

# Digestive System

## HASPI Medical Anatomy & Physiology 15a

### Lab Activity

## Background

Name(s): \_\_\_\_\_

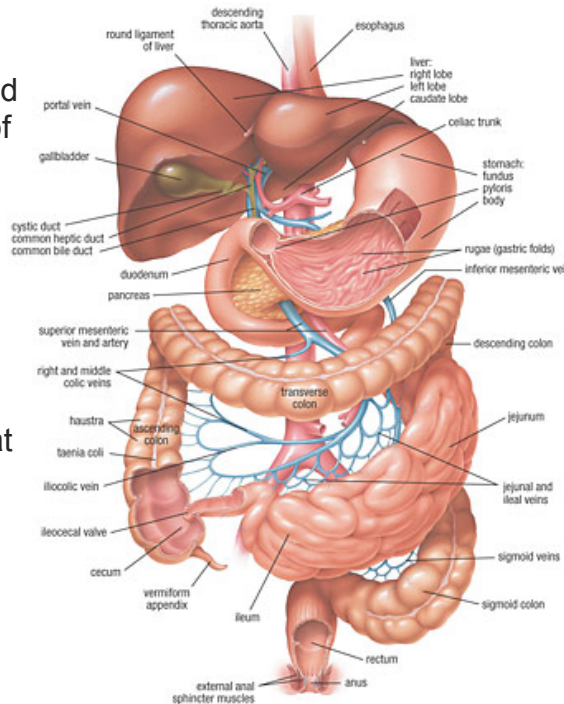
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### The Digestive System

Digestion is an important process that involves breaking down food and drink into small molecules that can be transported and used by the cells of the body. The digestive system consists of a one-way track, called the gastrointestinal (GI) tract, that food travels through. At various points of the GI tract, digestion, absorption, and elimination occur. Each portion has been structured to perform a specific function.

The GI tract includes the mouth, esophagus, stomach, small intestine, large intestine or colon, rectum, and anus. These organs contain a layer of tissue called the mucosa that is responsible for creating digestive juices, such as enzymes, that are capable of breaking down food. In addition to the mucosa layer there is also a tissue layer of smooth muscle that assists in moving food through the GI tract called the muscularis mucosae. The rhythmic contraction and relaxation of this smooth muscle layer is called peristalsis.

In addition to the GI tract, there are also two solid organs that assist with digestion by creating and releasing substances into the GI tract. The pancreas produces several digestive enzymes, while the liver is responsible for creating bile needed to break down fat. An additional accessory organ is the gallbladder that stores the bile produced by the liver.



<http://denverdigestive.com/art/DigestiveSystem.jpg>

### The Process of Digestion

Step	Process
1	Once food enters the mouth, salivary glands produce saliva that contains amylase. Amylase begins the digestion of starch and carbohydrates.
2	From the mouth, food is pushed down the esophagus by swallowing. The food then passes through the cardiac sphincter into the stomach. The cardiac sphincter prevents the contents of the stomach from moving back up the esophagus.
3	Within the stomach, digestive glands within the lining of the stomach produce acid and pepsin to break down proteins. A thick layer of mucus is also released to protect the stomach from the acid.
4	The stomach is a muscular pouch that contracts and releases to “mix up” the food and digestive juices of the stomach much like a washing machine. Once the food is properly mixed, the stomach pushes the contents through the pyloric sphincter into the first part of the small intestine, called the duodenum.
5	The liver, pancreas, and gallbladder are attached to the duodenum through ducts and release additional digestive juices into the small intestine. These include bile to emulsify fats, amylase to further break down carbohydrates, lipase to break down lipids, and trypsin to further break down proteins.
6	As the contents travel through the small intestine, they are absorbed through small projections on the surface of the intestines called villi. Each villi is connected to a capillary so, as molecules diffuse through the villi, they are transferred directly into the blood stream to be taken to the cells of the body.
7	Eventually, any contents that are left and have not been absorbed by the small intestine are pushed through the ileocecal valve into the colon.
8	As the contents move through the colon, water is removed and the leftover contents become feces that are expelled through the rectum and anus during a bowel movement.

