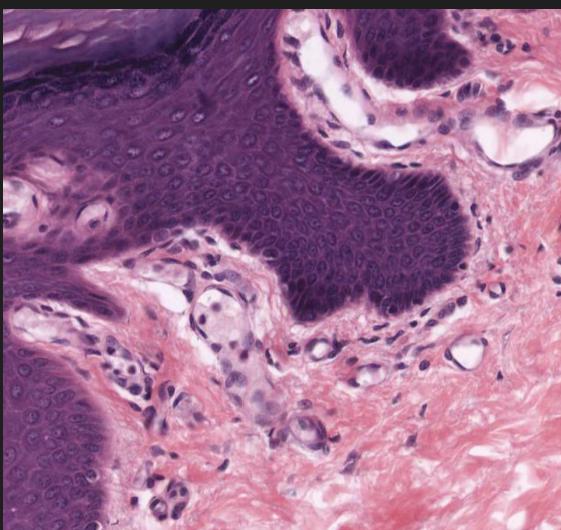
- **Papillary layer:** papillae that project into the dermis.



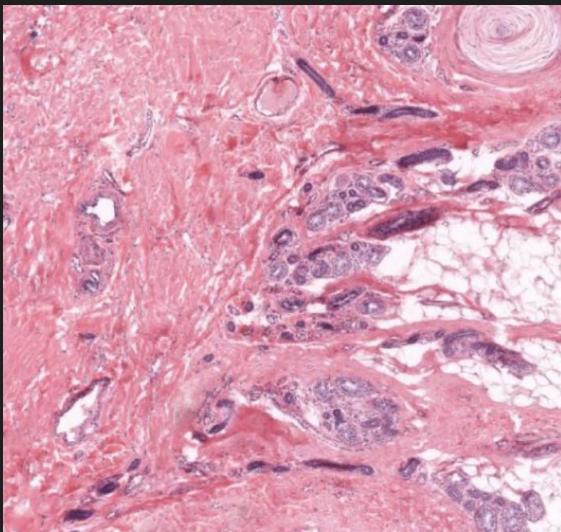
- **Dermal papillae:** increase adhesion between the epidermis and dermis.



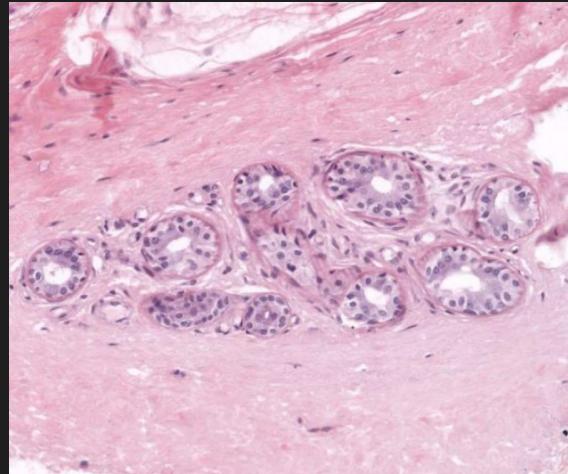
- **Papillary capillaries:** bring nutrients to the epidermis.



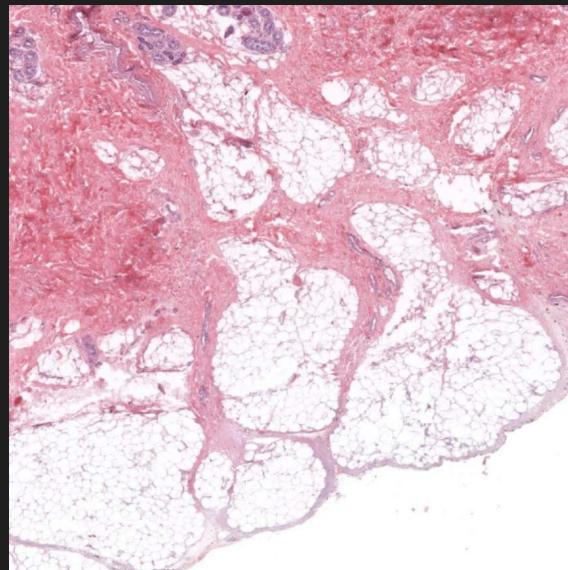
- **Reticular layer:** dense irregular connective.



- **Eccrine sweat glands:** coiled tubular gland with simple or stratified cuboidal epithelium (lightly stained) and duct cells (dark staining).



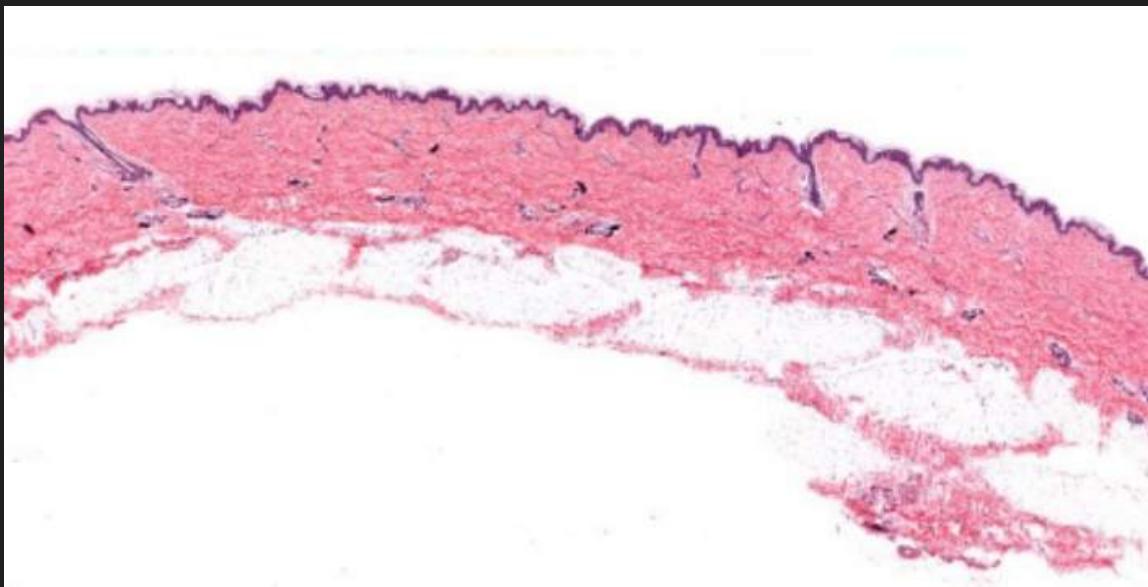
- **Hypodermis:** loose connective tissue with adipose tissue.



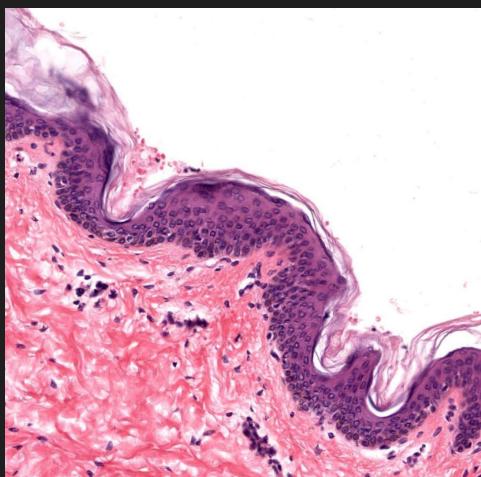
Thin Skin

Thin skin (1 to 2 mm) covers most of the body, whereas thick skin is restricted to the palms of the hands and soles of the feet.

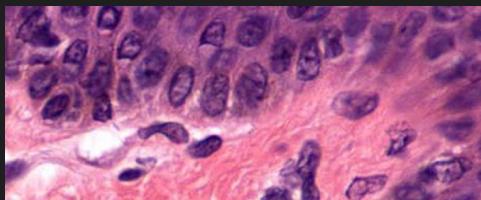
The keratin layers often become dislodged during preparation of thin skin. In the natural state, the keratin layers would be attached to the underlying layers. The thickness of the stratum corneum is less than the cellular layers.



- **Epidermis:** stratified squamous keratinized epithelium divided into four strata (or layers).



- **Stratum basale:** single layer of germinal cells resting on the basement membrane which is attached to the dermis.



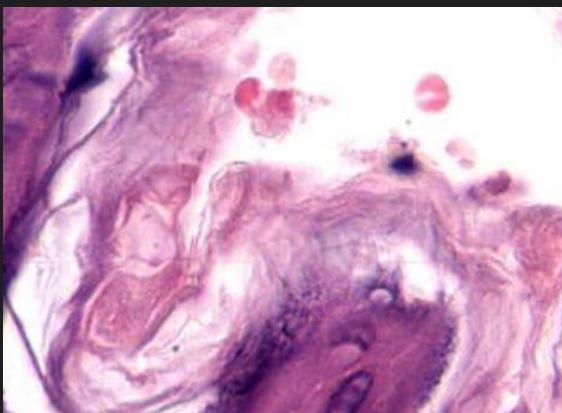
- **Stratum spinosum:** keratinocytes attached to each other by desmosomes on spiny processes.



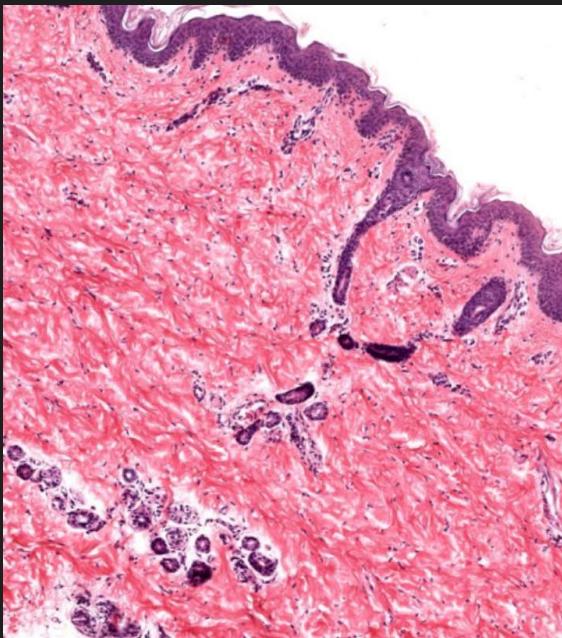
- **Stratum granulosum:** keratinocytes with numerous basophilic granules in their cytoplasm.



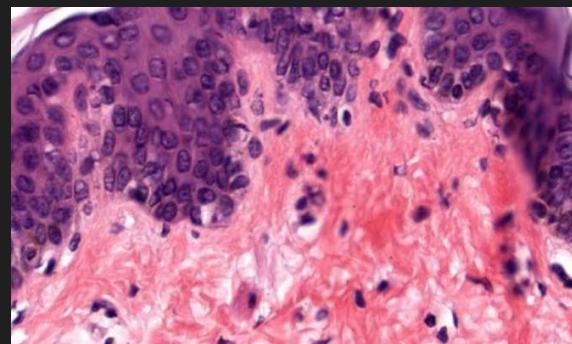
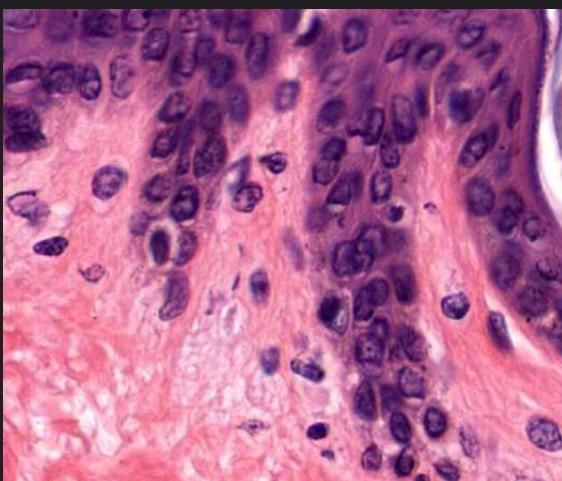
- **Stratum corneum:** thin layer of dead cells devoid of nuclei and organelles.



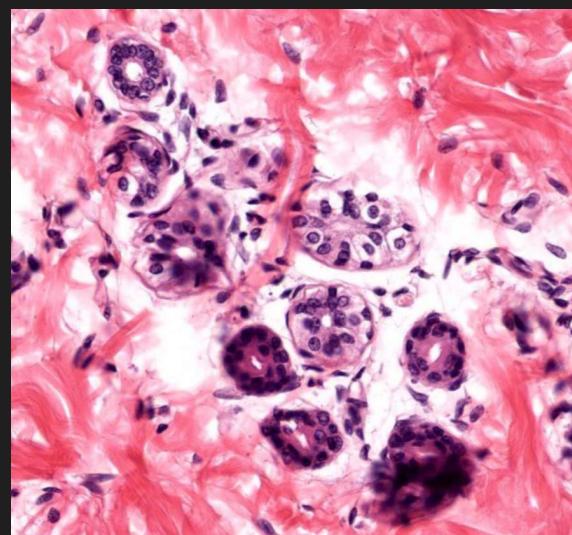
- **Dermis:** dense irregular connective tissue that supports the epidermis.



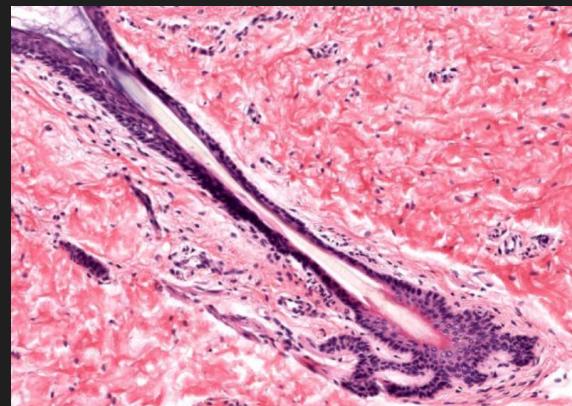
- **Dermal papillae:** less prominent than in thick skin. They increase adhesion between the epidermis and dermis.



- **Eccrine sweat glands:** coiled tubular glands (lightly stained) and ducts (dark stained) with simple or stratified cuboidal epithelium.

