

# AP2, Lab 6 - The Digestive System [a.k.a. Gastro-Intestinal (GI) Tract], DKA, and Insulin Shock

**Intro:** The GI tract is a continuous tube from your mouth to your anus.

- The overall objective is to mechanically and chemically break down raw foods into molecules small enough to be absorbed into the walls of the tube into the blood capillaries or lymphatic capillaries.
- Different segments of the tube perform different functions.
- Layers of muscle in the walls are smooth/visceral and controlled involuntarily by the autonomic nervous system.
- The hollow interior of the tube is called the **LUMEN**. What is in the lumen is not yet in your body.

## 5 DIVISIONS OF THE G.I. TRACT

### 1. MOUTH (p. 892 / 861)

- Food is mechanically ripped, crushed, shredded, etc. to increase surface area exposed to enzymes.
- **Saliva** is added to facilitate swallowing.
- **SALIVARY AMYLASE** begins the chemical digestion of **COMPLEX CARBOHYDRATES** such as **STARCH**.
- The back of the mouth opens up into an area called the **PHARYNX**.

### 2. ESOPHAGUS (p. 898 / 867)

- The muscular tube from the pharynx to the stomach.
- Once food reaches the pharynx involuntary waves of contraction, called **PERISTALSIS**, actively propel foods to the stomach. You can even swallow liquids and foods while standing on your head (if you can keep them from coming out your nose first.)
- At the distal end of this tube is a constrictive “ring” of muscle called the **GASTROESOPHAGEAL SPHINCTER** or **CARDIAC SPHINCTER**. Once food enters the stomach this sphincter contracts to prevent food from coming back up from the stomach into the esophagus.
- If this sphincter does not close tightly gastric juices (which are acidic) will back up and burn the unprotected esophagus. This is called **GASTRIC REFLUX** or **GASTRO-ESOPHAGEAL REFLUX DISEASE (GERD)**. In layman’s terms this is known as “**heartburn**.”

### 3. STOMACH (p. 899 & 907 / 868 & 876)

- Think of your stomach as a storage tank. Its storage capacity allows you to eat only a few meals per day and then gradually release that food to your small intestine over a period of several hours.
- A meal is in your stomach anywhere from 30 minutes to 4 hours depending on the volume of the meal and the complexity of the carbohydrates, lipids, and proteins.
- While food is in the stomach the muscular walls contract to mechanically churn and mix the food with 4 secretions from the stomach wall to produce a thick greenish, yellowish mixture called **CHYME**. (pronounced “kiiiiime”)
- The interior lining is ‘folded’ into ridges and valleys called **RUGAE**. [Best seen on the flat ‘board’ model. These allow for expansion of the stomach and they help to direct chyme toward the exit end of the stomach. When empty your stomach volume is approx. 50 ml. When fully distended it’s approx 4,000 ml (1 gallon).
- The 4 secretions of the stomach wall are: **HCl acid, MUCUS, PEPSINOGEN, and INTRINSIC FACTOR**.
  - The **HCl** makes the interior of the stomach strongly acidic (pH 2-4) with two resulting benefits: (1.) inactive enzyme **PEPSINOGEN** is converted into active **PEPSIN** to begin the digestion of proteins and... (2.) The strong acidity kills most microorganisms.
  - The **mucus** protects the stomach wall from being eroded by the HCl acid and digested by the pepsin. Other parts of the GI tract also have mucus but it is mainly for lubrication.
  - **Intrinsic factor** is needed for the absorption of vitamin B<sub>12</sub> in the sm. I.

- At the exiting end of the stomach is another constrictive ring of muscle called the **PYLORIC SPHINCTER**. This sphincter regulates the rate at which the stomach empties **CHYME** into the Sm. I.
- **Peptic Ulcers** (a.k.a. “stomach ulcers”) actually occur most often in the first few inches of the **small intestine** and the last few inches of the **esophagus** because the mucous membranes lining these structures are not as protective as those of the stomach.

OYO: What are **peptic ulcers** and what is the #1 cause? In what parts of the GI tract are they most likely to form? How are they best treated?

#### 4. **SMALL INTESTINE** (p. 883 & 916 / 852 & 887)

- The muscular tube from the stomach to the Lg. I. approx. 10 - 20 feet long.
- The vast majority of chemical digestion and nutrient absorption occurs in the Sm. I.
- It receives:
  - acidic **CHYME** from the stomach
  - BILE** from the gallbladder and liver
  - DIGESTIVE ENZYMES** from the pancreas
  - BICARBONATE SOLUTION** from the pancreas
- The bicarbonate ( $\text{HCO}_3^-$ ) solution neutralizes the acidity of the chyme.
- The bile **emulsifies** the chyme so that digestive enzymes can be more effective. Define “emulsify” or “emulsification”:

What is the benefit of emulsification?

- Chyme will be in the Sm. I. from 3 to 10 hours while the bile and digestive enzymes have their effect.
- The walls secrete **BRUSH BORDER ENZYMES** to assist the digestive enzymes from the pancreas.
- Peristaltic contractions mix and propel this “chyme soup” through this tube lined with **VILLI**.
- Define “**villi**.”

What is the advantage/benefit of having villi rather than a smooth surface?