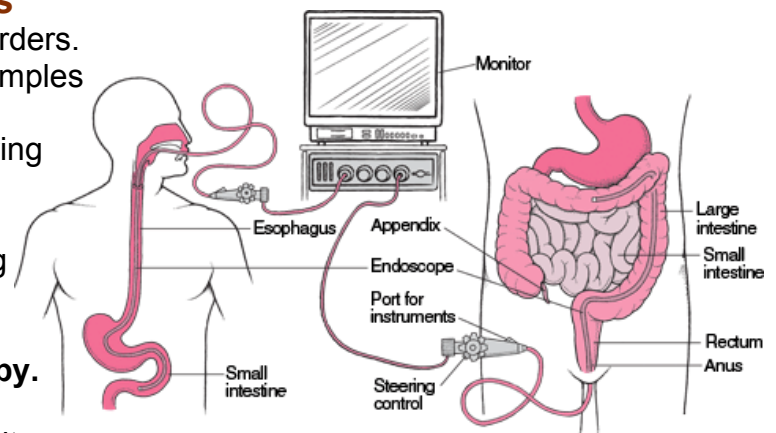
## Digestive Disorders

There are many diseases and disorders associated with the digestive system. Some of the most important aspects of digestive disorders are the prevalence, healthcare costs, and mortality. Digestive disorders cost the U.S. approximately \$141.8 billion dollars in 2004. The following chart summarizes the impact of the most common digestive disorders in the United States in 2004.

Digestive Disorder	Description	Diagnosis Prevalence	Healthcare & Hospital Visits	Annual Mortality Rate
<b>Constipation</b>	Infrequent bowel movements	63 million	6.9 million	137
<b>Diverticulitis</b>	Inflammation of small pouches of the intestines	3.2 million	2.2 million	3,372
<b>Gallstones</b>	Deposits that form in the gallbladder	20 million	2.4 million	1,092
<b>Gastroesophageal Reflux (GERD)</b>	Stomach contents leak back up through the esophagus	60 million	21.4 million	1,150
<b>GI Infections</b>	May be bacterial, viral, or fungal	211 million	2.7 million	4,396
<b>Hemorrhoids</b>	Swollen veins in the rectum or anus	75% 45+	3.5 million	14
<b>Abdominal Hernia</b>	Intestines protrude through the abdominal wall	4.7 million	3.7 million	1,663
<b>Inflammatory Bowel Disease (IBD)</b>	Inflammation of the intestinal lining	359,000	1.2 million	622
<b>Irritable Bowel Syndrome (IBS)</b>	Irritation of the intestinal lining	15.3 million	3.2 million	20
<b>Liver Disease</b>	Liver inflammation and tissue damage	2.6 million	3.1 million	36,090
<b>Pancreatitis</b>	Inflammation of the pancreas	1.1 million	454,000	3,480
<b>Peptic Ulcers</b>	Sores in the lining of the stomach	14.5 million	1.9 million	3,000
<b>Colitis</b>	Sores and inflammation of the colon	619,000	798,000	311
<b>Viral Hepatitis</b>	Inflammation of the liver caused by the hepatitis virus	5.4 million	3.9 million	5,298

## Diagnostic Tests for Digestive Disorders

There are many diagnostic tests for digestive disorders. Biopsy samples, gastric juice samples, or stool samples can be used to recognize whether there may be a digestive source for a patient's symptoms. Following lab tests that may signify a digestive disorder, imaging of the GI tract can be used. The most effective diagnostic procedures involve using an endoscope to view portions of the GI tract with a camera. When this process is done through the rectum to view the colon, it is called a **colonoscopy**. When this process is done through the mouth to view the esophagus, stomach, and/or duodenum, it is called an EGD or an **esophagogastroduodenoscopy**.



[http://www.merckmanuals.com/media/home/figures/GI\\_digestive\\_tract\\_endoscope.gif](http://www.merckmanuals.com/media/home/figures/GI_digestive_tract_endoscope.gif)

Upper and lower GI series can also create radiographic images of the GI tract using a contrast dye, such as barium. The images can show blockages, strictures, or other issues that may exist with the passage of food through the intestines. Using these imaging techniques, healthcare specialists are able to view and identify inflammation, ulcers, growths, and bleeding.

