Week 14
Human Physiology: BIO 3322

The concepts this resource covers are the topics typically covered during this week of the semester. If you do not see the topics your particular section of class is learning this week, please take a look at the weekly resources listed on our website for additional topics throughout the semester.

We also invite you to look at the group tutoring chart on our website to see if this course has a group tutoring session offered this semester.

If you have any questions about these study guides, group tutoring sessions, private thirty minute tutoring appointments, the Baylor Tutoring YouTube channel or any tutoring services we offer, please visit our website www.baylor.edu/tutoring or call our front desk during open business hours (M-Th 9 AM-8PM on class days) at 254-710-4135.

Keywords: Gastrointestinal System, Digestion of Macromolecules

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Topic of the Week: *The Gastrointestinal System*

RETRIEVAL PRACTICE: ***(Reference Week 13 Resource if Needed/Answers at the End!)***

1. Describe the process of bone growth in detail.
2. What are the three major hormones involved in the regulation of calcium?

The **gastrointestinal system** is responsible for the digestion, absorption, and movement of food and nutrients. Let's walk through the anatomy of the **GI tract** and its **accessory organs** as it is crucial to your understanding of this topic!

As food travels through the digestive tract, it will take the path described below (also depicted on the image on the next page)!

1. Mouth
2. Pharynx
3. Upper Esophageal Sphincter
4. Esophagus
5. Lower Esophageal Sphincter
6. Stomach
7. Duodenum (small intestine)
8. Jejunum (small intestine)

9. Ileum (small intestine)
10. Cecum (large intestine)
11. Ascending Colon (large intestine)
12. Transverse Colon (large intestine)
13. Descending Colon (large intestine)
14. Sigmoid Colon (large intestine)
15. Rectum

Highlight #1: Anatomy of the GI Tract

Now that we have seen a general overview of how food travels through the **digestive tract**, let's walk through the specific details anatomy of the **GI tract** and its **accessory organs** as it is crucial to your understanding of this topic!

ANATOMY OF THE GI TRACT

Mouth/Pharynx: Initial entry point for food

Esophagus: Muscular passageway for food, no absorption; uses **peristaltic contractions** (muscular contractions that move food along the **GI tract**)

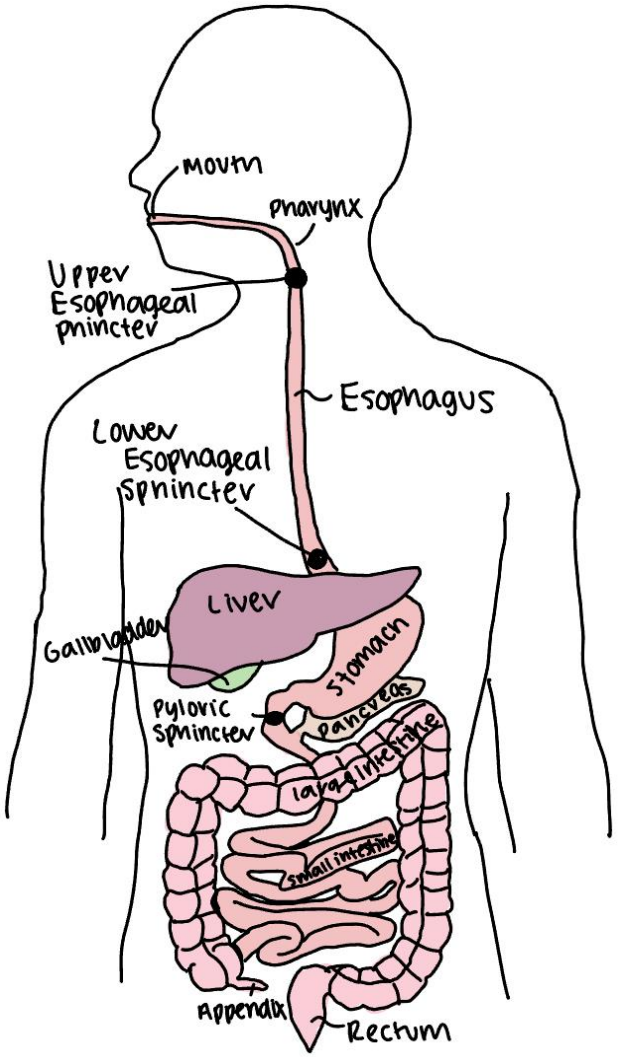
- **Upper Esophageal Sphincter:** Opens/closes for food passage
- **Lower Esophageal Sphincter:** At stomach entrance

Stomach: No absorption in stomach (only **digestion**)