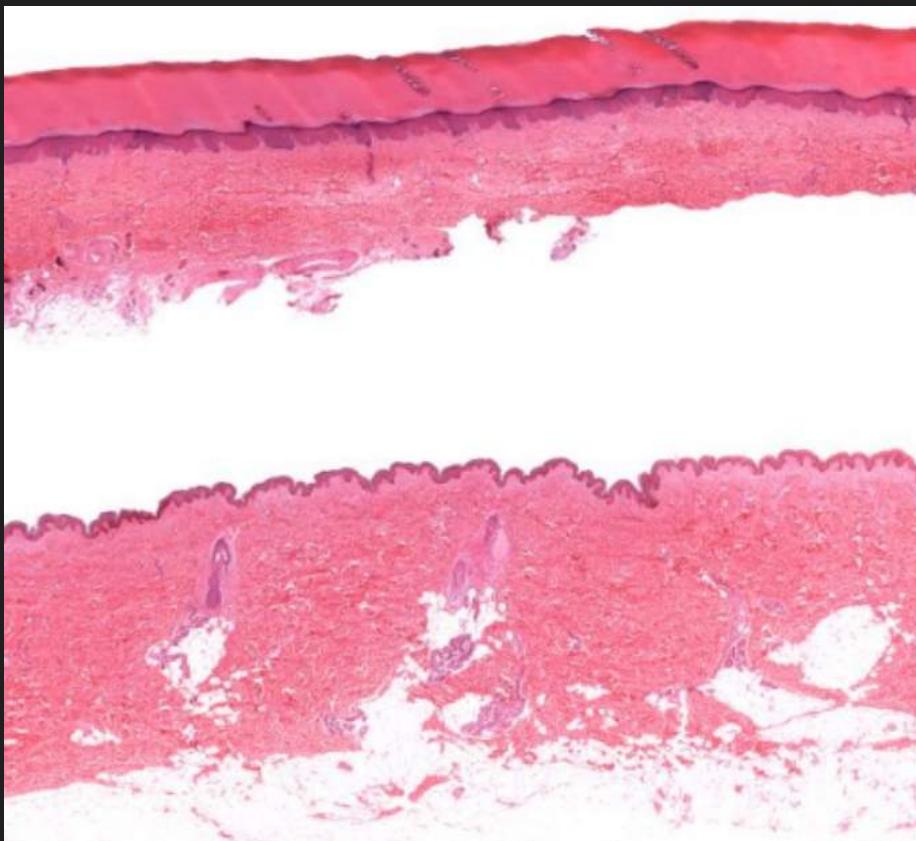


- **Hair follicle:** thin skin has hair follicles.

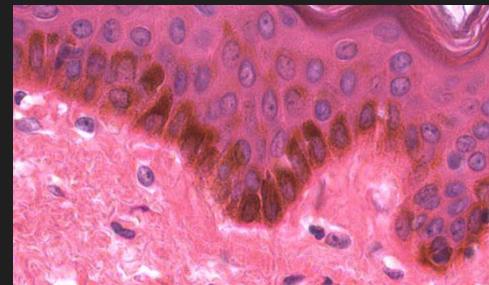
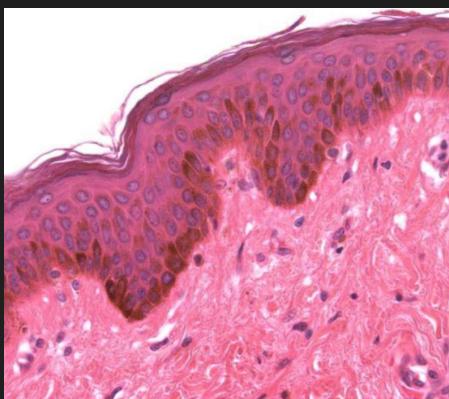


Pigmented Skin

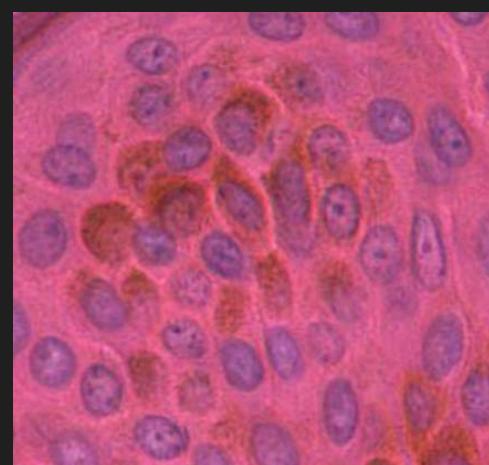
Thick and thin skin from a dark skinned individual.



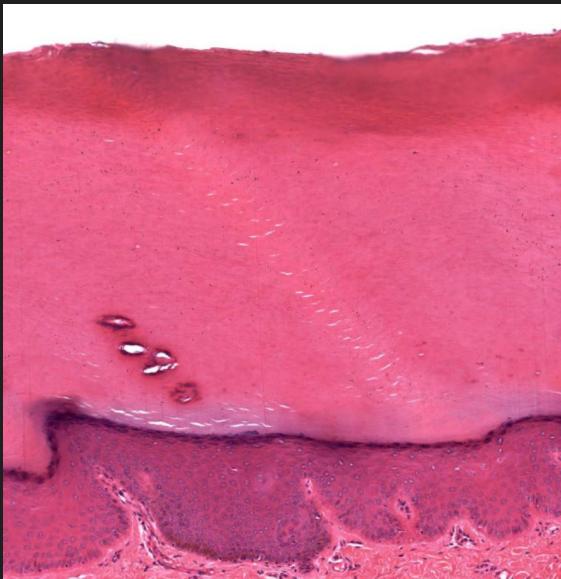
- **Thin skin:** covers most of the body and is heavily pigmented.
- **Stratum basale:** heavily pigmented with dark brown granules of melanin.



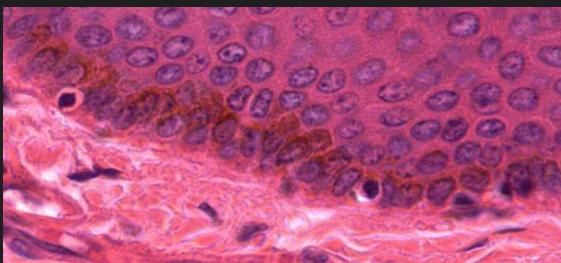
- **Melanocytes:** melanin-producing cells located in the stratum basale.



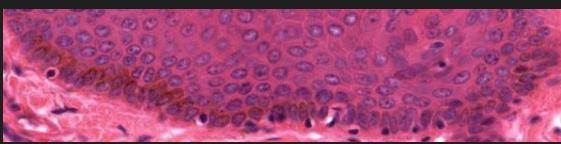
- **Thick skin:** covers the palms of the hands and soles of the feet and is lightly pigmented.



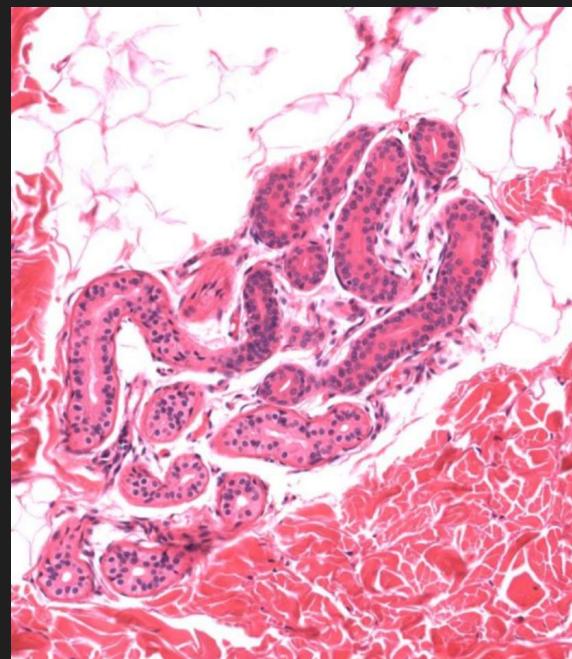
- **Melanocytes:** covers the palms of the hands and soles of the feet and is lightly pigmented.



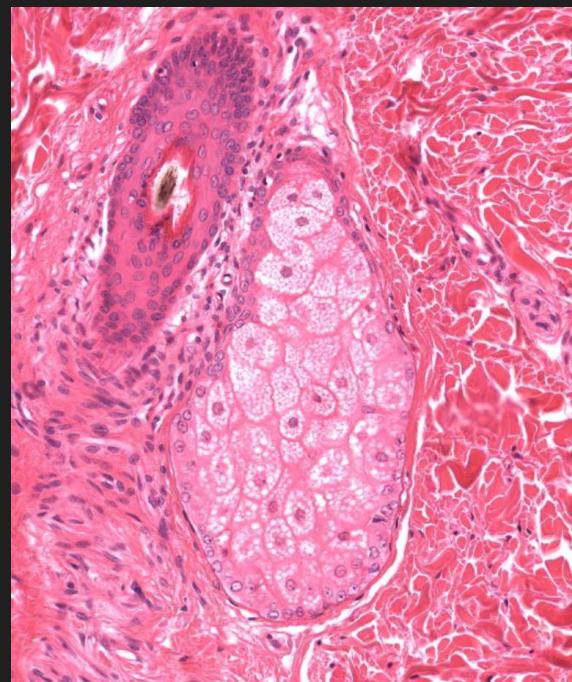
- **Stratum basale:** lightly pigmented with dark brown granules of melanin.



- **Sweat gland:** coiled tubular gland with simple or stratified cuboidal epithelium (lightly stained) and duct cells (dark staining).



- **Hair follicle and sebaceous gland:** common in thin skin. The sebaceceus glands are large cells with a central nuclei and foamy cytoplasm. These cells produce an oily, waxy substance called sebum that is released onto the surface of the skin.



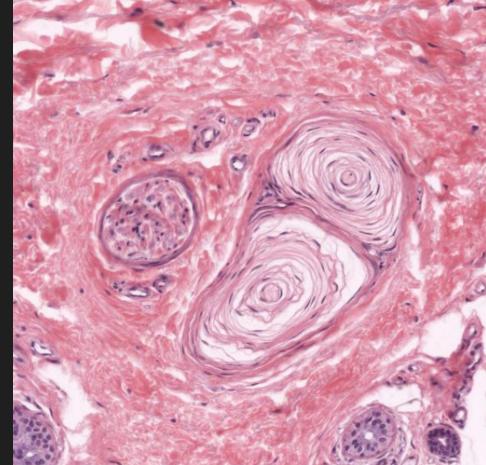
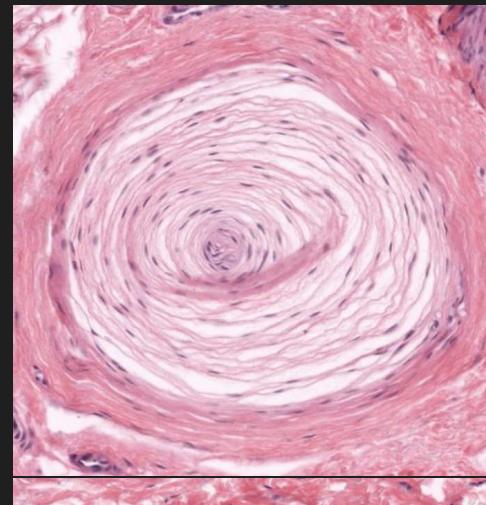
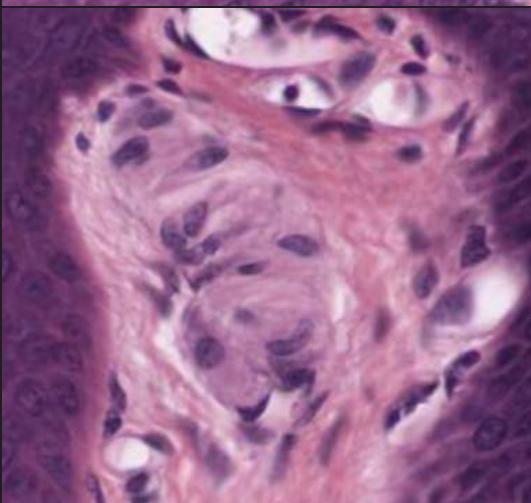
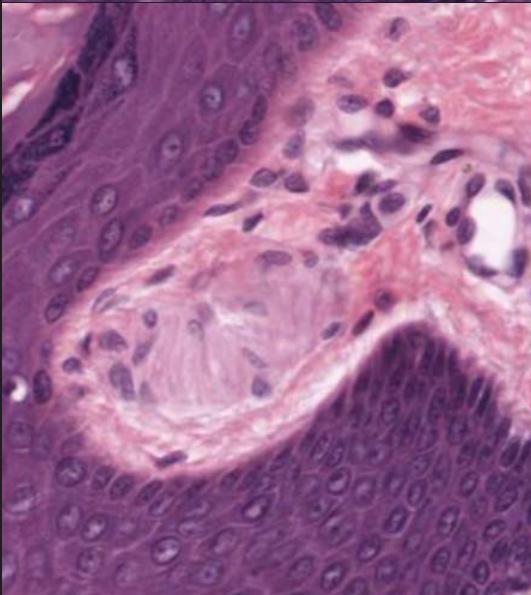
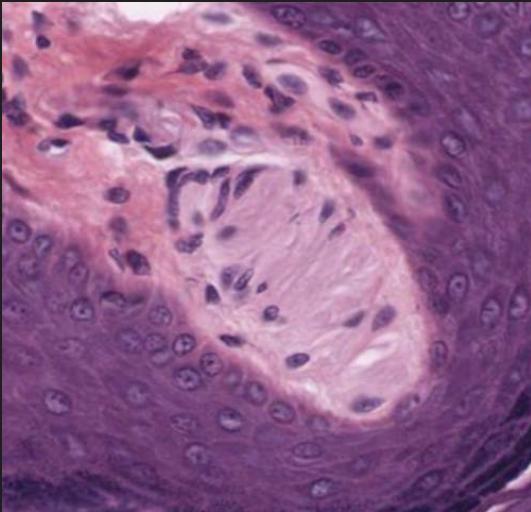
Questions

- What are the cell junctions in the stratum spinosum? – Desmosomes, with spiky membrane projections.
- Where are the melanocytes located? – Stratum basale.

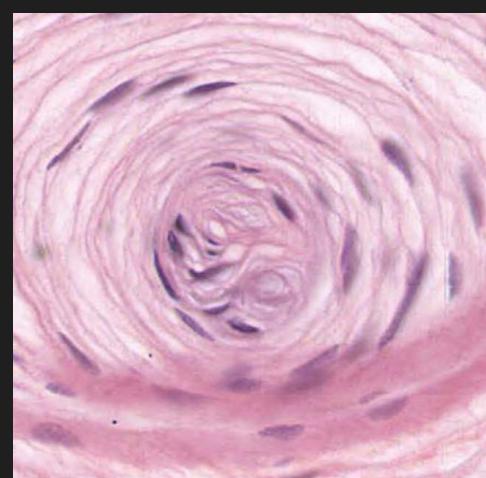
Meissner and Pacinian Corpuscles

Meissner and Pacinian corpuscles are two types of touch/pressure receptors that are found in skin.

- **Meissner corpuscles:** nerve endings in skin responsible for sensitivity to light touch.
- **Pacinian corpuscles:** nerve endings in skin responsible for sensitivity to vibration and pressure.