NIH. 2008. Your Digestive System and How it Works. National Institutes of Health (NIH), National Digestive Diseases Information Clearinghouse (NDDIC), NIH Publication No. 08-2681, <http://digestive.niddk.nih.gov/ddiseases/pubs/yrdd/>

NIH. 2010. Digestive Diseases Statistics for the United States. No. 10-3873, <http://digestive.niddk.nih.gov/statistics/statistics.aspx#ack>

## Materials

Station 1: Anatomy Posters (4)  
 Station 2: Yarn, scissors, marker, ruler, tape  
 Station 3: Histology Posters (4)

Station 4: Stethoscope, cups, water, timer  
 Station 5: Disease Posters (5)  
 Station 6: Stool sample, Q-tip, test sheet

## Procedure

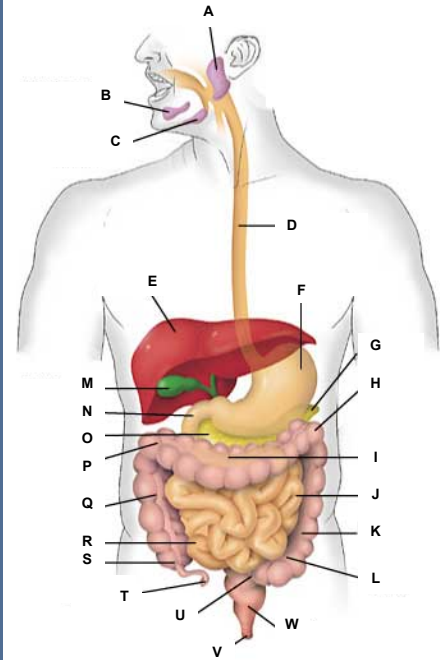
This is a station lab activity. There are 6 stations set up around the classroom. Each station will take approximately 10-15 minutes.

### Station 1: The Digestive System

**Digestive System Anatomy** – Using the “Digestive System Anatomy” chart, identify the organs or parts of the organ labeled A-W in **Table 1** below. If there are any that you cannot identify, use a textbook or online resource. A smaller version of this chart is included here for later review.

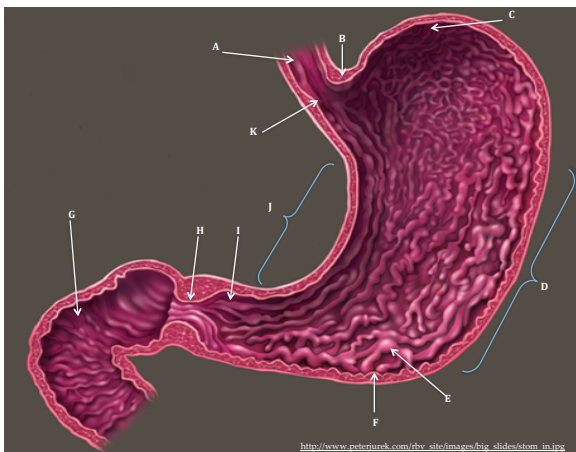
**Table 1: Digestive System Anatomy**

A	I	Q
B	J	R
C	K	S
D	L	T
E	M	U
F	N	V
G	O	W
H	P	



<http://www.encyclopive.com/images/digestive-system-2.jpg>

**The Stomach** – Using “The Stomach” chart, identify the parts of the organ A-K in **Table 2** below. If there are any parts you cannot identify, use a textbook or online resource. A smaller version of this chart is included here for later review.



[http://www.peterdurek.com/rbv\\_site/images/big\\_slides/stom\\_in.jpg](http://www.peterdurek.com/rbv_site/images/big_slides/stom_in.jpg)

