Digestive System

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ORAL CAVITY

- Oral mucosa:
  - Composed of wet stratified squamous epithelium and under lying connective tissue.
  - Classification of oral mucosa:
    - Masticatory mucosa:
      - Parakeratinized to completely keratinized stratified squamous epithelium.
      - Dense irregular collagenous connective tissue.
      - Presented in (gingiva, dorsal surface of the tongue, and hard palate) (keratinized).
    - Specialized mucosa:
      - Have taste buds.
      - Presented in (dorsal surface of the tongue, soft palate, and pharynx).
    - Lining mucosa
      - Remainder of oral cavity
      - Nonkeratinized stratified squamous epithelium
      - Dense irregular collagenous connective tissue
- Palate:
  - Hard palate:
    - Keratinized stratified squamous epithelium.
  - Soft palate:
    - Nonkeratinized stratified squamous epithelium.
  - Uvula:
    - Nonkeratinized stratified squamous epithelium.
  - Function:
    - They separate the nasal cavity from the oral one.

LIPS

- Rich in adipose tissue .
- It's a core of skeletal muscles fibers (orbicularis oris) .
- Sub divisions of the lips:
  - External aspect (outer):
    - Covered with thin skin.
    - Associated with sweat glands, hair follicles, and sebaceous glands.
  - Vermilion zone:
    - Pink region.
    - Thin skin.
    - No sweat glands or hair follicles.
    - Occasional non-functional sebaceous glands.
  - Mucous aspect (inner):
    - Stratified squamous nonkeratinized epithelium.
    - Sub-epithelial irregular collagenous connective tissue.
    - Mucous minor salivary glands.

TONGUE

- Has a skeletal muscle fibers which arises from:
  - Outside the tongue (extrinsic muscles).
  - Within the tongue (intrinsic muscles).
- Surfaces:
  - Dorsal surface:
    - Posterior one third:

        - Has lingual tonsils.
        - Uneven because of palatine tonsil.
    - Anterior two thirds:
        - Covered by lingual papillae.
    - Separated by a shallow V shaped groove (suclus terminalis) which contains a deep concavity (foramen cecum).
- Ventral surface.
    - Nonkeratinized stratified squamous epithelium.
- Two lateral surfaces

❖ Types of lingual papillae:
- Filiform papillae:
    - Numerous.
    - Slender structure
    - Covered by stratified squamous keratinized epithelium.
    - Do not have taste buds.
- Fungiform papilla:
    - Stratified squamous non keratinized.
    - Fungi shaped (as mushroom), has slender stalk connects a broad cap to tongue surface.
    - Appears as red dots on the dorsum of the tongue.
    - Have taste buds.
- Foliate papilla:
    - Have functional taste buds in the neonate.
    - They disappear by the second or third year.
    - Have serous minor salivary glands of Von Ebner.
- Circumvallate papillae:
    - 8 to 12 large papillae.
    - Anterior to sulcus terminalis.
    - Surrounded by and epithelial groove .
    - Glands of von ebner and taste buds are presented (on their sides only).

❖ Taste buds:
- Intra-epithelial sensory organs.
- Oval structure.
- Pale acidophilic.
- Types of cells:
    - Basal cells (type IV)
    - Dark cells (type I)
    - Light cells (type II)
    - Intermediate cells (type III)
- Taste pore:
    - Project into and opening.
    - Formed by squamous epithelial cells.
- Nerve fibers enter the taste buds and form junctions with type I, II, III cells.
- Microvilli protrude from taste buds and called taste hairs.
- Progression of cells:
    - Basal cells →(give raise)→ Dark cells →(mature)→ Light cells → Intermediate cells → Die