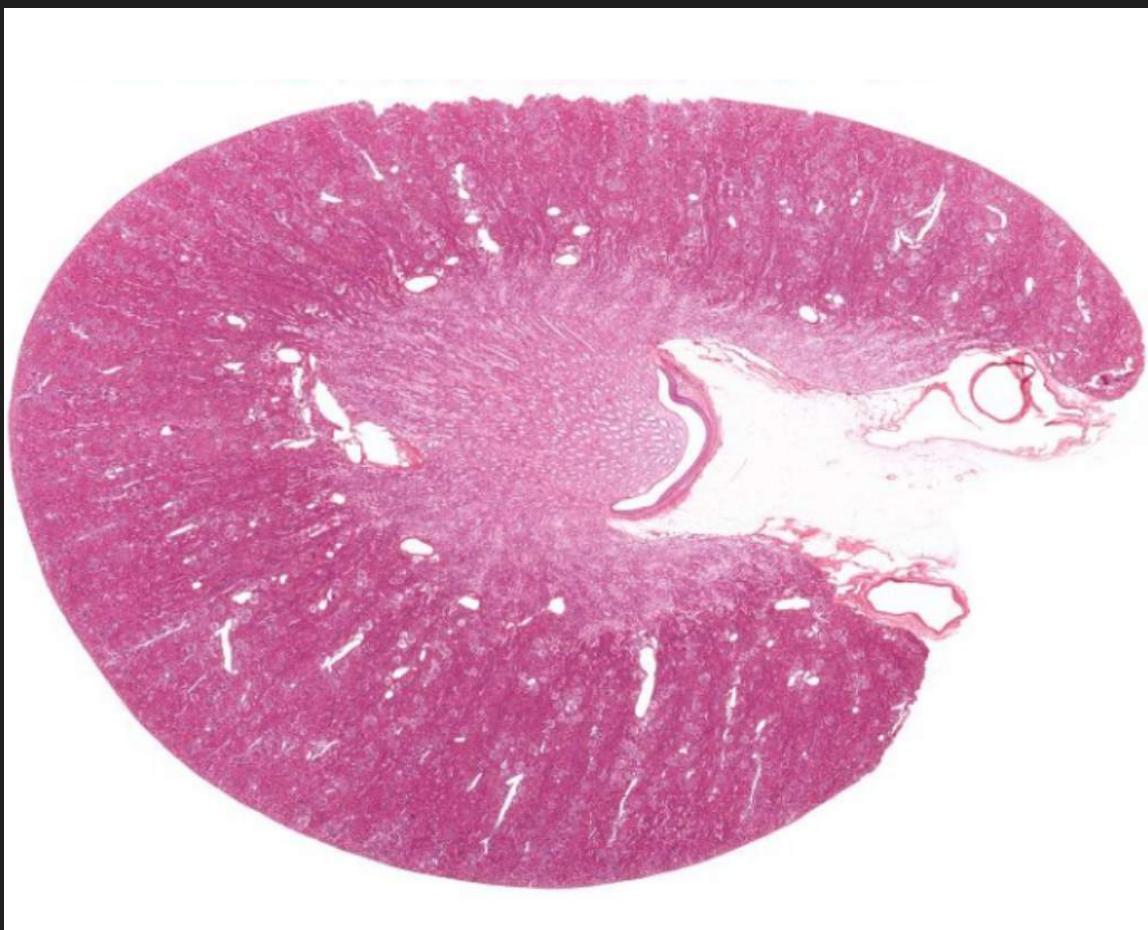
- **Inner bulb:** an unmyelinated axon within a fluid-filled cavity formed by several lamellae of Schwann cells.



Urinary

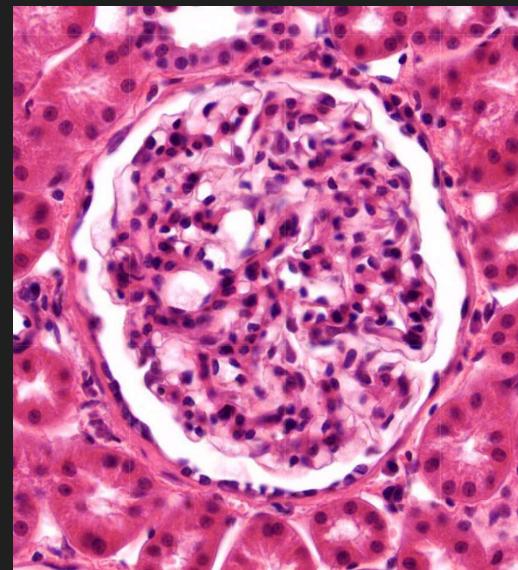
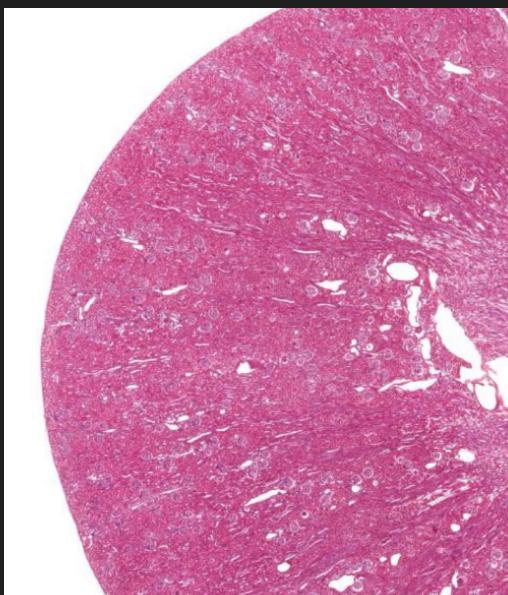
Kidney

Kidneys filter blood and produce urine. Unlike the human kidney which is multilobed (10 to 12 lobes) separated by renal columns (cortical tissue that extends alongside the margin of pyramids in the medulla), the monkey kidney is unilobular.

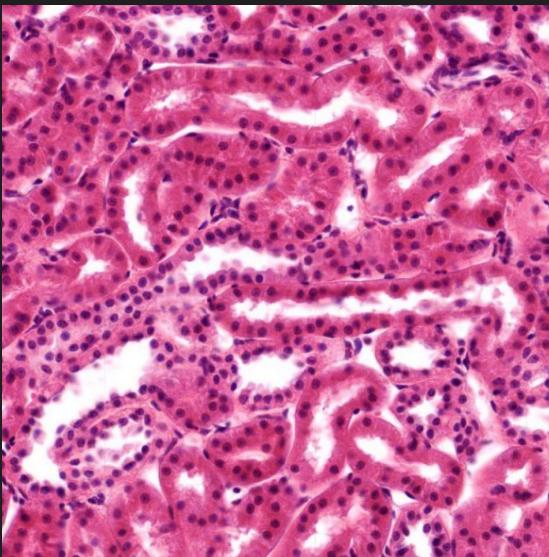


- **Cortex:** darker outer region.

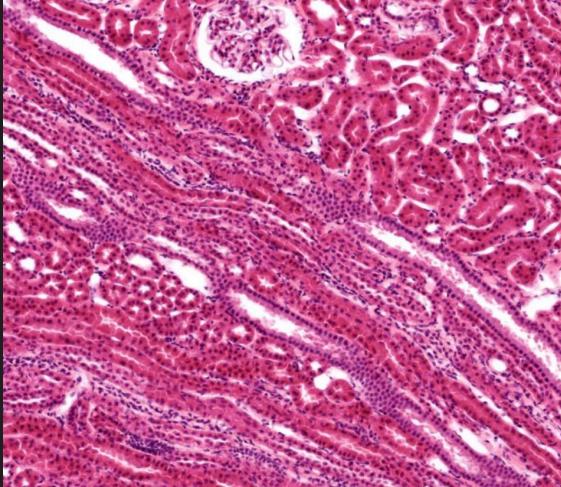
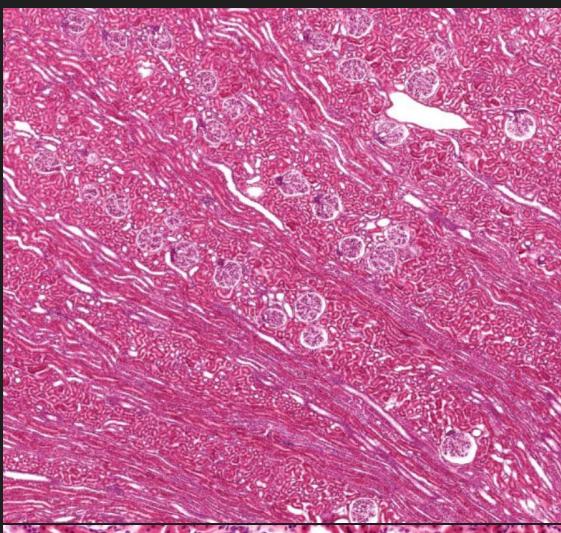
- **Renal corpuscles:** spherical structures that form ultrafiltrate from blood.



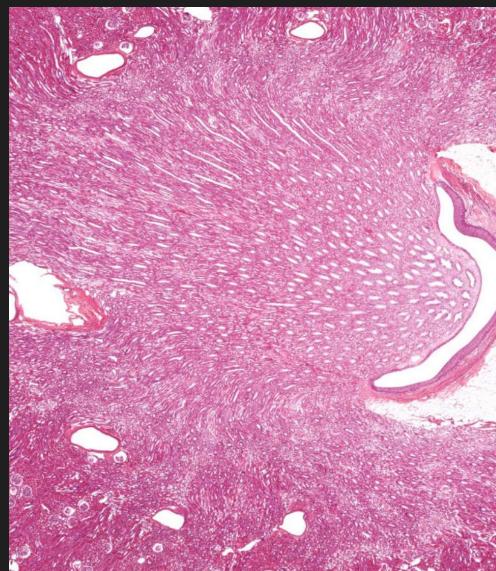
- **Cortical labyrinths:** regions between renal corpuscles and medullary rays that contain proximal and distal convoluted tubules.



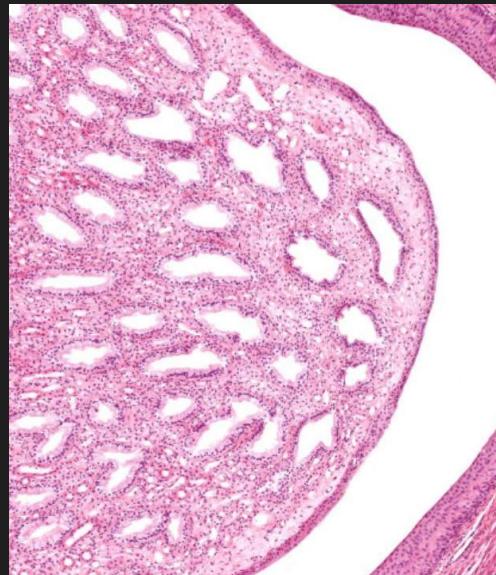
- **Medullary rays:** projections of tubules between the cortex and medulla that contains straight tubules and collecting ducts.



- **Medulla:** lighter inner region.



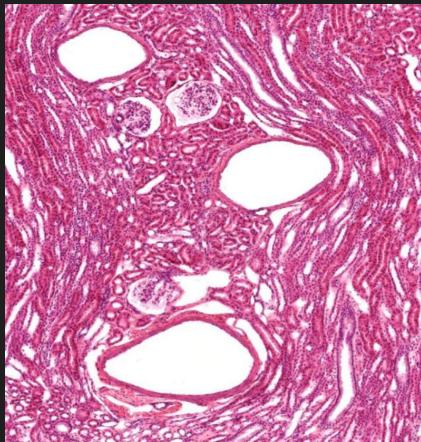
- **Renal papilla**



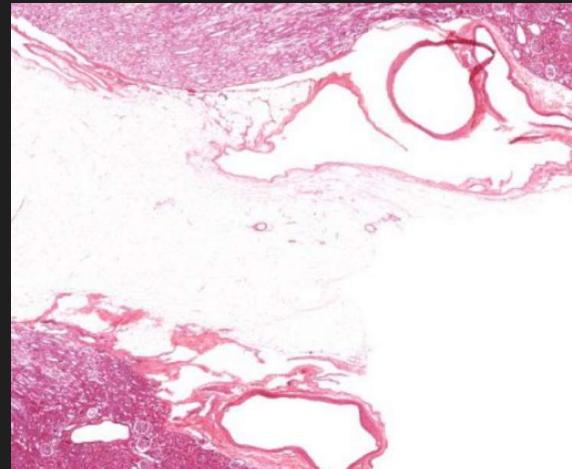
- **Renal pelvis:** funnel-shaped origin of the ureter.



- **Arcuate arteries:** branches of interlobular arteries that form an arcade over the pyramids at the junction of the cortex and medulla.

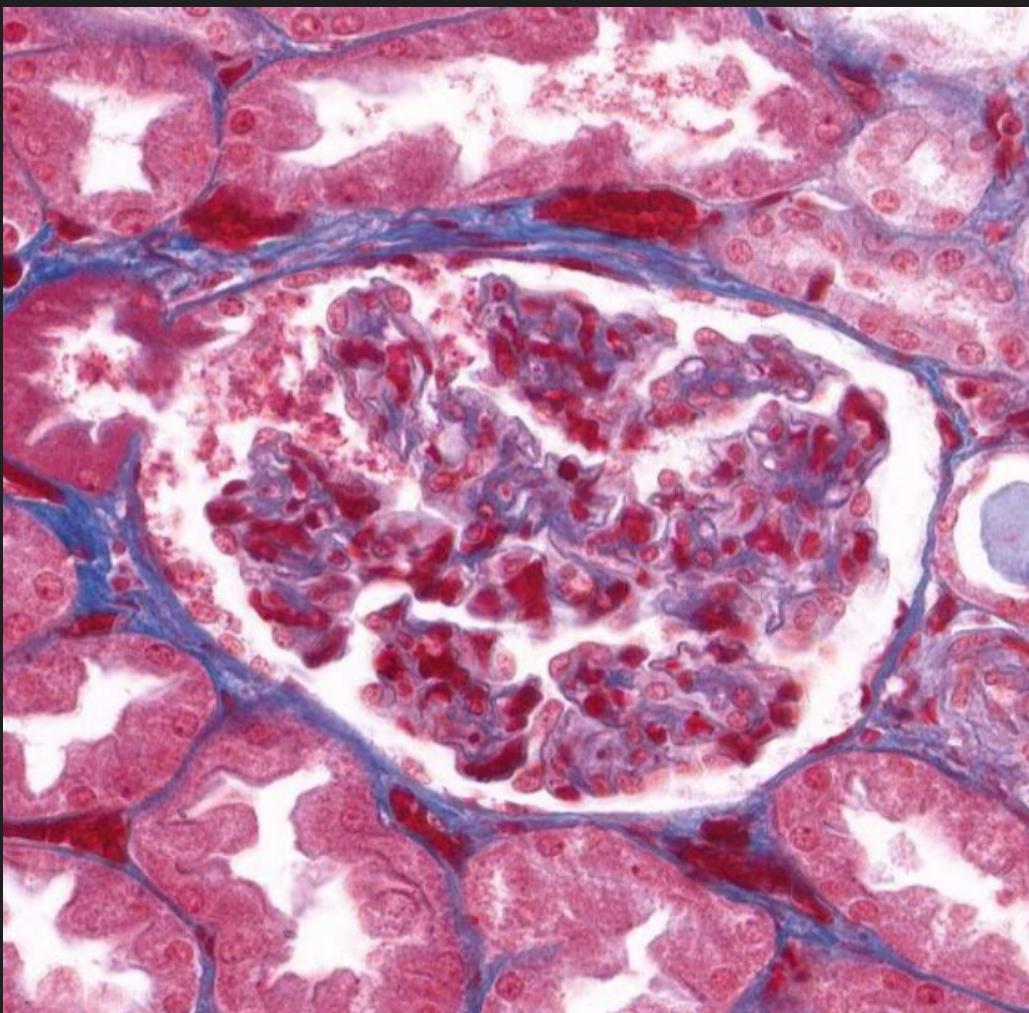


- **Hilum:** concave surface with a deep fissure in which vessels enter and exit the kidney.

