Accessory Glands of the GI Tract

- Salivary glands
- Pancreas

John Klingensmith
john.klingensmith@duke.edu
Objectives

By the end of this lecture, students will be able to:

• describe the functional organization of the salivary glands and pancreas at the cellular level
• distinguish parenchymal tissue in the pancreas and salivary glands
• understand the structural relationships of exocrine and endocrine functions of the pancreas
• contrast the structure of the three major salivary glands relative to each other and the pancreas

(Lecture plan: overview of structure and function, then increasing resolution of microanatomy and cellular function)
Salivary Glands

Parotid gland
Parotid duct
(Masseter muscle)
(Body of mandible)
Tongue
Openings of ducts of sublingual gland
Openings of duct of submandibular gland
Teeth
Sublingual gland
Submandibular duct
Submandibular gland

adapted from Marieb, 1989
Saliva functions to

- Begin chemical digestion (salivary amylase)
- Solubilize/suspend “flavor” compounds (water)
- Lubricate food for swallowing (mucous, water)
- Clean teeth and membranes (water)
- Inhibit bacterial growth (lysozyme, sIgA)
- Expel undesired material (water)

Contribution to saliva (~1 liter/day):
  65% submandibular; 25% parotid; 5% sublingual; 5% minor glands
Secretory cells of the salivary glands

- **Mucous** – triggered by sympathetic stimuli (e.g. fright)… thick and viscous
- **Serous** – triggered by parasympathetic stimuli (e.g. food odors)… watery and protein-rich
- **Striated ducts** modify the exudate
- **Plasma cells** outside secretory acini produce IgA
Serous secretory cell

- Amino acids from the capillary blood
- Synthesis into proteins in rER, requires ATP
- Proteins move apically via Golgi
- Secretion vesicles/granules formed
- Granules extruded into lumen
Functional unit of salivary parenchyma

![Diagram showing the functional unit of salivary parenchyma with labeled parts: Basal lamina, Myoepithelial cells, Acinar cells, Intercalated duct, Striated duct, Acinus.]

*(Intralobular ducts)*
Structure of salivary glands

- Lobular parenchyma
- Connective tissue septa
- Excretory (interlobular) ducts – cuboidal to stratified columnar as diameter increases
- Intralobular ducts
- Acini
Histology of saliva secretion

- Serous acini
- Mucous acini
- "Serous demilunes" (mixed acini; demilune is fixation artifact)
- Myoepithelial cells
- Intercalated ducts
- Striated ducts
Serous

- Nucleus round, near base
- Basal cytoplasm has RER, ribosomes (stains w/ H)
- Apical cytoplasm has zymogen secretion granules (stains w/ E)
- Typically in rounded acinus
- May cap mucous tubule as “demilune”

Mucous

- Nucleus flat, near base
- Organelles mostly near base
- Mucinogen granules in apical cytoplasm (lost in paraffin/H&EE)
- Cyclical activity
- Typically tubular arrangement
Myoepithelial cells

- Contractile cells
- Occur between secretory cells and basal lamina
- Stellate around serous acini
- Longitudinal along mucous glands and intercalated ducts
Intralobular salivary ducts

- Intercalated ducts: low cuboidal epithelium
- Striated ducts: cuboidal to columnar epithelium, big lumen
Cell types of the salivary gland

- Intercalated ducts
- Serous acinus
- Striated duct
Striated ducts

- Link intercalated to interlobular ducts
- Cuboidal to columnar epithelial cells
- Basal striations with stacks of elongated mitochondria
- Reabsorb Na, add K (makes secretion hypotonic)
Parotid Gland

- Serous acini, no mucous
- Long intercalated ducts
- Striated ducts
- Plasma cells
- Adipose tissue
- Excretory ducts pseudostratified to stratified
Blockage of the parotid duct is...
...a serous pain in the acinus!
Sublingual gland

- Mucous acini
- Serous demilunes (mixed acini)
- Plasma cells
- Intercalated ducts but no striated
- Many ducts to mouth
Submandibular Gland