SALIVARY GLANDS

- Minor.
- Major:
  - Parotid (largest).
  - Submandibular.
  - Sub-lingual.
- Tubualveolar glands.
- Connective tissue capsule has a septa that subdivide the gland to lobes and lobules.
- Salivon is composed of:
  - Acinus.
  - Ducts.
- Minor salivary glands are scattered in the mucosa of oral cavity
- Parenchyma:
  - Secretory portion:
    - Contain one of two cells arranged in acini:
      - Serous cells:
        - Secrete protein and polysaccharides.
        - Resemble truncated pyramid.
        - Single, round, basally located nuclei.
        - Well developed RER and Golgi complex, numerous mitochondria.
        - Basal part is basophilic.
        - Abundant secretory granules in the apical part (acidophilic).
        - They have tight junctions, intercellular canaliculi and interdigitated baso-lateral processes.
      - Mucos cells:
        - Secrete carbohydrates.
        - Truncated pyramid.
        - Basal, flattened nuclei.
        - Fewer mitochondria, less RER, greater Golgi apparatus.
        - Abundant secretory granules.
        - Have less lateral processes and intercellular canaliculi than serous cells.
      - Myoepithelial cells (basket):
        - Share the basal laminae of acinar cells (hemidesmosomes).
        - Have several long processes.
        - Facilitating release the secretory product into the duct of the gland.
        - Rich in actin and myosin.
        - They envelope the cells of acinus and intercalated ducts (desmosomes).
  - Duct portion.
    - Intercalated ducts →(form)→ Striated ducts →(join to form)→ Intralobular ducts.
    - The above three are all interlobular.
    - Intercalated ducts:
      - Smallest branches.
      - Secretory portion (acini) are attached to it.
      - Cuboidal cells.
      - Possess some myoepithelial cells.
    - Striated ducts:
      - Cuboidal to columnar cells with basolateral folds containing mitochondria.
    - Interlobular ducts:
      - Intralobar ducts
      - Interlobar ducts
    - Terminal (principal) ducts delivers saliva to the oral cavity

- Parotid gland:

- Largest salivary gland.
- Produced 30% of total saliva.
- Pure serous secretion rich in amylase enzyme, lactoferrins, lysozymes and secretory IgA.
- Connective tissue capsule that forms septa subdividing it to lobes and lobules.

❖ Sublingual gland:
- Smallest salivary gland.
- Produce 5% of total saliva.
- Composed of mucous units capped by serous cells known as serous demilunes.
- Produces mixed but mostly mucous saliva.
- Scant connective tissue.
- Does not form terminal ducts.

❖ Submandibular gland:
- Produce 60 % of total saliva.
- 90 % serous secretion.
- Number of serous demilunes is limited.
- Connective tissue capsule that forms septa subdividing it to lobes and lobules.

ALIMENTARY CANAL

❖ Composed of
- Mucosa:
  - Lined by epithelium.
  - Deep is a loose connective tissue (Lamina propria) that houses glands and lymph vessels.
  - Muscularis mucosae surround lamina propria and composed of :
    - Inner circular layer.
    - Outer longitudinal layer
- Submucosa:
  - Dense irregular fibroelastic connective tissue.
  - No glands except in the esophagus and duodenum.
  - Meissner's submucosal plexus: houses postganglionic nerve cell bodies.
  - Rich in blood and lymph vessels.
- Muscularis externa:
  - Responsible for peristaltic activity.
  - Smooth muscle except in the esophagus (which has skeletal muscle as well).
  - Interstitial cells of Cajal are the pacemakers.
  - Arranged helically.
  - Composed of:
    - Outer longtitudunal smooth muscle.
    - Inner circular smooth muscle.
- Serosa (adventita):
  - Connective tissue envelopes the muscularis externa that may or may not surrounded by squamous epithelium
  - If the organ is:
    - Intraperitoneal it's known as serosa.
    - Retroperitoneal it's known as adventitia.
  - Between the muscle is Auerbach's myenteric plexus composed of postganglionic parasympathetic nerve cells.

ESOPHAGUS

- Mucosa:
  - Epithelium:
    - Stratified squamous nonkeratinized epithelium.
  - Lamina propria:
    - Unremarkable.
    - Houses esophageal cardiac glands in two clusters:
      - Near the pharynx.
      - Near its juncture with stomach.
  - Muscularis mucosae:
    - Single layer of longitudinal smooth muscle.
- Submucosa:
  - Fibroelastic connective tissue.
  - Houses esophageal glands proper.
- Muscularis externa:
  - Inner circular and outer longitudinal layers.
  - They have both skeletal and smooth.
    - Upper third: mostly skeletal.
    - Middle third: both skeletal and smooth.
    - Lowest third: only smooth.
- The esophagus it covered by and adventitia until it pierces the diaphragm after that it's covered by serosa.