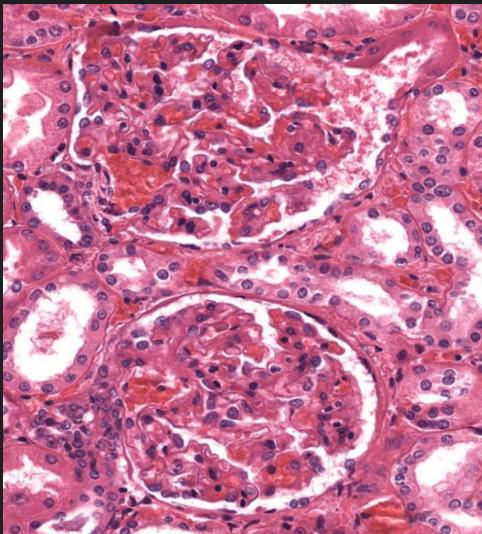


Nephron

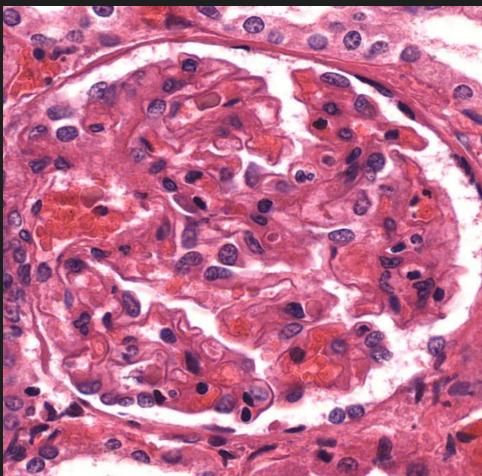
The nephron is the functional unit of the kidney. Each nephron includes a filter (renal corpuscle), and a single, long tubule (renal tubule) through which the filtrate passes before emerging as urine.



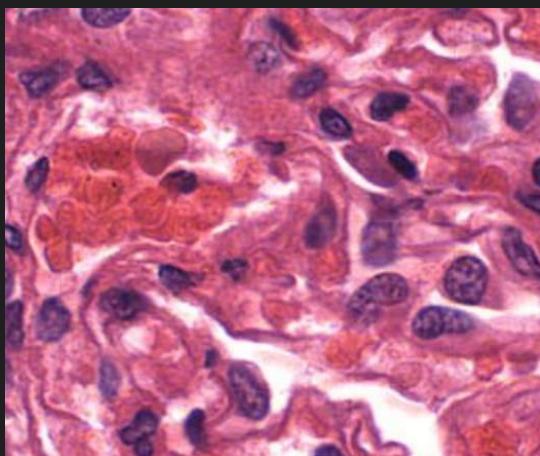
- **Renal corpuscle:** spherical structures with an average diameter of 200 µm distributed throughout the cortex.



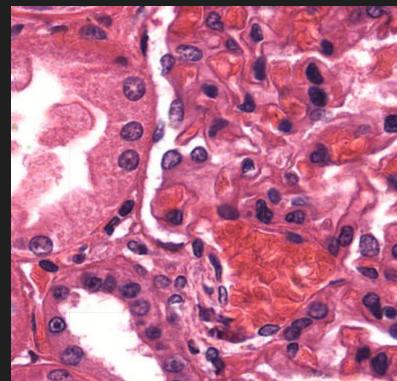
- **Bowman's capsule:** encloses the glomerulus.



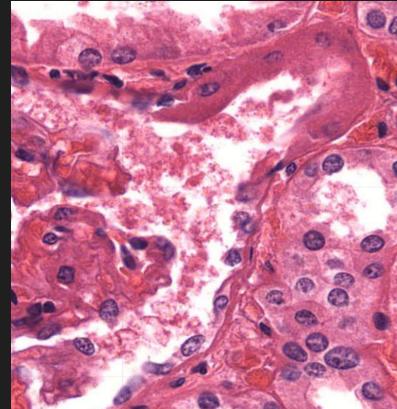
- **Glomerulus:** blood flowing through a capillary network (or tuft) undergoes filtration to produce the ultrafiltrate.



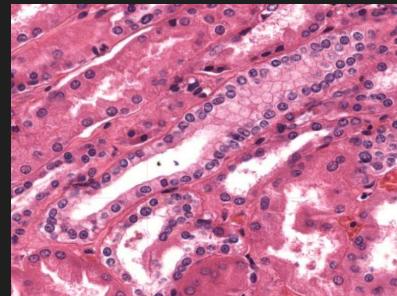
- **Vascular pole:**



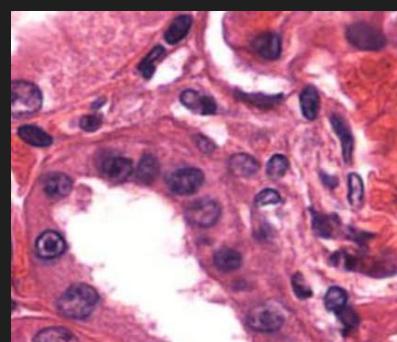
- **Urinary pole:**



- **Collecting ducts:** convey urine from nephrons to collecting ducts within medullary rays.

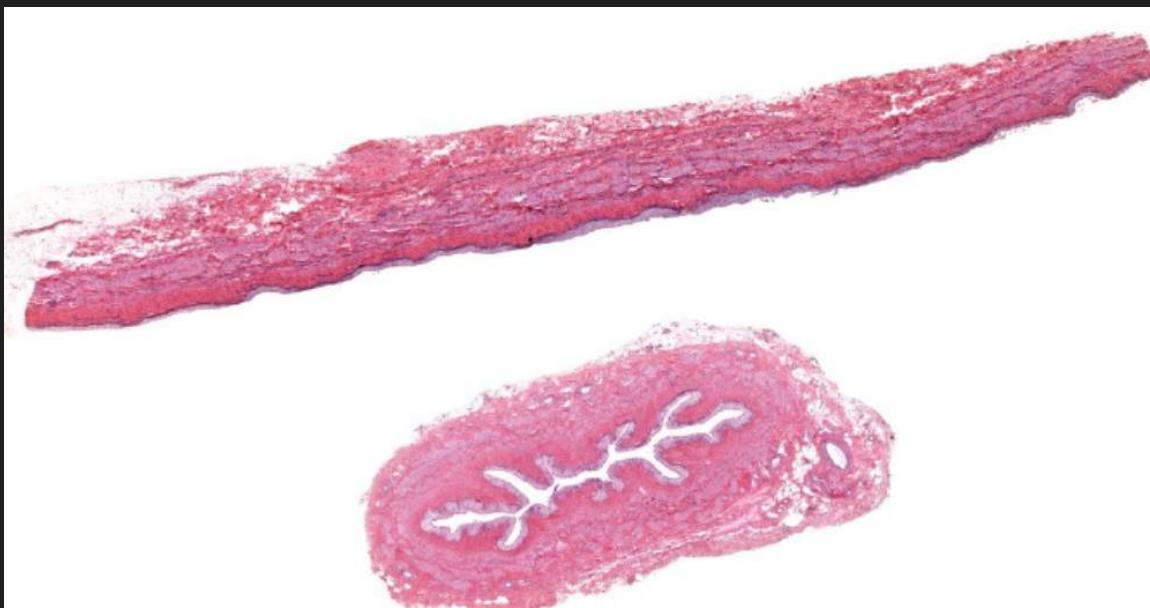


- **Macula densa:** tightly packed cells where the distal straight tubule contacts the afferent arteriole of the vascular pole of the renal corpuscle.

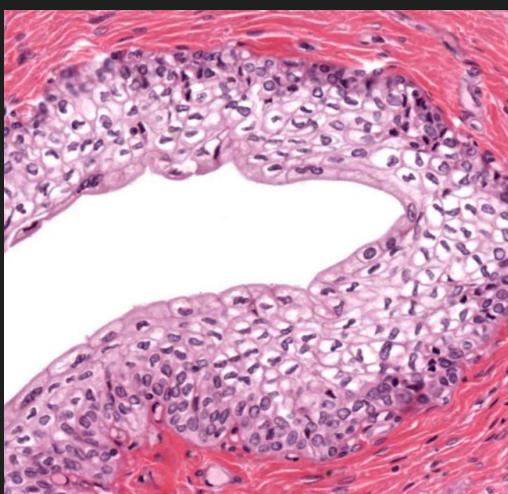


Ureter

Ureter transport urine from the kidney to the bladder. It is lined with an epithelium that is impermeable to water and ions. Peristaltic contraction of the smooth muscle moves urine from the kidney to the bladder.



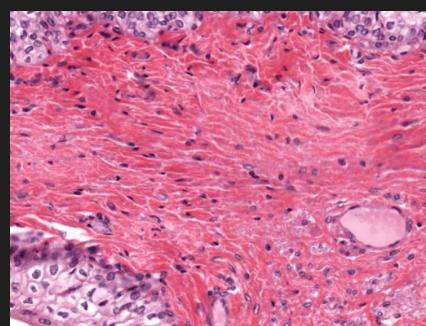
- **Cross-section:** composed of four concentric layers.
- **Transitional epithelium (Urothelium):** consists of two to three cell layers in the upper ureter with up to ten cell layers near the bladder



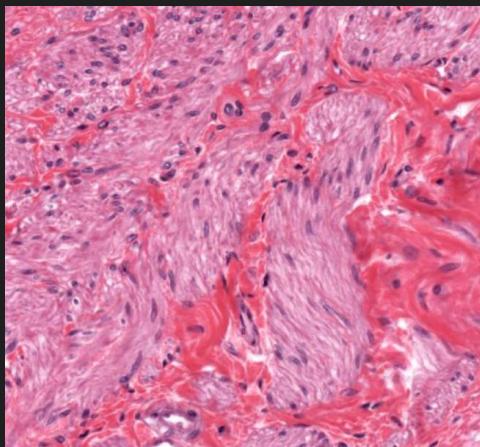
- **Umbrella cells:** upper layer of cells that change shape depending on the distention of the ureter (relaxed)



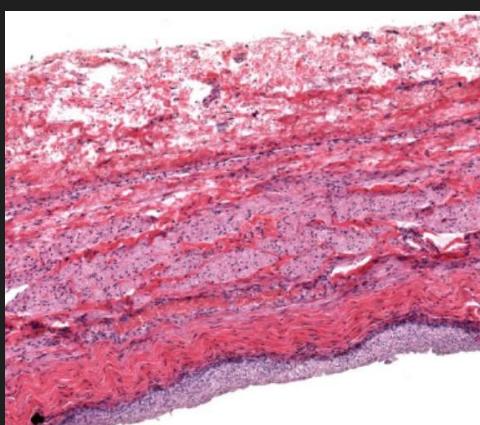
- **Lamina propria:** thick layer of dense irregular connective tissue rich in collagen and elastic fibers



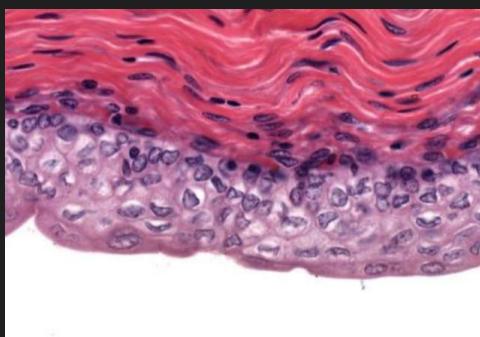
- **Muscularis externa:** irregular arrangement of smooth muscle in two layers (inner longitudinal and outer circular) in the upper ureter or three layers (inner longitudinal, middle circular and outer longitudinal) near the bladder.



- **Longitudinal section:**



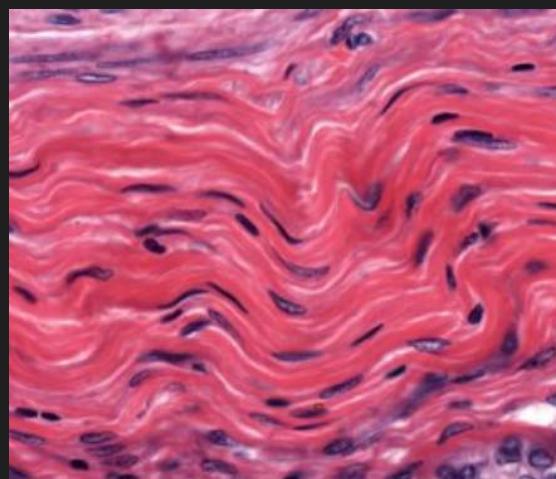
- **Transitional epithelium:**



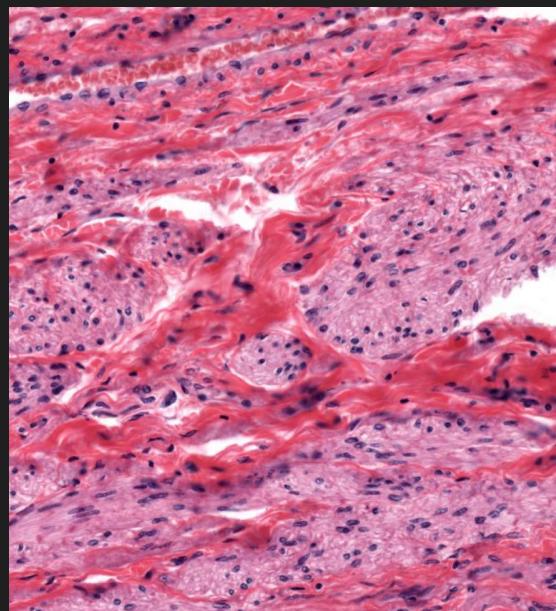
- **Umbrella cells:**



- **Lamina propria:**



- **Muscularis externa:**



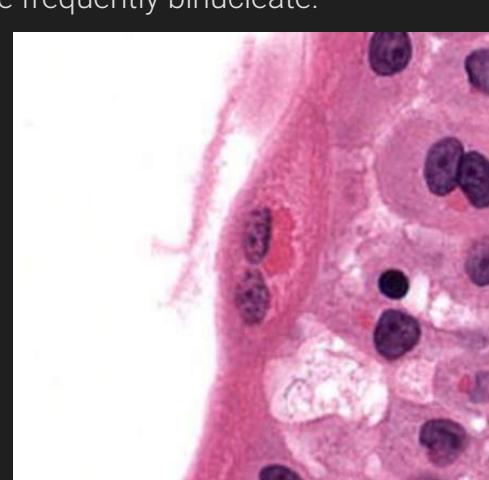
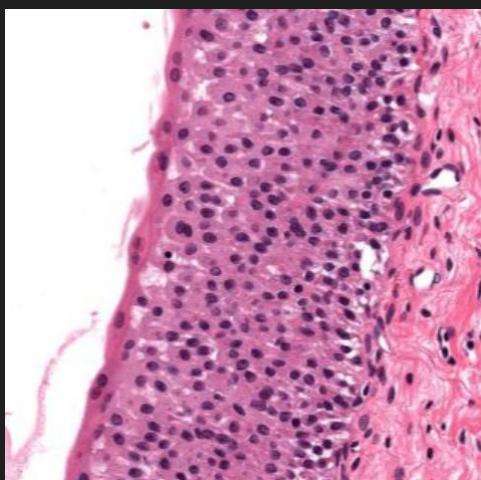
Urinary Bladder

Bladder is an expandable vessel for the storage of urine. It is lined with an epithelium that is impermeable to water and ions.