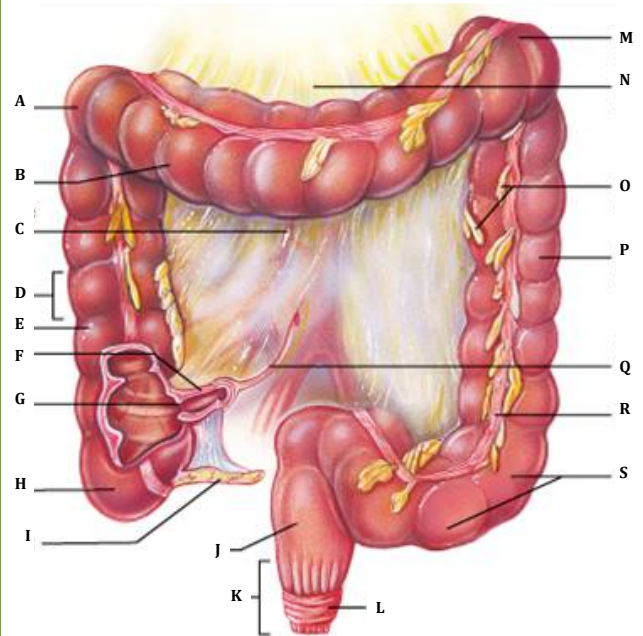
**Table 2: The Stomach**

A	G
B	H
C	I
D	J
E	K
F	

**The Large Intestine** – Using “The Large Intestine” chart, identify the parts of the organ A-S in **Table 3** below. If there are any parts you cannot identify, use a textbook or online resource. A smaller version of this chart is included here for later review.

**Table 3: The Large Intestine**

A	K
B	L
C	M
D	N
E	O
F	P
G	Q
H	R
I	S
J	



**Digestive System Function** – Fill in the function of each digestive organ in Table 4. Use the “Digestive Organ Function” chart to check your answers. Make any changes if needed.

**Table 4: Digestive System Function**

	<b>Function</b>
<b>Mouth</b>	
<b>Salivary Gland</b>	
<b>Pharynx</b>	
<b>Esophagus</b>	
<b>Stomach</b>	
<b>Pancreas</b>	
<b>Liver</b>	
<b>Gallbladder</b>	
<b>Small Intestine</b>	
<b>Large Intestine</b>	
<b>Rectum</b>	
<b>Anus</b>	

## Station 2: The GI Tract *Adapted from "The Digestive System" by M. Poarch, 2002.*

The entire length of the adult GI tract from mouth to anus is approximately 9-10 meters in length. Various portions of the GI tract vary in length depending on their function. The large majority of this length is located in the intestines. In this activity we will be measuring out the length of the GI tract in a scaled version to compare the lengths of each section.

### Directions

✓ when complete

Step 1	Using the ruler measure out 332 cm of string.	
Step 2	Using the ruler measure out 4 cm from one end of the string and make a line or dot on the string with a marker. 0-4 cm represents the <b>MOUTH</b> .	
Step 3	Starting from your 4 cm mark, measure out 9 cm and make a line or dot on the string with a marker. The 4-13 cm represents the <b>ESOPHAGUS</b> .	
Step 4	Starting from your 13 cm mark, measure out 8 cm and make a line or dot on the string with a marker. 13-21 cm represents the <b>STOMACH</b> .	
Step 5	Starting from your 21 cm mark, measure out 251 cm and make a line or dot on the string with a marker. 21-272 cm represents the <b>SMALL INTESTINE</b> .	
Step 6	Starting from your 272 cm mark, measure out 55 cm and make a line or dot on the string with a marker. 272-327 cm represents the <b>LARGE INTESTINE</b> .	
Step 7	Starting from your 327 cm mark, measure out 5 cm and make a line or dot on the string with a marker. 327-332 cm represents the <b>RECTUM</b> .	
Step 8	Tape your string flat (no overlapping) in the area provided below with the "mouth" portion of the string at the top. Zigzag the string back and forth to fit.	
Step 9	Label the mouth, esophagus, stomach, small intestine, large intestine, and rectum next to each portion of the string it represents below.	



### Station 3: Digestive System Histology

The cell and tissue structure of digestive organs is suited for the function they perform. Draw and label what you see in Image B for the following digestive organs below. Image A in each chart is for reference!

#### Esophagus

Using colored pens/pencils, draw the histology Image B from the “The Esophagus” chart in the space below. Using Image A as a reference, label your drawing with the muscularis externa, lamina propria, and stratified SQ. epithelium. Also label the lumen (the lumen is the center “space” of the esophagus).