STOMACH

- Has 4 regions
  - Cardiac.
  - Fundus.
  - Body.
  - Pylorus.
- Rugae:
  - Longitudinal folds (transverse in the anturm) of mucosa and submucosa.
  - Disappear in distended stomach.
- Gastric Pits (in mucosa of the fundus) :
  - Formed by epithelial lining.
  - Gastric glands empty in the bottom of each gastric pit.
  - Can be simple or branched.
  - Rich in parietal & chief cells.

- Fundic mucosa:
  - Epithelium:
    - Simple columnar epithelium.
    - Surface lining cells: manufacture mucin.
    - No goblet cells.
  - Lamina propria:
    - Connective tissue.
    - Occupied by fundic (oxyntic) glands:
      - Short pits.
      - Simple or branched.
      - Have 3 regions:
      - Isthmus
        → Regenerative cells, Surface lining cells
      - Neck

→ Mucous neck cells, regenerative cells, parietal cells
- Base
  → Chief cells, DNES cells

❖ Fundic gland cells
- Surface lining cells:
- Mucous neck cells:
  - In the neck region.
  - Secrete mucous to lubricate gastric content.
  - Cannot function at low pH, lined by HCO3- layer to raise pH.
  - Golgi apparatus, RER are present.
  - Mitochondria in the basal region of the cell.
  - Apical cytoplasm has secretory granules.
  - Columnar.
- Regenerative cells:
  - In the neck region.
  - Proliferate to replace all of the specialized cells.
- Parietal cells:
  - At the periphery of the gland.
  - Produce (HCl) and intrinsic factors.
  - Absorb B_{12}.
  - Basally located nuclei.
  - Acidophilic.
  - Apical membrane invaginates to form intracellular canaliculi lined by microvilli.
  - Cytoplasm in the canaliculi has round and tubular vesicles tubulovesicular system.
  - Rich in mitochondria.
  - Have tuplaco servese.
- Chief cells:
  - In the base region.
  - Manufacture pepsinogen, renin, gastric lipase.
  - Exhibit rich RER, Golgi apparatus, apical granules.
  - Basophilic.
- DNES cells (APUD or enteroendocrine cells):
  - In the base region.
  - Manufacture: endocrine, paracrine, neurocrine hormones.
  - Well-developed RER and Golgi apparatus and numerous mitochondria.
  - Basal granules.
  - Secrete into the mucosa to enter the bloodstream.
  - The cell reach the lumen of the gut called (the open type).
  - The cell doesn't reach the lumen called (the closed type).

❖ Submucosa:
- Dense, irregular collagenous connective tissue.

❖ Muscularis Externa:
- Three layers:
  - Innermost oblique muscle layer:
    - Not well defined except in the cardiac region.
  - Middle circular muscle layer:
    - Especially pronounced where it forms the pyloric sphincter.
  - Outermost longtitudunal muscle layer:

❖ Serosa:
- Thin loose subserous connective tissue.

- Covered by wet smooth wet simple squamous epithelium.

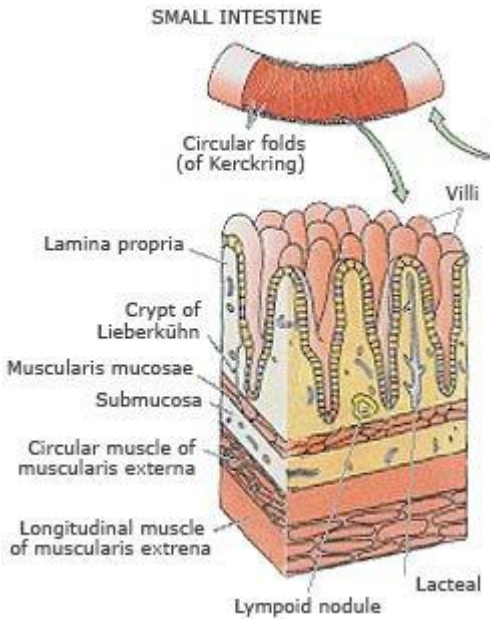
❖ Cardiac region
- Gastric pit are shallower.
- No chief cells.
- Base of its gland if highly coiled.

❖ Fundus region:
- Gastric pit are shallow.
- There are chief cells.

❖ Pyloric region:
- Gastric pit are deeper.
- No chief cells.
- Glands are highly convoluted.
- Mucous neck cells are dominant and they produced lysozyme.