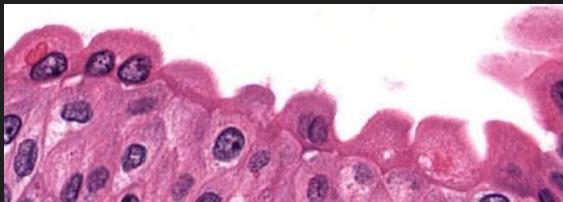
Like the ureters, the bladder is composed of four concentric layers.



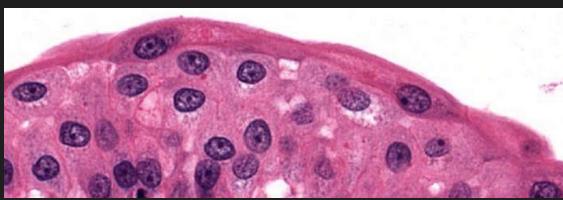
- **Urothelium:** consists of two to three cell layers in the upper ureter with up to ten cell layers near the bladder.
- **Umbrella cells:** the upper layer of cells that change shape depending on the distention of the bladder. Umbrella cells are frequently binucleate.



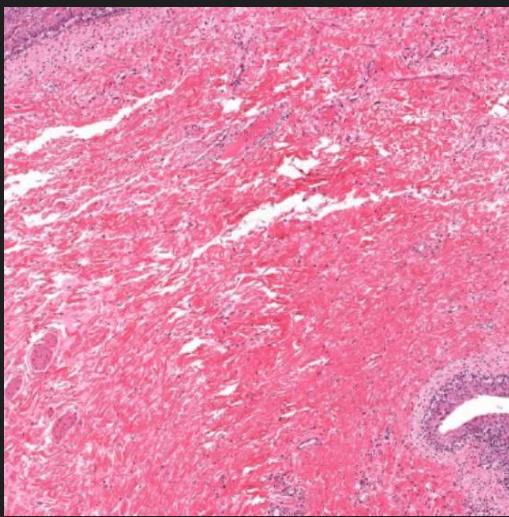
- **Dome-shaped umbrella cells:** rounded and bulge from the surface of the epithelium.



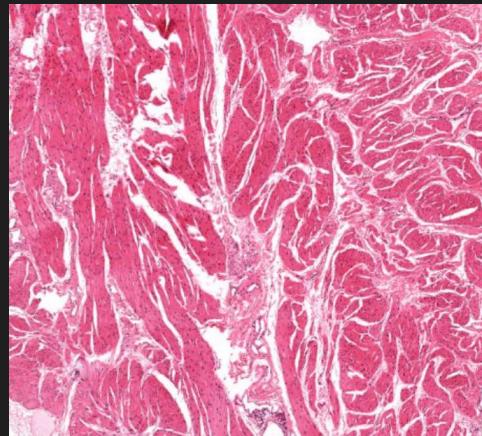
- **Flattened umbrella cells:** stretch over several underlying epithelial cells.



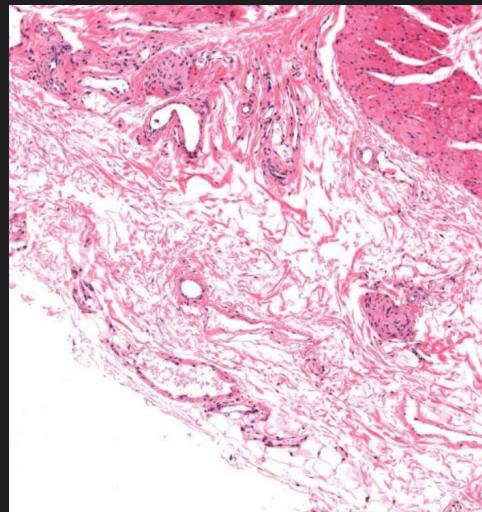
- **Lamina propria:** thick layer of dense irregular connective tissue rich in collagen and elastic fibers.



- **Muscularis externa:** loosely arranged smooth muscle in two layers (inner longitudinal and outer circular) in the upper ureter or three layers (inner longitudinal, middle circular and outer longitudinal) near the bladder.

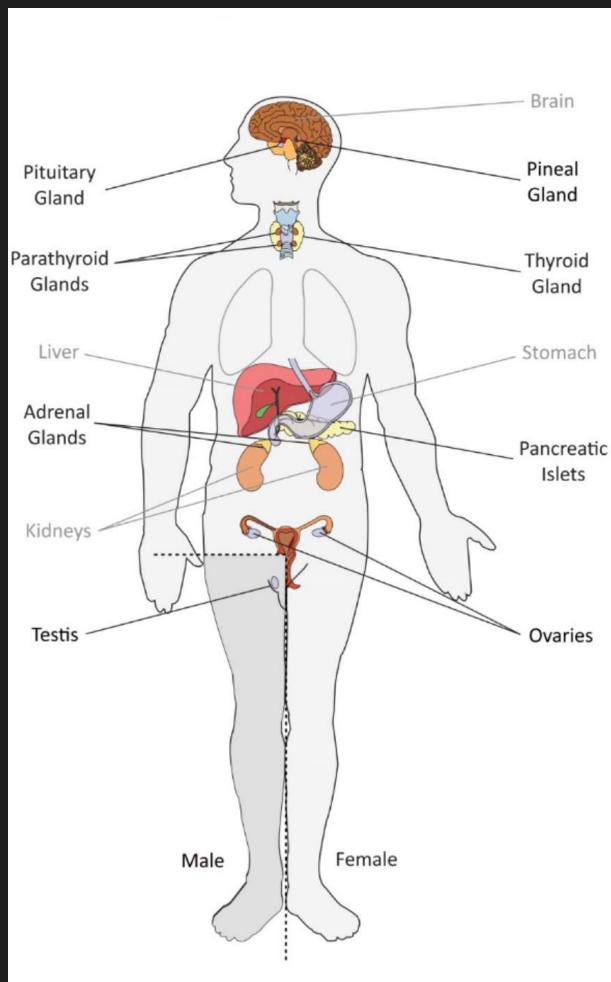


- **Adventitia:** loose connective tissue with blood vessels, nerves and adipose cells.



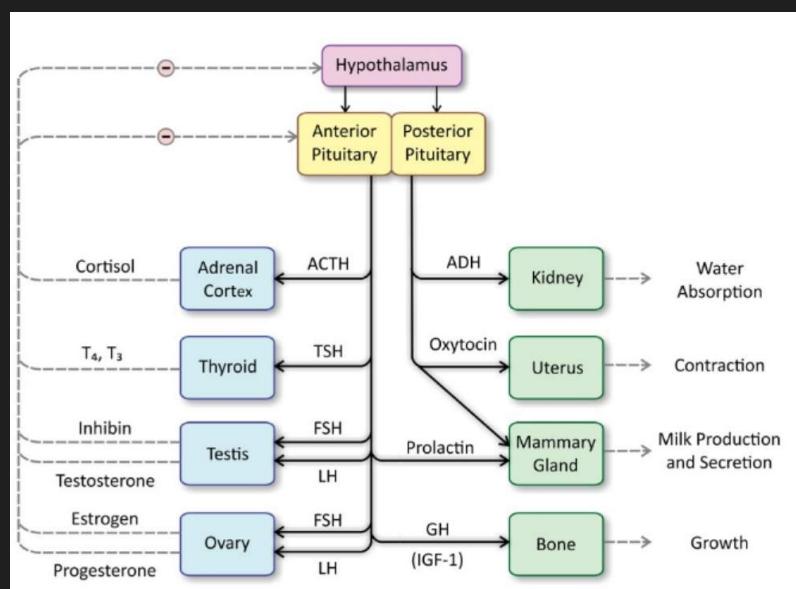
Week 8: Endocrine, Male Reproductive

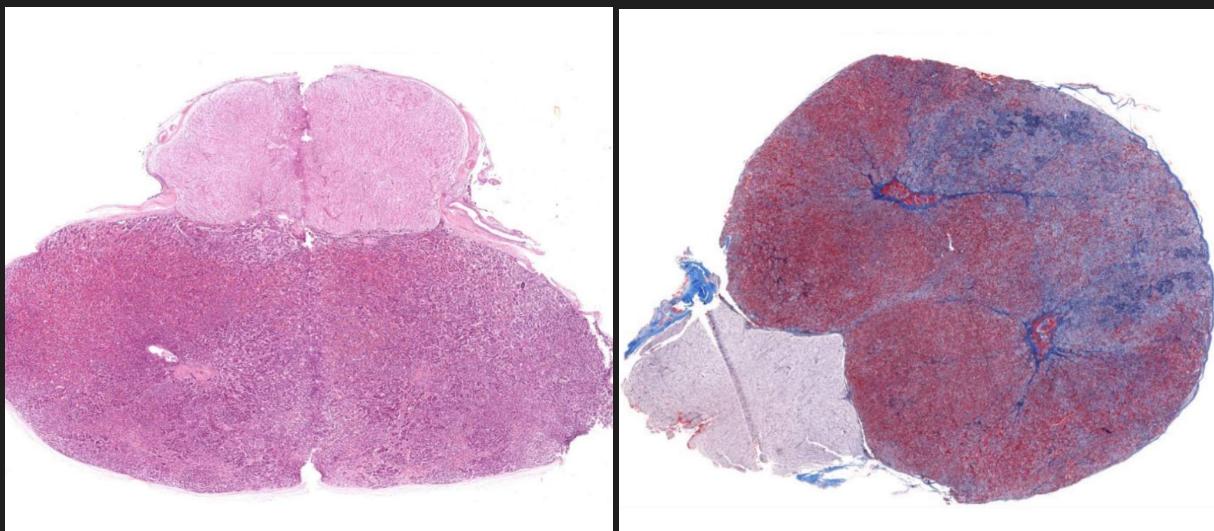
Endocrine Glands



Pituitary Gland

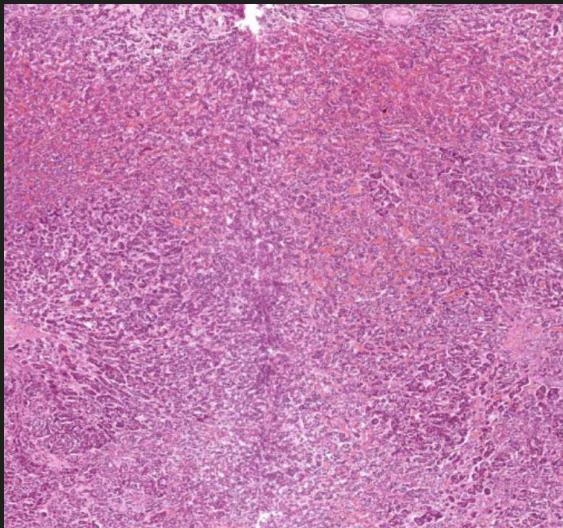
The pituitary is often called the “master gland” of the body because it produces hormones that regulate other endocrine glands, as well as, have direct effects on target tissues.



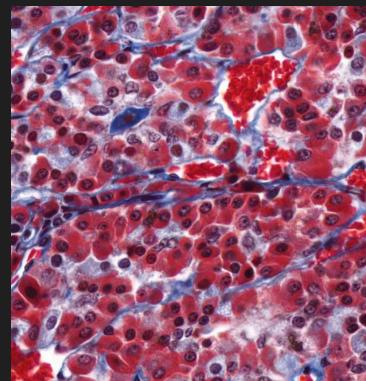


- **Anterior pituitary**

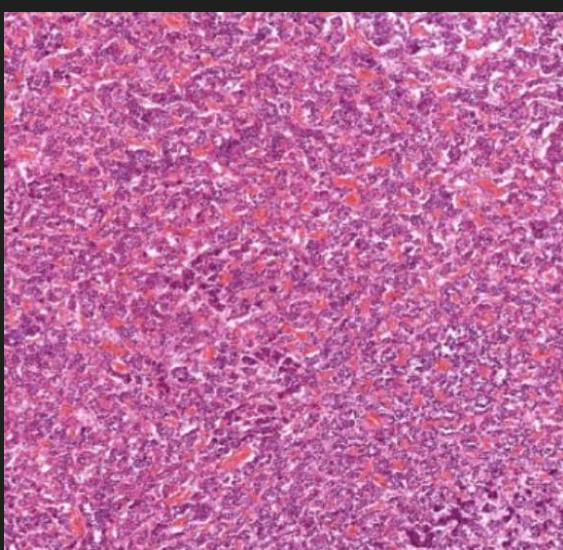
- **Acidophils:** stain dark red with azan.



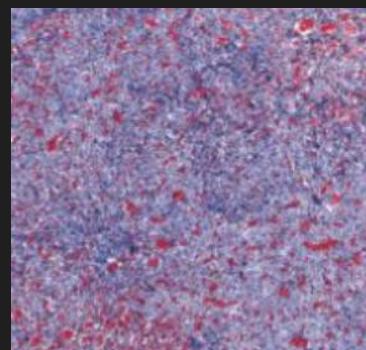
- **Chromophils:** stain with H&E and secrete hormones.