#### **DUODENUM** (pronounced “doo-oh-dee-num” or “du-odd-deh-num”)

- Is the first 10 - 12 inches of the Sm. I. immediately after the stomach.
- It receives:
  1. **CHYME** from the stomach
  2. **BILE** from the gall bladder and liver
  3. **PANCREATIC JUICES** (both enzymes and bicarbonate solution) from the pancreas.
- is the most common location for peptic ulcers

#### **JEJUNUM** and **ILEUM**

- are the remaining two portions of the Sm. I. (can not be distinguished on model)
- at the end of the ileum where it joins the Lg. I. is another constrictive ring of muscle called the **ILEOCECAL SPHINCTER**. It controls the emptying of the Sm. I. into the cecum of the Lg. I.

**\*\*Invite your instructor to verify accuracy of your identifications up to this point.**

5. **LARGE INTESTINE (a.k.a. THE COLON)** (p. 923 / 891)

- Approx 3-6 feet in length with lots of undulating ‘pockets’ called **HAUSTRA**.
- Receives from the Sm. I. whatever could not be digested and absorbed.
- Stores and periodically propels this waste material to the rectum.
- Water is the #1 nutrient absorbed from this waste material. As water is reabsorbed the remaining waste becomes a semisolid stool called **FECES**.
- Bacteria normally inhabit the Lg. I. and feed on what you couldn’t digest. These bacteria produce **VIT. K** and various gasses as by-products. These gasses released through the anus = farts.

**CECUM** (or **caecum**) (pronounced “see-cum”)

- the “blind” pouch of the Lg. I. just inferior to the ileocecal sphincter.

**APPENDIX**

- the blind tube, about the size of your little pinkie, attached to the cecum.
- It has no function other than to keep doctors and hospitals in business. Each year in the U.S. 500,000 of these get infected and have to be removed surgically.

**ASCENDING COLON**

- the portion of the Lg. I. that travels upward from the cecum up to where it turns to go transversely across the abdomen.

**TRANSVERSE COLON** - duh

**DESCENDING COLON** - duh

**SIGMOID COLON**

- the S-shaped portion of the Lg. I. from the descending colon to the rectum.

**RECTUM**

- the last few inches of the G.I. tract.
- It stores feces received from the colon and as the walls are stretched due to filling, signals are sent to the brain creating the urge to defecate.

**ANUS** (a.k.a. your “butt hole”)

- Officially, it’s the opening of the rectum to the exterior of the body.
- A combination of internal and external anal sphincters provides you control over the emptying of the rectum.

**Strange but true:** Everything in the lumen of the GI tract is actually outside your body. Explain.

We will view the following all together as a group with sample quiz questions. Identify as many structures as possible on the following frames: 1208 – 1210, 1218, 1219, 1221, 1223, 1224, and 1226, 1255 - 1259

View film clip 13: 11322 → Chewing and swallowing

View film clip 13: 13275 → Endoscopy.

View film clip 13: 21755 → Barium Radiography.

## ORGANS / STRUCTURES CLOSELY ASSOCIATED WITH THE G.I. TRACT.

Terms you need to know before you begin:

**HEPAT-** means liver.

**CHOLE** (pronounced “ko-lay”) - means bile.

**CYSTIC** - means sac-like or bag-like.

**ID the following structures on the torso models:**

**SALIVARY GLANDS** - secrete **SALIVA** to moisten food for ease of swallowing.

Also contains **SALIVARY AMYLASE** to begin digestion of complex carbohydrates such as **STARCH**.

### **LIVER**

1. **PRODUCES BILE** to assist with lipid digestion by **EMULSIFYING** lipids.
2. **DETOXIFIES** potentially harmful substances in the blood.
3. **SYNTHESIZES** blood proteins.
4. **STORES GLUCOSE IN THE FORM OF GLYCOGEN** for later release to the blood.
5. **REGULATES SERUM LIPIDS** such as **HDL, LDL, VLDL, & cholesterol**.
6. **PERFORMS INTERCONVERSION** of certain nutrients.

**GALL BLADDER** - stores and concentrates bile that was produced by the liver. When chyme rich in lipids arrives at the duodenum the hormone **CHOLECYSTOKININ (CCK)** is released from the Sm. I.

1. **CCK** targets the gallbladder causing contraction of the smooth muscles in the wall thereby releasing concentrated bile to the duodenum to emulsify lipids for efficient digestion.
2. **CCK** also triggers the release of pancreatic enzymes into the duodenum to promote digestion.

**PANCREAS** – on our models it’s the pebbly textured structure on the medial border of the stomach.

- Produces 2 distinct secretions and adds them to the chyme as it enters the duodenum.
- One secretion is rich in **DIGESTIVE ENZYMES** for the breakdown of proteins, carbs, and lipids.
- The other is rich in **BICARBONATE IONS** to raise the pH of chyme to approximately 6 or 7 so that
  1. the pancreatic enzymes can work and
  2. to prevent the strongly acidic chyme from irritating the duodenum and Sm. I. Any ulcers present in the duodenum are also quite sensitive to the acidic chyme.

**MESENTERY** – on our torso models it’s visible as the sheet of tissue connected to the medial borders of the ascending and descending colons and the inferior border of the transverse colon.

- are membranous sheets of connective tissue that anchor the intestines to the posterior abdominal wall and prevent them from becoming entangled. Also supports the vessels and nerves that supply these organs.

Use illustrations on p. 909 / 878 identify the following. Most of the ducts do not show up well on the models.

**LIVER (not illustrated, draw it in)**

**L & R HEPATIC DUCTS**

**COMMON HEPATIC DUCT**

**GALLBLADDER**

**CYSTIC DUCT**

**BILE DUCT (a.k.a. Common bile duct)**

**PANCREAS**

**PANCREATIC DUCT**

**DUODENUM**