SMALL INTESTINE

❖ 3 types of modification are present in the small intestine to increase the surface area:
- Plicae circulares (valves of Kerckring)
  - Transverse folds of submucosa and mucosa.
  - Permanent.
  - Increase surface area by factor 2 to 3
- Villi:
  - Protrusions of the lamina propria.
  - Epithelially covered.
  - The core composed of :
    - Capillary loops.
    - Lymphatic channel (lacteal).
    - Few smooth muscle fibers.
    - Loose connective tissue rich in lymphoid cells.
  - Numbers are greater in the duodenum.
  - Increase the surface area 10 times.
- Microvilli:
  - Increase by factor of 20.



❖ Invaginations of the epithelium into the lamina propria between villi form glands (crypts of Lieberkühn)

❖ Intestinal mucosa:
- Simple columnar epithelium with 3 cells:
  - Surface absorvative cells.
  - Goblet Cells:
    - → Duodenum has the smallest number.
  - DNES Cells.
- In regions where lymphoid nodules about the epithelium.
- M cells replace simple columnar epithelial lining of the small intestine.
- Function: presents antigen.
- Lamina propria:
  - Loose connective tissue.
  - Crypts of Lieberkuhn:
    - Tubular (or branched) gland.
    - Open into the intervillus space.
    - The crypts composed of

- → Surface absorptive cells
- → Goblet cells.
- → Regenerative cells.
- → DNES cells.
- → Paneth cells:
  - ➢ In the bottom of the crypts.
  - ➢ Acidophilic
  - ➢ Apical granules.
  - ➢ Manufacture lysozyme.

- ➢ Muscularis mucosae:
  - ▪ Inner circular layer.
  - ▪ Outer longitudinal layer.

❖ Submucosa:
- ➢ Irregular fibroelastic connective tissue.
- ➢ Submucosa of the duodenum houses glands known as Brunner's glands that produce a mucous and bicarbonate-rich fluid as well as urogastron that inhibits HCl production.

❖ Muscularis Externa:
- ➢ Inner circular layer.
- ➢ Outer longitudinal layer.

❖ Second and third part of the duodenum have adventitia.
- ➢ Everything else has serosa.

❖ Duodenum:
- ▪ Has Brunners's glands that secretes mucous and bicarbonate fluid.

❖ Ileum:
- ▪ Has Peyer's patches which is lymph nodules located opposite the attachment of the mesentery.

❖ Jejunum:
- ▪ No features.

LARGE INTESTINE

❖ No villi.
❖ Have crypts of Lieberkühn.
❖ Absent Paneth cells.
❖ Goblet cells increase from cecum to the sigmoid.
❖ The outer layer of muscularis externa is not continuous (3 fascicles-taeniae coli).
❖ Lamina propria, muscularis mucosa, submucosa resemble small intestine.
❖ Muscularis externa:
- ➢ Unusual outer longitudinal muscle layer.
- ➢ The muscle gathered in three narrow ribbons known as taenie coli

❖ Serosa has a fat-filled pouches called appendices epiploicae.

APPENDIX

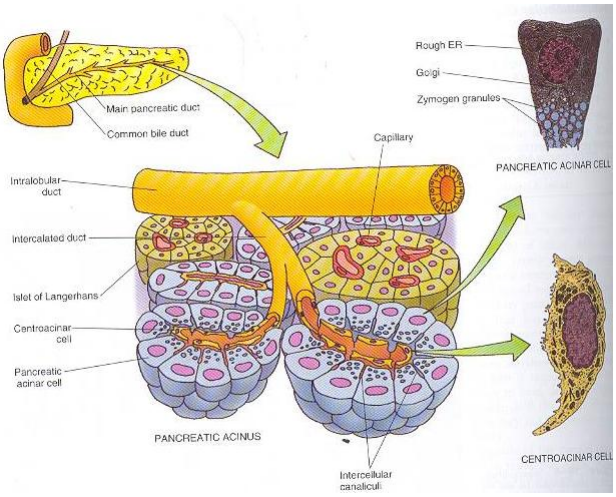
❖ Vermiform appendix.
❖ Mucosa:
- ➢ Simple columnar epithelium consisting of surface absorptive, goblet cells, M cells, enteroendocrine cells.
- ➢ Don't have lysosomes
- ➢ Lamina propria:
  - ▪ Loose connective tissue with lymph nodules and crypts of Liebekühn.

- Same muscularis mucosae as colon.