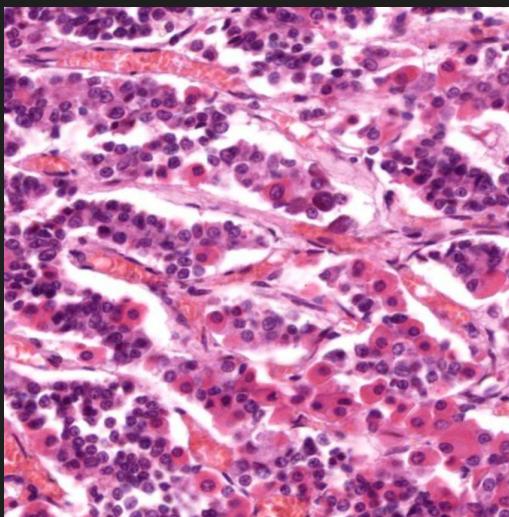
- **Basophils:** stain bluish-purple with H&E



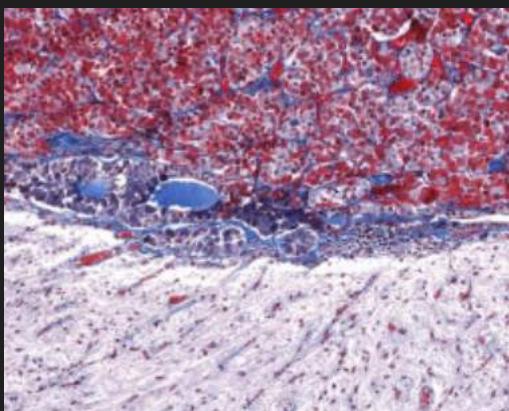
- **Chromophobes:** stain light blue with azan and do not secrete hormones.



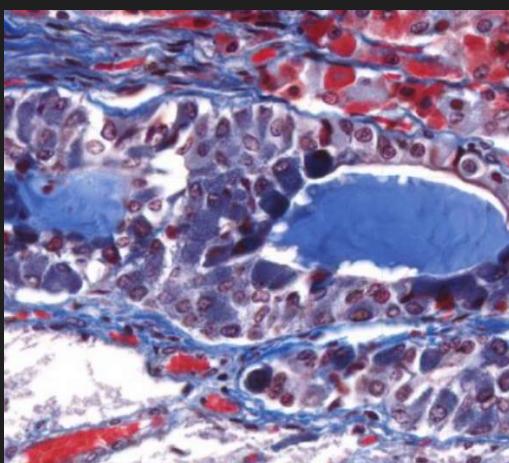
- **Sinusoidal capillaries:** extensive network that receives hormones from acidophils and basophils.



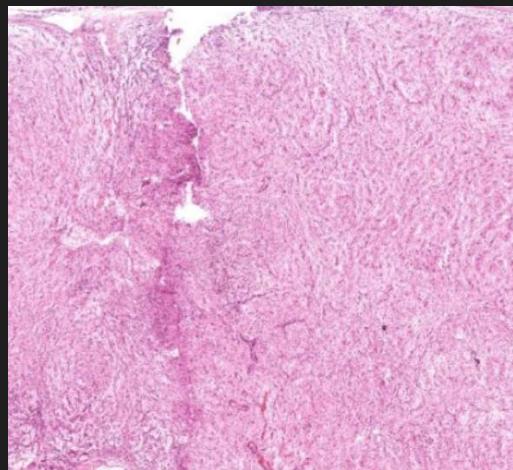
- **Pars intermedia:** thin remnant (<2%) at interface between the anterior and posterior lobes that contains numerous colloid (protein)-filled cysts (Rathke's cysts)



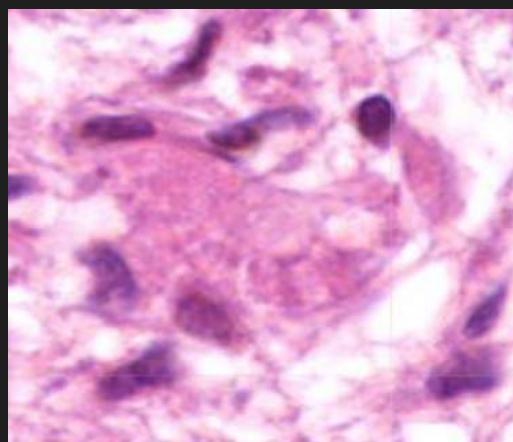
- **Rathke's Cysts:**



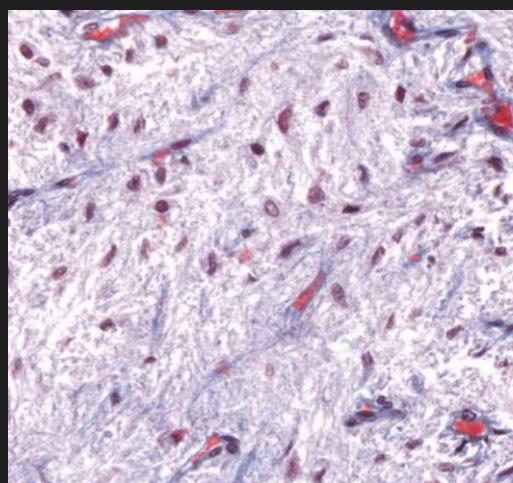
- **Posterior pituitary:** axons from the hypothalamus that release hormones into the capillaries of the pars nervosa.



- **Herring bodies:** dilations of axons filled with neuro-secretion vesicles.



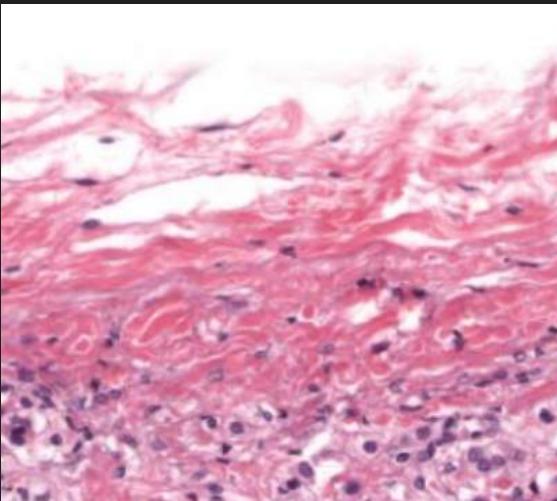
- **Pituicytes:** most nuclei belong to these glial cells.



Adrenal Gland

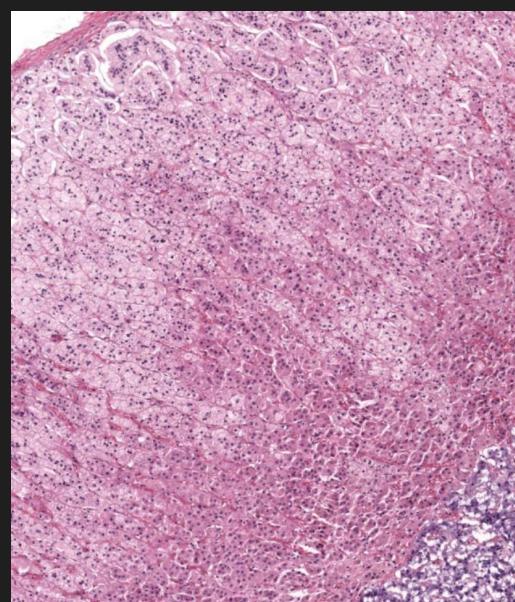


- **Capsule:** enclosed by a thin layer of connective tissue.

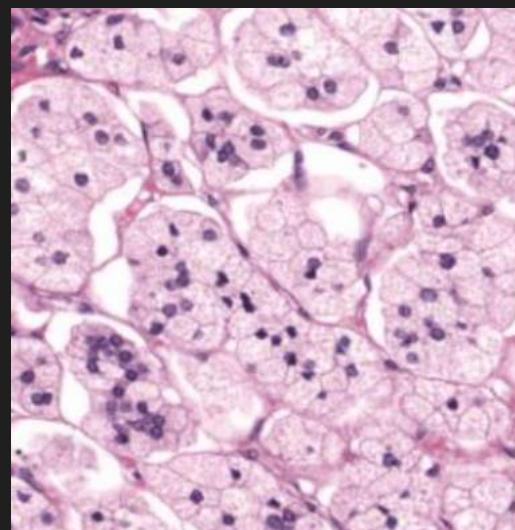
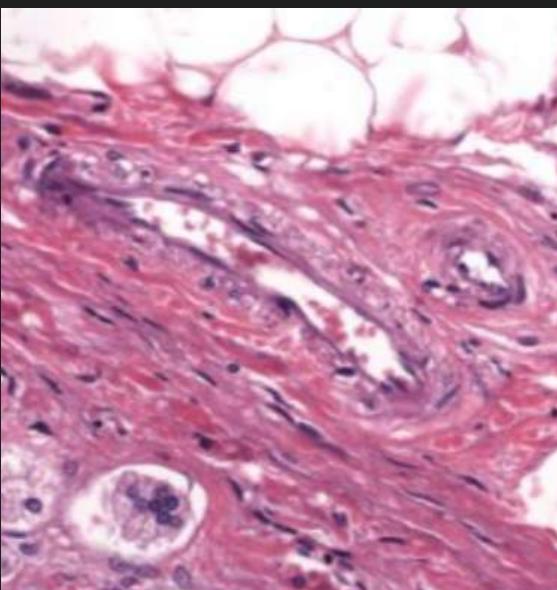


- **Afferent blood vessels:** penetrate the capsule and branch into sinusoids that supply the cortex and medulla.

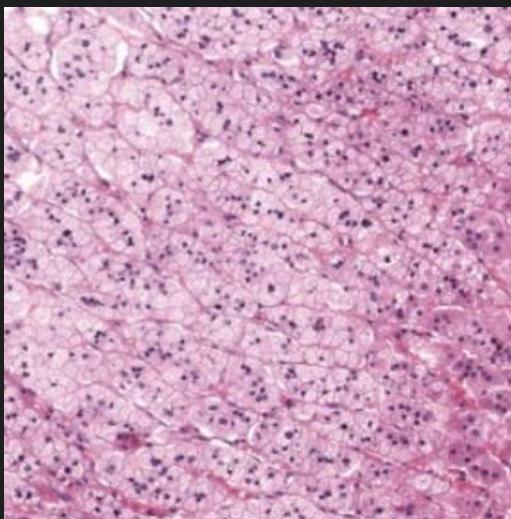
- **Cortex:** cells that synthesize and secrete steroid hormones.



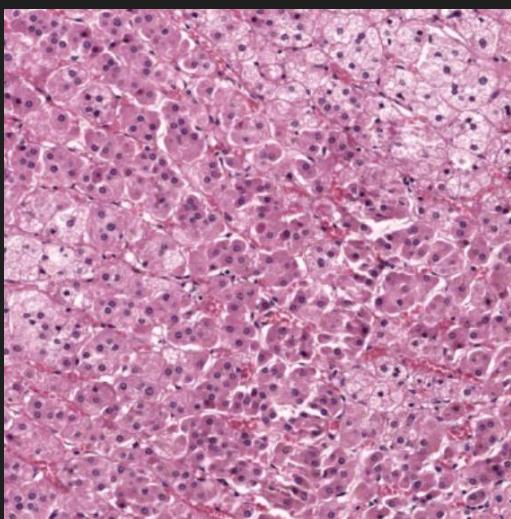
- **Zona glomerulosa:** outer zone (15%) of glomerular-like clusters of cells and secrete aldosterone.



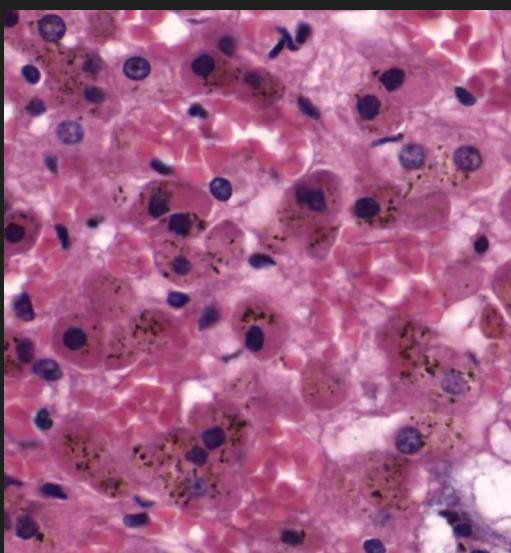
- **Zona fasciculata:** middle zone (80%) of two-cell wide vertical cords that secrete cortisol.



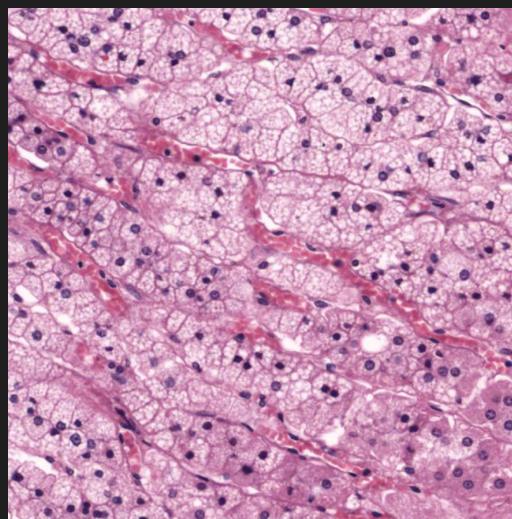
- **Zona reticularis:** inner zone (7%) of one-cell wide anastomosing rows that secrete precursors of testosterone.



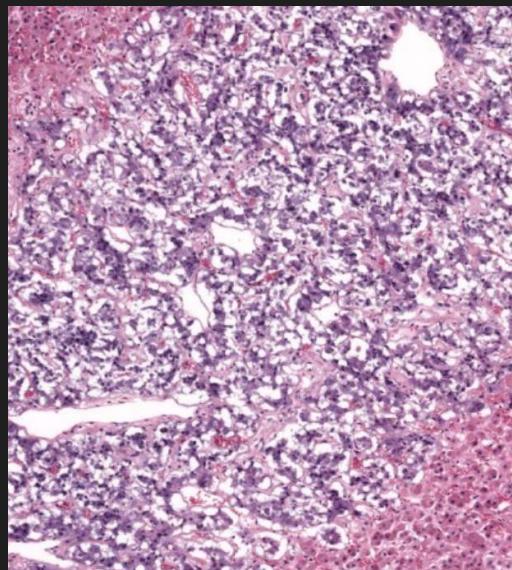
- **Lipofuscin pigment:**



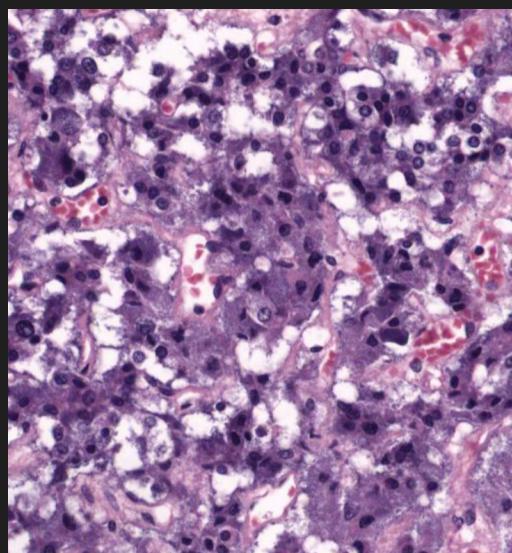
- **Sinusoidal capillaries:** rich network of blood vessels.