- Serous acini
- Mucous acini
- Serous demilunes
- Few adipose cells
- Striated ducts
- Short intercalated ducts
Distinguishing the salivary glands

• Parotid has serous acini, lots of striated ducts, fibrous capsule, adipocytes in septa
• Sublingual has mostly mucous acini with some mixed (demilunes), loose CT septa, no striated ducts or fibrous capsule, many ducts to mouth
• Submandibular has serous and mucous acini, many mixed acini (demilunes), some striated ducts, few adipocytes, fibrous capsule
Pancreas has exocrine and endocrine functions

**exocrine**
- Serous acinar cells secrete digestive juice
- Secretion to duodenum (pH 8, 1L/day)
- Digestive enzymes which hydrolyze proteins, carbs and fats
- Enzymes released largely as zymogens

**endocrine**
- Islets of Langerhans produce hormones
- Hormones primarily involved in glucose metabolism and levels
- Released into efferent capillaries leaving islets
Pancreas has both exocrine and endocrine functions

- Exocrine - serous acini
- Endocrine - islets of Langerhans
Pancreatic exocrine tissue
Pancreatic acini

- Tightly packed
- All serous
- Acinar cells have eosinophilic, granular apical cytoplasm
- AC have basophilic basal cytoplasm
- Round, basal nuclei
- Drained by intercalated ducts
- Surround centroacinar cells
Pancreatic acinar cells

- Pyramidal in shape
- Basal rough endoplasmic reticulum
- Basal, round nucleus w/ large nucleolus
- Prominent Golgi
- Apical zymogen granules
- Apices face lumen
Centroacinar cells

- Line acinar lumen
- Low cuboidal or squamous epithelial cells
- Continuous with cells of intralobular duct
- Unique to pancreatic acini
Centroacinar cells

- Have no secretory granules
- Have little rough endoplasmic reticulum
Intercalated ducts drain pancreatic acini
Pancreatic ductal system

- *Intercalated ducts* - includes squamous centroacinar cells, becomes cuboidal
- *Intralobular ducts* - not striated as in SG.
- *Interlobular ducts* - low columnar epithelium, dense CT rim
- *Main pancreatic duct* - runs length of pancreas, wall contains SM, drains into duodenum at duodenal papilla
- *Accessory pancreatic duct* - similar duct from head of pancreas
Zymogen excretion (e.g. trypsin)
Exocrine secretion by the pancreas

- Zymogen granules released into lumen of intercalated ducts, ultimately to duodenum
- Release stimulated by hormones (CCK-acini, secretin-IC ducts)
- Secretion includes proenzymes activated in small intestine
- Enzymes digest various foodstuffs: protein (endopeptidases); carbs (amylase); lipids (lipase); nucleic acids (nucleases)
Endocrine pancreas: Islets of Langerhans
Islet of Langerhans is well vascularized
Endocrine Cell types of the Islet
- A, B, D

- Special staining
- *blue stains Type B*
- *pink stains Type A*
- Immuno-histochemistry
- Function
Type A (α-cells)

- Secrete glucagon
- 25% of islet
- Tend to be peripheral
Type B (β-cells)

• Secrete insulin
• 65% of islet
• Tend to be most dense centrally
• Polyhedral core in granules (crystalline insulin?)
Type D (δ-cells) and others

- D cells secrete somatostatin
- 5-10% of islet
- Peripheral location
- minor cell types comprise remaining 5%
Functions of insulin and glucagon are largely reciprocal

- Insulin lowers blood glucose
- Stimulates uptake from circulation
- Promotes storage, utilization and phos.
- Promotes synthesis of glycogen from phos. Glucose
- Secretion inhibited by somatistatin

- Glucagon raises blood glucose
- Stimulate release into blood
- Promotes synthesis of new glucose and breakdown of glycogen
- Secretion inhibited by somatistatin
Distinguishing pancreatic and salivary exocrine tissue

- Pancreas acini are all serous
- Long intercalated ducts
- No striated ducts
- Centroacinar cells
- Larger ducts simple columnar
- Islets of Langerhans

- Parotid acini are all serous
- Long intercalated ducts
- Lots of striated ducts
- Large ducts pseudostratified