❖ Same submucosa also it have lymphoid nodules and fatty infiltration.
❖ Same muscularis externa.
❖ Covered by serosa.
❖ Meissner's plexus and Auerbach plexus present in all tissues of alimentary canal.
❖ Goblet cells starts at the duodenum and increases gradually.

PANCREAS

❖ Connective tissue forms septa which subdivide the gland into lobule.
❖ Produce:
- Exocrine secretion.
  - Produce proenzymes.
  - 40 to 50 acinar cells form acinus.
  - Acinar cells:
    - Shaped like truncated pyramid.
    - Lie on the basal lamina.
    - Basal, rounded nucleus.
    - Basophilic cytoplasm.
    - Apex has secretory granules (acidophilic).
    - Basal cell membrane have receptors for CCK and acetylcholine.
    - Abundance of RER, Mictochondria, polysomes.



  - No myoepithelial cell
  - Ducts begins within the center of acini with the terminus of intercalated duct forming centroacinar (pale simple cuboidal cells) but not form wall of acini.
  - Centroacinar cells:
    - In the lumin of acinus.
    - Low cuboidal.
    - Have receptors for secretin and acetylcholine.
    - No myoepithelial cells.
- Duct System
  - Intercalated ducts: composed of centroacinar cells. ➔
  - Intralobular ducts. ➔
  - Interlobular ducts. ➔
  - Main pancreatic duct.

- Endocrine secretion.
  - Islets of langerhans:
    - Spherical, vascularized, ductless surrounded by reticular fibers.
    - Greater number in the tail region of the pancreas.
    - Cells composing Islets of Langerhans:
      - → Alpha cells α: (20%)
        - Secrete glucagon
        - Increase blood glucose level.
      - → Beta cells β: (70%)
        - Secrete insulin.
        - Decrease blood glucose level.
      - → Delta cells δ: (5%)
        - Secrete somatostatin.
        - Reduce smooth muscle contraction.

- → PP cells: (1%)
  - ➢ Secrete pancreatic polypeptide.
  - ➢ Inhibit exocrine pancreatic secretion.
- → G cells: (1%)
  - ➢ Secrete gastrin.
  - ➢ Decrease HCl.

LIVER

- ❖ The largest gland.
- ❖ General hepatic structure:
  - ➢ Irregular connective tissue capsule (Glisson's capsule).
  - ➢ Parenchymal cells (hepatocytes).

- ❖ Classic lobules:
  - ➢ The most important in histology and in difficency of vitamin A.
  - ➢ Connective tissue elements (portal tracts) arrange hepatocytes in hexagon-shaped lobules (classical lobules).
  - ➢ The place where 3 classical lobules are in contact is called portal area (triads)
  - ➢ Contents of portal area:
    - ▪ Connective tissue.
    - ▪ Lymph vessels.
    - ▪ Branch of hepatic artery.
    - ▪ Branch of portal vein.
    - ▪ Interlobular bile duct (simple cuboidal epithelium).
      - ⬥ Space of Möll separate limiting plate from the conncective tissue of portal area.
      - ⬥ Limiting plate (modified hepatocytes) separate portal area from the parenchyma of the liver.

- ❖ Hepatica artery → Distributing arteriole → Inlet arteriole → hepatocytes

- ❖ Venules have 2 sizes
  - ▪ Distributing veins
  - ▪ Inlet venules
- ❖ Interlobular bile duct are vascularized by peribiliary capillary plexus
- ❖ Central vein:
  - ➢ At the central of lobule.
  - ➢ Tributary of hepatic veins.
  - ➢ Cells are radiating from central vein forming plates of cells separated by sinusoids.

- ❖ Pathway for central vein:
  - ➢ Central vein → Sublobular vein → Collecting veins → Hepatic veins.

- ❖ The three concepts of liber lobules:
  - ➢ Classical liver lobules:
    - ▪ Blood flows from periphery to the center of lobule into central vein.
  - ➢ Portal lobule:
    - ▪ Hepatocytes deliver bile to interlobular duct.
  - ➢ Hepatic acinus (acinus of Rappaport):
    - ▪ Based on blood flow from ditributing arteriole.

- ❖ Hepatic sinusoids:
  - ➢ Spaces between hepatocytes.
  - ➢ Have two types of cells:

- Sinusoidal lining cells:
  - Leaving gap between them.
  - The cells themselves have fenestrae.
- Kupffer Cells:
  - Associated with the sinusoidal lining cells.
  - Have a gap junction.
  - Phagocytic cells.
  - Have filopodia-like pojections.
- No basement membrane

❖ The narraow space between heptocytes and sinusoids is known as perisinusoidal space of Disse.