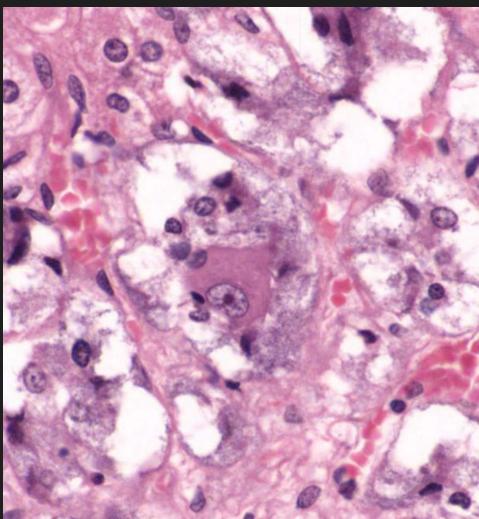
- **Medulla:**



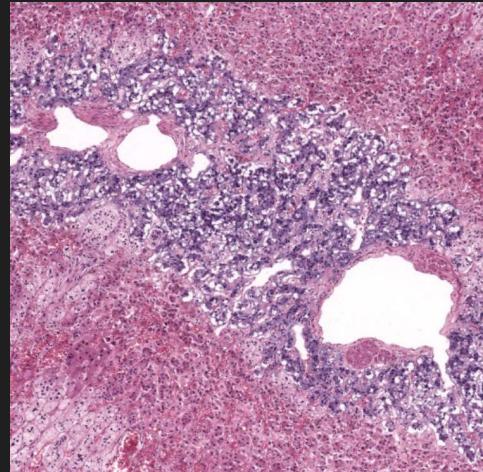
- **Chromaffin cells:** modified postganglionic sympathetic neurons that secrete catecholamines



- **Ganglion cells:** infrequent sympathetic ganglion cells.



- **Medullary vessels:** large veins that drain the organ.

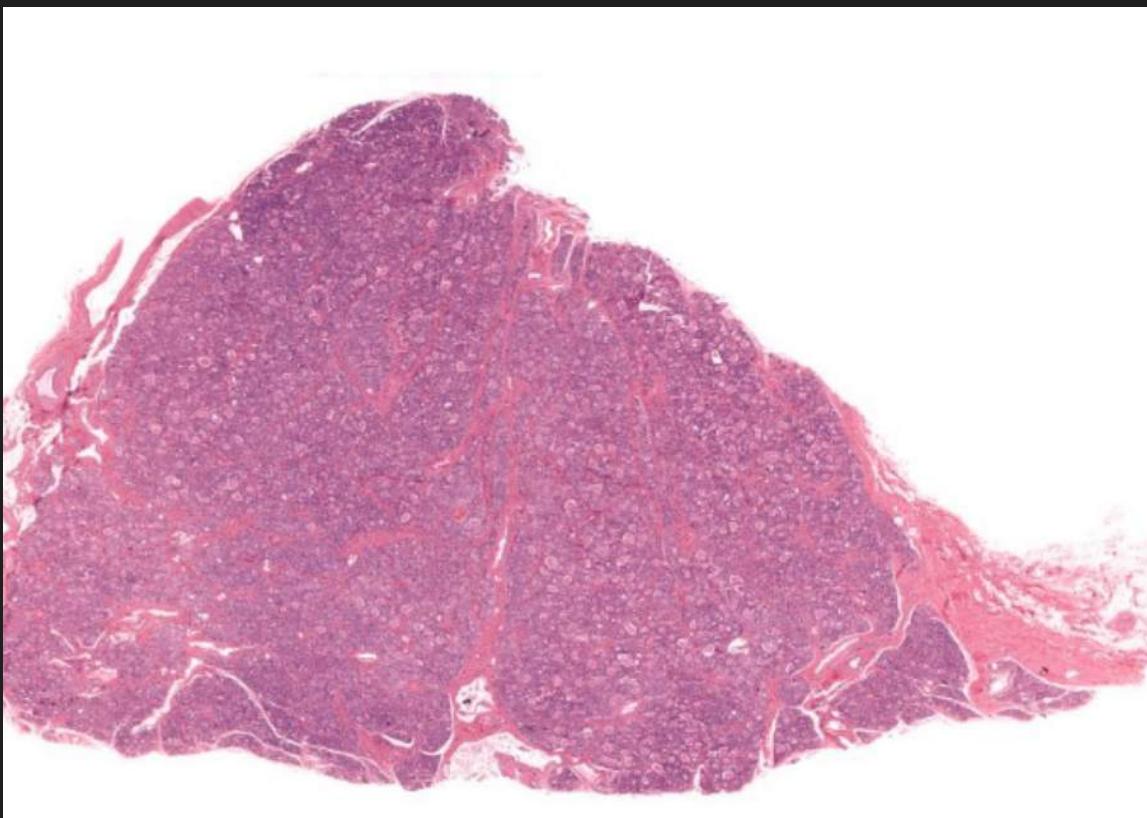


Questions

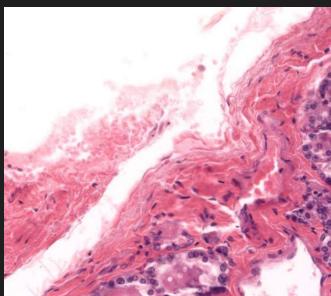
- What hormone is produced by the zona glomerulosa?
 - Aldosterone, which plays a central role in regulating blood pressure and certain electrolytes.
- By the zona fasciculata?
 - Cortisol, involved in response to stress.
- By the zona reticularis?
 - Androgens, various sex hormones.
- By the medulla?
 - Epinephrine and norepinephrine.
- What hormones regulate the function of the cortex?
 - Corticotropin-releasing hormone (CRH) and vasopressin.
- How is medullary function regulated?
 - CRH and adrenocorticotropin hormone (ACTH).

Thyroid

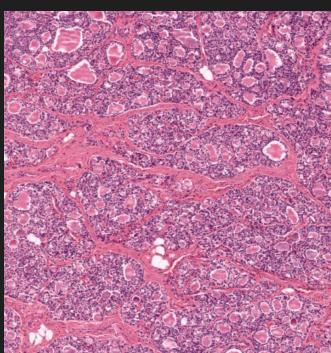
The thyroid gland is a bilobed endocrine gland. It is unique in that it stores its hormones bound to an extracellular pool of protein (colloid)



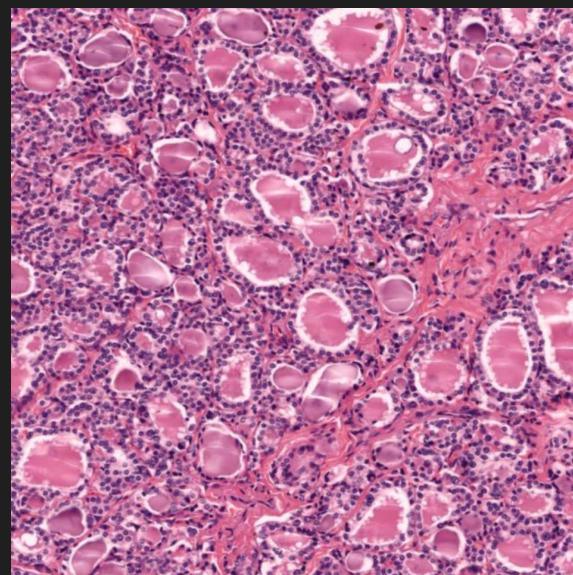
- **Capsule:** enclosed by a thin layer of connective tissue.



- **Trabeculae:** connective tissue extends inwards from the capsule to partially outline irregular lobes and lobules.



- **Thyroid follicles:** spherical follicles of varying size (50 to 500 µm) in which thyroid hormones are stored.

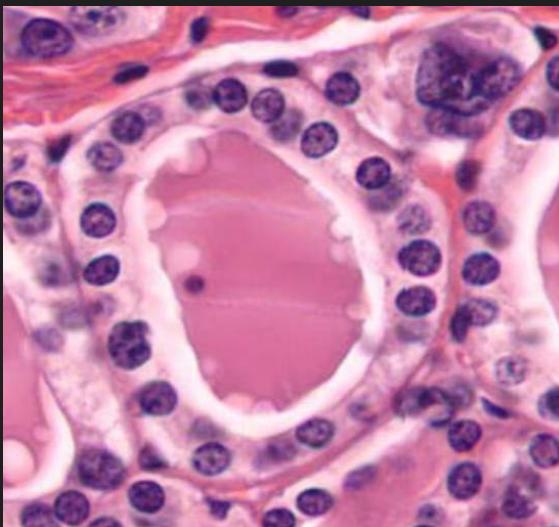


- **Colloid:** lumen of each follicle is filled with the gel-like mass called colloid. It is mostly the protein thyroglobulin (pink) and bound thyroid hormones

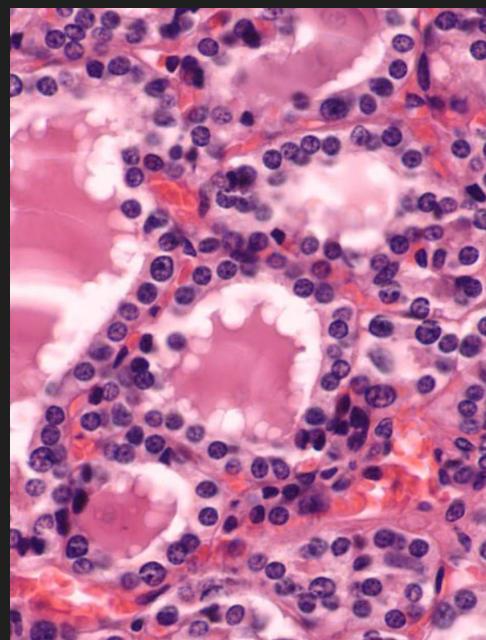
(triiodothyronine and tetraiodothyronine (or thyroxin)). The clear space around the colloid is a shrinkage artifact.



- **Follicular cells:** follicles are lined by a simple cuboidal to columnar epithelium depending on functional activity. Secrete thyroid hormones when active.



- **Capillaries:** a rich network surrounds each follicle.



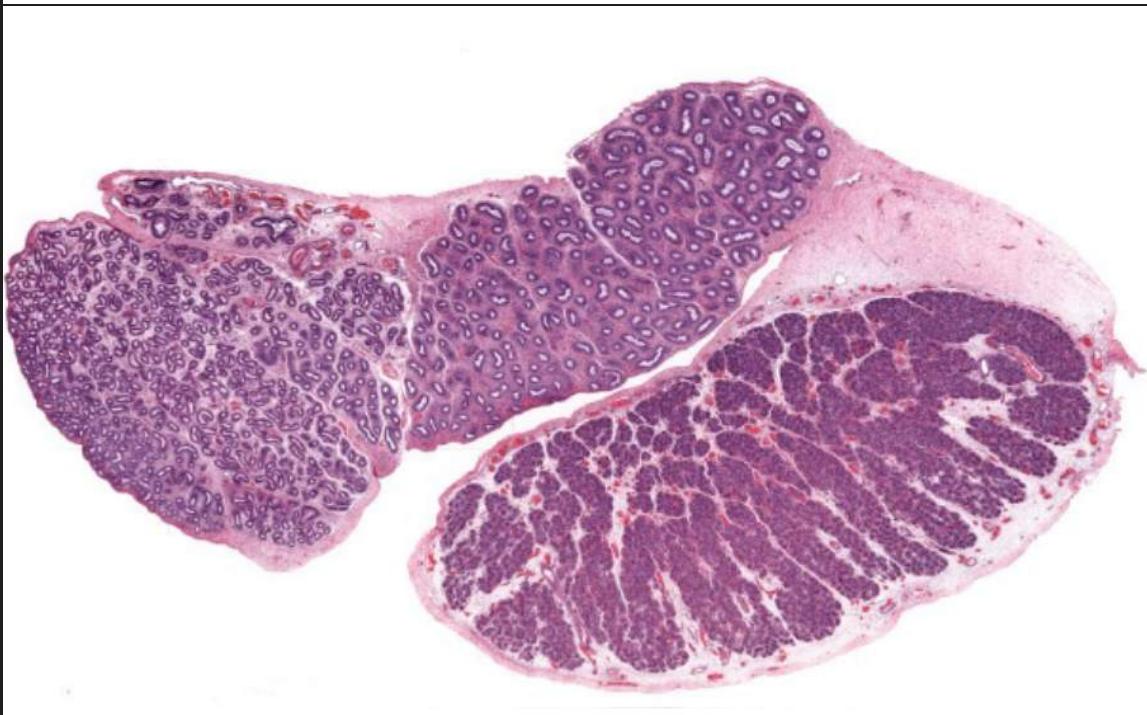
- **Parafollicular cells:** small numbers of larger cells located at the periphery of follicles that secrete calcitonin. They stain poorly with H&E making identification difficult.



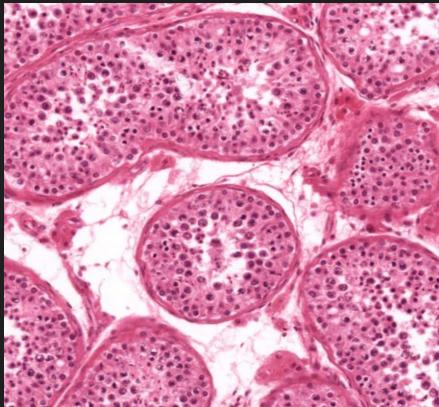
Male Reproductive System

Testis (Adult and Neonatal)

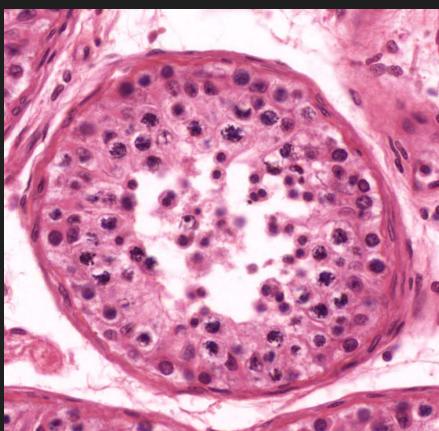
Testes are responsible for the production of sperm (spermatogenesis) and secretion of male sex hormones (testosterone). The production of sperm occurs within the seminiferous tubules that make up most of the testis.