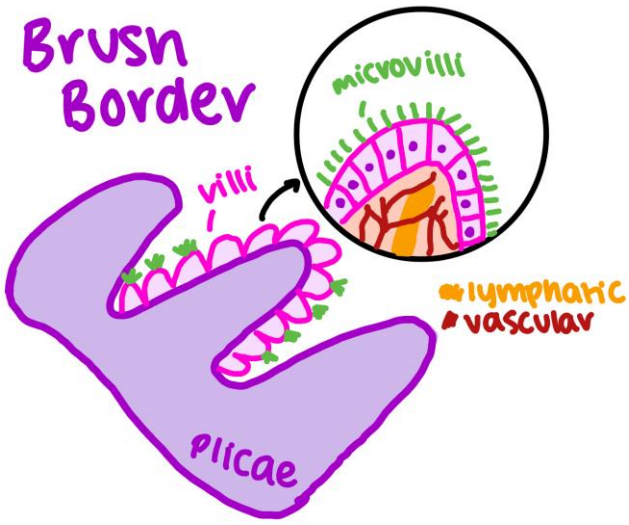
- **NOTE:** The **rugae**, or the folds in the lining of the **stomach**, expand when the **stomach** is full. In addition, the **stomach** has microscopic "**gastric pits**" consisting of **mucous neck cells**, **parietal cells**, **chief cells**, and **G-cells**.

Small Intestine: consists of the **duodenum**, **jejunum**, and **ileum**; primary site of **absorption** of nutrients in the **GI tract** as it is lined with muscular layers crucial for **peristaltic contractions**

- **NOTE:** The **small intestine** consists of numerous folds meant to increase the overall surface area for the absorption of nutrients and has a rich, velvety lining. Beyond that,



there are **plicae**, or folds in the walls of the **small intestine**, which are lined with **villi** that have **microvilli** on top of them, all of which make up the **brush border** crucial for the absorption of nutrients. The **small intestine** is also HIGHLY vascularized and connected to the **lymphatic system** for **fat absorption**.



Large Intestine: consists of the **cecum**, **ascending colon**, **transverse colon**, **descending colon**, **sigmoid colon**, and **rectum**; **absorption** of water occurs here

NOTE: The **large intestine** consists of **haustra** which gives it a segmented appearance due to the **taenia coli**, or muscle bands. Beyond that, the lining of the **large intestine** is flat with no **villi**.

ACCESSORY ORGANS:

Salivary Glands: produces **salivary enzymes** that help with the initial digestion of food

NOTE: These are the **parotid**, **sublingual**, and **submandibular glands**.

Appendix: hands off of the **cecum** with no true useful function

Pancreas: has an **endocrine** (secretes substances into the bloodstream) and **exocrine** (secretes substances through **ducts** into internal organs) portion

Endocrine Portion: consists of the **Islets of Langerhans;** secretes **insulin** from **beta cells** and **glucagon** from **alpha cells**

Exocrine Portion: secretes **bicarbonate** and **digestive enzymes**

Liver: nutrients absorbed form the **small intestine** are sent to the **liver** via the **hepatic portal vein** to be processed and transported throughout the body for different functions

NOTE: The **liver** aids in **glucose** and **fat metabolism**, **protein synthesis**, detoxification of harmful substances in the body, and storage (**glycogen**, **iron**).

Gallbladder: stores and concentrates **bile** that is produced by the **liver**

Highlight #2: Digestion of Carbohydrates, Proteins, and Lipids

The table below describes how **carbohydrates**, **proteins**, and **lipids** are all broken down in each section of the **digestive tract**!

	CARBOHYDRATES	PROTEINS	LIPIDS
MOUTH	- **Salivary Amylase** begin to digest **carbohydrates**	N/A	- **Lingual Lipase** is secreted by cells on the back of the tongue, working to break up the surface of **lipid globules**
STOMACH	- **Salivary Amylase** is inactivated by the acidic environment in the stomach	- **Chief Cells** release **pepsinogen** - **Parietal Cells** release **HCl** - **HCl** converts **pepsinogen** to **pepsin** - **Pepsin** works by breaking down **polypeptide chains**	- **Gastric Lipase** is secreted by **chief cells** to assist in breaking them down - Regulates the movement of **chyme** into the **small intestine**
SMALL INTESTINE	- **Pancreatic Amylase** breaks down **polysaccharides** into **disaccharides** - **Brush Border Enzymes** digest **disaccharides** into **monosaccharides** (on the **apical** surface of the **small intestine**)	- **Pancreas** releases **trypsinogen** - **Trypsinogen** is converted to **trypsin** by **membrane-bound enterokinase** activity - **Trypsin** then works to activate other **enzymes** from the **pancreas**	- **Pancreatic Lipase** is secreted by **exocrine pancreas** into **small intestine** and works on the surface of **lipid globules** - **Bile Salts** break down large fat droplets for the **lipase** to work - **Emulsification!!**

The process of **emulsification** and the **absorption** of **lipids** in the **small intestine** is described below:

1. **Pancreatic lipase** is secreted by the **exocrine pancreas** into the **small intestine** to continue breaking down **lipids**
2. **Bile salts** from the **liver** break up large fat droplets into smaller ones, increasing surface area for **lipase** action in a process called **emulsification**