➢ Contents of space of Disse:
- Microvlli of hepatocytes.
- Type III collagen fibers (reticular fibers).
- Hepatic stellate cells
  - Known as Ito cells and fat storing cells.
  - Functions:
    - → Store vitamin A
    - → Manufacture and release type III collagen.
    - → Secrete growth factor.
    - → Form fibrous connective tissue.
- Pit cells:
  - Natural killer cells.
- It also contains plasma
- Basal lamina is absent

❖ Hepatic Ducts

➢ Pathway for bile in liver:

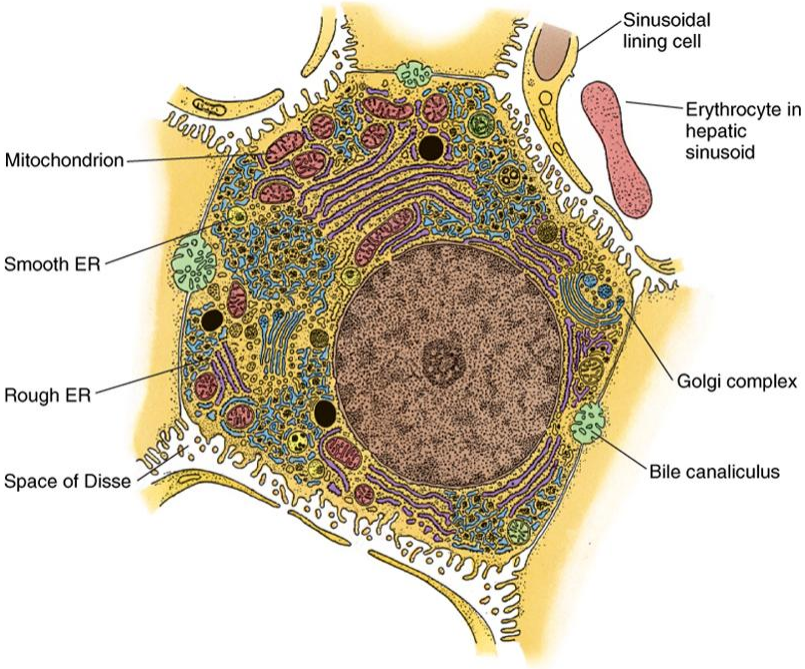
➢ Bile canuliculi. →

➢ Cholangioles: →
- Composed of :
  - Hepatocytes.
  - Low cuboidal cells.
  - Occasional oval cells.

➢ Canals of hering. →
- Composed of :
  - Low cuboidal cells
  - Some ovoid cells

➢ Interlobular bile ducts. →

➢ Right and left hepatic ducts.



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❖ Hepatocytes:

➢ Polygonal cells.

➢ Acidophilic.

➢ Plasma membrane have two domains:
- Between hepatocytes (lateral domain):
  - Responsible for formation of bile canaliculi.
  - Leakage of bile is prevented by tight junction (fasciae occludentes).
  - Hepatocyte microvilli project into bile canaliculi.
  - Hepatocytes plasmalemma is the wall for bile canaliculi.
  - Have isolated gap junction to communicate with other cells.
- Between hepatocytes and sinusoids (sinusoidal domain):
  - Have microvilli.

- Interlobular ducts are lined with simple cuboidal epithelium.
- Function: storage of lipids, detoxification.
- Hepatocytes organelles and inclusions:
  - 75% have one nucleus:
    - Remainder have two nuclei.
  - Free ribosomes, RER, SER, Golgi apparatus.
  - Mitochondria.
  - Endosomes, lysosomes, and perixisomes.
  - Few lipid droplets and glycogen.

GALLBLADDER

- Mucosa is highly folded into ridges.
- Wall composed of
  - Epithelium:
    - Simple columnar epithelium.
  - Lamina propria:
    - Vascularized, loose connective tissue (small mucos gland).
  - Smooth muscle:
    - Inner oblique layer.
    - Outer longtitudinal layer.
  - Serosa/adventita:
    - Invested by peritoneum: Serosa.
    - Not invested: Adventitia.
- No goblet cells.
- No muscularis mucosa.