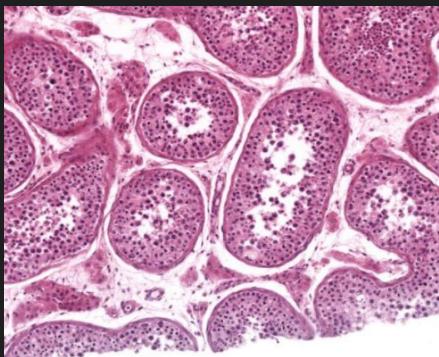
- **Seminiferous tubules:** each lobule contains 1 to 4 highly-coiled seminiferous tubules lined by a germinal epithelium that is the site of sperm production.



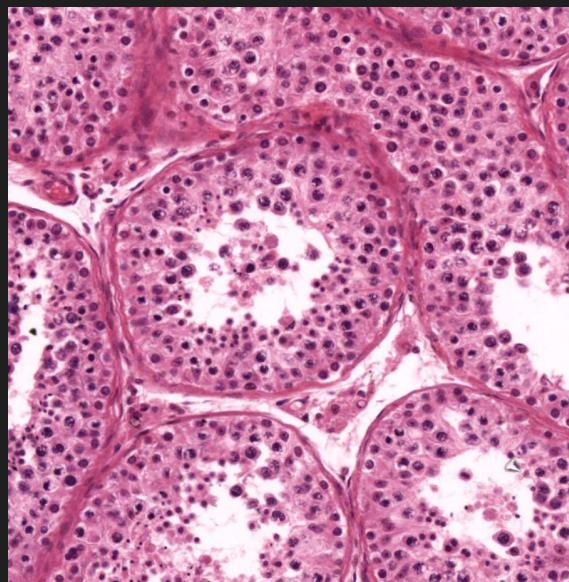
- **Sertoli cells:** large, columnar cells that extend the full thickness of the germinal epithelium that separate the basal epithelial compartment (of spermatogonia) from the luminal compartment (of spermatocytes, spermatids and sperm).



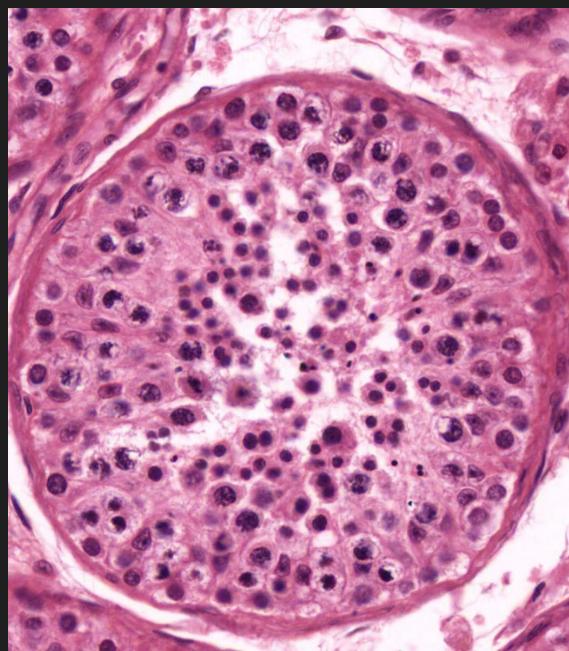
- **Spermatogonia:** single layer of germ cells resting on the basement membrane.



- **Primary spermatocytes:** arise from spermatogonia and cross from the basal epithelial to luminal compartment of the germinal epithelium.

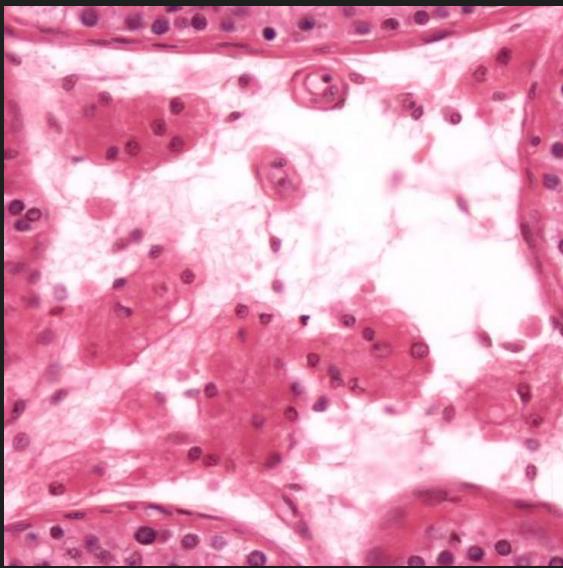


- **Spermatids:** Small, spherical cells (8 µm or less) with intensely stained nuclei near the lumen that arise from secondary spermatocytes and undergo spermiogenesis to transform into sperm and embed in the cytoplasm of Sertoli cells.

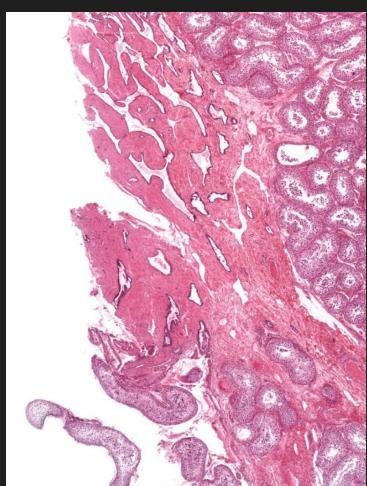


- **Leydig cells:** Large, round cells (20 to 30 µm diameter; usually clustered) with vesicular nuclei and eosinophilic

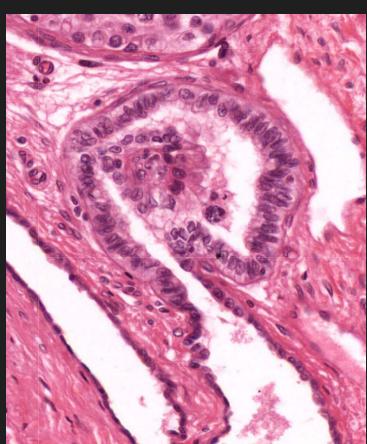
cytoplasm found in the connective tissue (or interstitium) between seminiferous tubules that secrete testosterone.



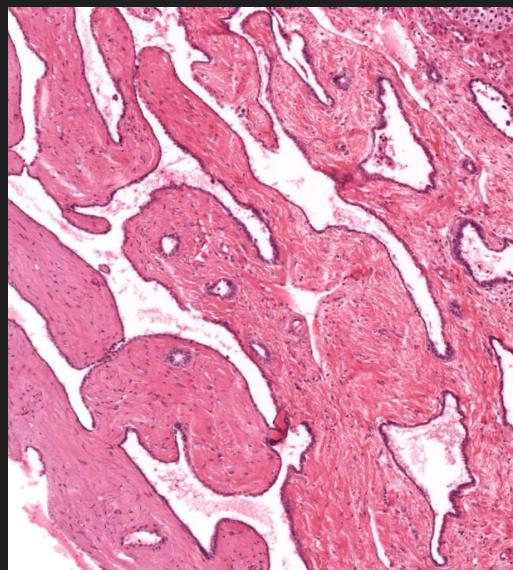
- **Mediastinum:** region in which seminiferous tubules converge and sperm exits the testis.



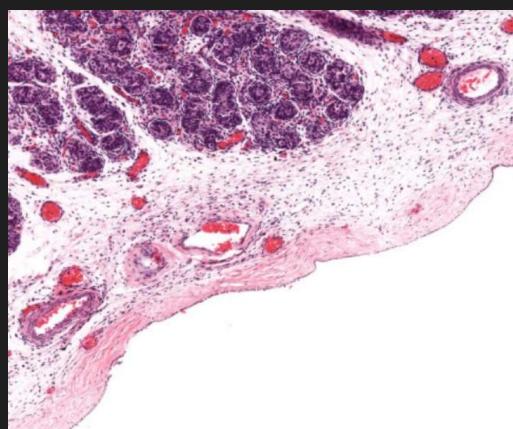
- **Straight tubules (tubuli recti):** short, terminal section of each seminiferous tubule lined only by Sertoli cells.



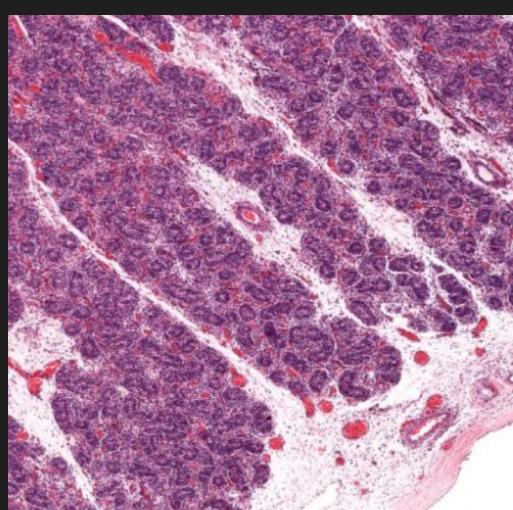
- **Rete testis:** straight tubules empty in an anastomosing labyrinth lined by a simple cuboidal or columnar epithelium.



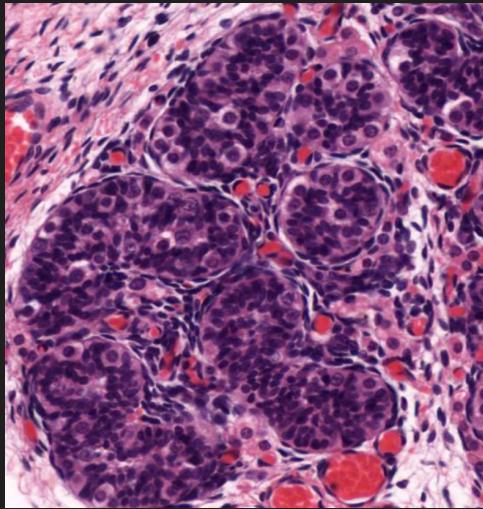
- **Tunica albuginea:** capsule of thick connective tissue.



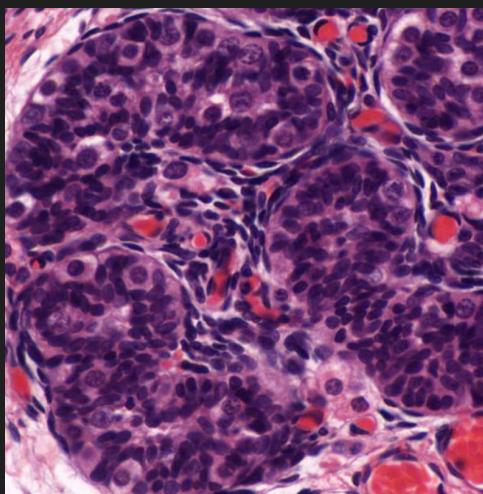
- **Lobules:** pyramid shaped lobules separated by septae of connective tissue that extend inward from the capsule.



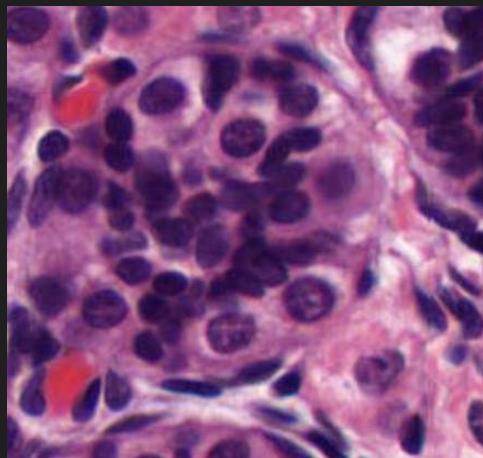
- **Seminiferous tubules:** each lobule contains 1 to 4 highly-coiled seminiferous tubules with an immature germinal epithelium and small lumen.



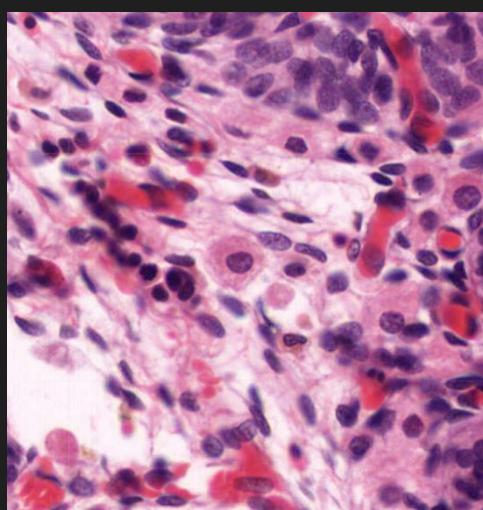
- **Sertoli cells:** most of the cells within the tubule. The columnar cells have dark, round to oval nuclei.



- **Spermatogonia:** single layer of germ cells resting on the basement membrane. Large cells with a thin rim of lightly stained cytoplasm.



- **Leydig cells:** found in the connective tissue (or interstitium) between seminiferous tubules.



Epididymis

Sperm leave the testes and enter the epididymis. Each epididymis is a long, tightly coiled duct in which sperm undergo maturation as they move through it. Mature sperm are stored in the tail of the epididymis.

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Ductus Deferens

Ductus deferens (vas deferens) is a thick walled, fibromuscular tube that is continuous with the epididymis. Peristaltic movements propel sperm through the duct.

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Seminal Vesicle

The seminal vesicles are unbranched, highly-coiled tubular glands. Their secretions make up 60 percent of the volume of the semen. This fluid is high in fructose that acts as the main energy source for sperm outside the body.

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Prostate Gland

The prostate is composed of compound tubuloalveolar glands that contributes a slightly alkaline fluid to semen. These secretions help neutralize the acidity of the vagina, prolonging the lifespan of sperm.

-

Penis With Penile Urethra

The penis is composed of three cylindrical bodies of erectile tissue.

-

Questions

- Give an overview of the process of spermatogenesis and spermiogenesis.
 -
- What is the effect of castration on the accessory sex glands (prostate and seminal vesicles)?
 -
- Where is the primary source of testosterone?
 -
- Where is the principal site of storage of spermatozoa in the male reproductive system?
 -
- Follow the passage of spermatozoa from the seminiferous tubules of the testis up to ejaculation.
 -
- Which organs are the major sources of seminal fluid?
 -
- What are the components of the blood-testis barrier, and what is its significance?
 -

Week 9: Female Reproductive, Eye, Ear

Female Reproductive System

Ovary

-

Oviduct

-

Uterus

-

Cervix

-

Questions

- In which portion of the uterine tube does fertilization occur?
 -
- What is the primary ovarian hormone stimulating the endometrium during each stage?
 -
- What is the dominant ovarian structure during the secretory stage?
 -
- Which ovarian hormone is necessary for the maintenance of the secretory stage of the endometrium?
 -
- Which zones of the endometrium may be lost during menstruation?
 -
- What are some possible functions of cervical mucus?
 -
- In what other regions of the body does one observe an abrupt junction between simple columnar and stratified epithelia?
 -

- What are the major hormones that are responsible for the cyclic changes in the mammary gland?

◦

Placenta

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Breast

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Eye

•

Ear

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