3. **Micelles** are formed with the lipid portion inside (**hydrophobic**) and the **hydrophilic** portion outside. They function to facilitate the transport of **lipids** to the **absorptive cells** in the **small intestine**.
4. **Fatty acids** (not in **micelles**) can easily pass through the **apical membrane** of the **absorptive cells** (**enterocytes**).
5. Inside the **enterocytes**, **fatty acids** are reformed into **triglycerides** in the **smooth endoplasmic reticulum (ER)**.
6. Newly formed **triglycerides** are packaged into **chylomicrons** in the **Golgi apparatus**. **Apoproteins** (**ApoB**) are incorporated into the **chylomicrons** for transport.
7. **Chylomicrons** are too large to enter capillaries, so they are absorbed into the **lymphatic system**. The **lymphatic vessels** carry **chylomicrons** to the bloodstream, eventually reaching the **liver**.
8. **Bile salts** complete their **emulsification** role and are reabsorbed in the **ileum**. Recycled **bile salts** are returned to the **liver** for storage or reuse in digestion.

Highlight #3: Hormones of the Digestive System

Beyond just the important **enzymes** necessary for **digestion**, there are four **hormones** important to discuss and information about them is in the table below!

	GASTRIN	CHOLECYSTOKININ (CCK)	SECRETIN	GLUCOSE INSULINOTROPIC PEPTIDE (GIP)
Origin	**G-Cells** in the **stomach**	Cells of the **small intestine** (**duodenum**)	Cells of the **duodenum**	Cells of the **small intestine** (**duodenum**)
Stimuli	- Food in **stomach** -**Parasymp-athetic** stimulation	- Fat/protein in **duodenum** - **Chyme** in **duodenum**	- **Acid** in **duodenum**	- **Chyme** in the **duodenum**
Action	- Increase **gastric secretions** (**HCl** from **parietal**/**pepsinogen** and **lipase** from	- Stimulates **pancreatic secretions** (enzyme-rich) - Stimulates contractions of the **gallbladder** - Inhibits **gastric secretions** and **motility**	- Stimulates **pancreatic secretions** (**bicarb**) to neutralize the acid and allow the	- Stimulates **insulin** secretion from **pancreas** - Inhibits **gastric motility**

	chief) - Stimulate **gastric motility** - **Gastroileal Reflex** - **Gastrocolic Reflex**		other **enzymes** to be active	

Lastly, the **medulla** has a **swallowing center** that initiates the succession of automatic **reflexes** needed when an individual swallows. This process is as follows:

1. Elevation of the **uvula** prevents food from entering **nasal passages** when **swallowing**.
2. **Swallowing center** in the **medulla** inhibits **respiratory center** in the **medulla** to protect the **windpipe** when **swallowing**.
3. Positions **tongue** to prevent food from reentering the mouth.
4. **Epiglottis** is pressed over the closed **glottis** as an auxiliary mechanism to prevent food from entering the airways.
5. Once material gets into the **esophagus**, there are a series of **peristaltic contractions** that get the food to the **stomach**.

CHECK YOUR UNDERSTANDING

Concept Check: *(answers found on the last page)*

1. Describe the composition of the lining of the small intestine. Why is this important for absorption?
2. What are the different portions of the pancreas and how do they contribute to the gastrointestinal system?
3. Walk through how proteins and carbohydrates are digested in the mouth, stomach, and small intestine in detail.
4. Describe the steps of the process by which lipids are broken down and absorbed.
5. How does gastrin differ from the other three hormones of the digestive system? Why is the main function of gastrin different from the other three?

THINGS YOU MAY STRUGGLE WITH

1. The digestive system unit has a lot of small details and terms that are important to know to enhance your understanding of the material. Therefore, it can be helpful to organize your notes similarly to the charts in the resource above to ensure that all of the material for this unit is in one place.

2. There are many digestive processes and mechanisms that are important in this unit and can be tricky to master. Similar to the other processes in this course, it can be helpful to walk through the steps of these processes with a study group or using the blank page method where you write down the steps from memory!
    a. Active recall is so important in this course!! As you near the end of the semester, make sure to review topics from previous weeks using these techniques to spread out your studying for the final exam.

CONGRATS: You made it to the end of the resource! Thanks for checking out these weekly resources! Don't forget to check out our website for group tutoring times, video tutorials, and lots of other resources at www.baylor.edu/tutoring!

Answers to Retrieval Practice and Check Your Understanding questions are below!

Retrieval Practice:

1. **Occurs at the epiphyseal plate, allows cartilage to calcify here and become bone; chondrocytes lay down this cartilage and osteoblasts deposit bone matrix; occurs before puberty**
2. **Calcitonin, Calcitriol, and Parathyroid Hormone (more information about these is in the Week 13 resource)**

Concept Check:

1. **Plicae lined with villi with microvilli along them to form the brush border; increases surface area for absorption!**
2. **Endocrine (releases insulin and glucagon into bloodstream) and Exocrine (releases enzymes into ducts for digestion and other processes)**
3. **These are listed in Highlight 2 in the chart above!**
4. **The 8 steps are listed under the chart in Highlight 2!**
5. **Gastrin is released in the stomach and promotes gastric motility while the other three hormones are released in the small intestine and inhibit gastric motility so they can spend time absorbing the nutrients necessary for the body**