#### Stomach

Using colored pens/pencils, draw the histology Image B from the “The Stomach” chart in the space below. Using Image A as a reference, label your drawing with the gastric lumen, epithelium, gastric pits, neck, gastric glands, muscularis mucosae, and submucosa.



#### Small Intestine

Using colored pens/pencils, draw the histology Image B from the “The Small Intestine” chart in the space below. Using Image A as a reference, label your drawing with the villus, crypts, submucosa, and muscularis externa.



#### Large Intestine

Using colored pens/pencils, draw the histology Image B from the “The Large Intestine” chart in the space below. Using Image A as a reference, label your drawing with the luminal surface, goblet cells, submucosa, muscularis externa, and serosa.



**Station 4: Gravity or Peristalsis?** Adapted from “Fast Food” by M. Poarch, 2004.

The time it takes food and drink to pass through the GI tract can vary from 24 hours to 3 days depending on the type and ingredients. For example, carbohydrates are digested very quickly and only remain in the stomach for an hour at most, while protein and fat can remain in the stomach for several hours for further digestion. In this activity you will investigate how long it takes water to move through the esophagus and whether gravity affects the speed at which it reaches the stomach.

**Directions**

✓ when complete

<b>Step 1</b>	Obtain a stethoscope, ruler/tape measure, cup of water, and a timer.	
<b>Step 2</b>	Choose a partner to use as the test subject. Using the tape measure/ruler measure from the test subject’s mouth to the bottom of the sternum in cm. Record this as the “Esophagus Length” in Table 5 below under “Distance”.	
<b>Step 3</b>	Using the stethoscope, listen slightly below and to the left of the sternum of the test subject. You are listening for the sound made by the opening/closing of the cardiac sphincter located between the esophagus and stomach.	
<b>Step 4</b>	Have the test subject swallow a drink of water from the cup and continue listening with the stethoscope. You should hear the water move through the cardiac sphincter. You may need to practice this a few times to make sure the stethoscope is in the correct area to hear this clearly.	
<b>Step 5</b>	Have the test subject stand and sip the water, <u>WITHOUT SWALLOWING!</u> Keep the stethoscope in place to hear the cardiac sphincter.	
<b>Step 6</b>	When you say go, start the timer and have the test subject swallow the water. Stop the timer as soon as you hear the water move through the cardiac sphincter.	
<b>Step 7</b>	Record the time in seconds in the “Time” column for Standing Trial 1.	
<b>Step 8</b>	Repeat Steps 5-7 for a total of 3 trials.	
<b>Step 9</b>	Find the average for all 3 trials and record in the “Average” row.	
<b>How much is gravity a factor??? Let’s find out!</b>		
<b>Step 10</b>	Have the test subject take a sip of the water <u>WITHOUT SWALLOWING</u> and lay down flat on his or her back.	
<b>Step 11</b>	Repeat Steps 6 – 9 with the test subject lying down, but record that data in the “Laying Down” time column.	
<b>Step 12</b>	Calculate the Speeds for the standing up and laying down average. <b>Speed = Distance ÷ Average Time</b>	

**Table 5. Time for Water to Reach the Cardiac Sphincter**

<b>Standing Up</b>	<b>Time in Seconds</b>	<b>Distance</b>	<b>Speed = Distance ÷ Average Time</b>
<b>Trial 1</b>			
<b>Trial 2</b>			
<b>Trial 3</b>			
<b>Average</b>			
<b>Laying Down</b>	<b>Time in Seconds</b>		
<b>Trial 1</b>			
<b>Trial 2</b>			
<b>Trial 3</b>			
<b>Average</b>			

## Station 5: Digestive Disease

Using the digestive disease charts, complete the following table. List ONLY THREE Causes or Risk Factors, Symptoms, and Treatment Options for each disease.

<b>Cholecystitis</b>			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
Approximately how many MORE high volume cholecystectomy surgeries were performed in 2007 than 1998?			
<b>Gastroesophageal Reflux Disease (GERD)</b>			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
What country spends the most on research & development for GERD?			
<b>Inflammatory Bowel Disease (IBD)</b>			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
Approximately how many MORE IBS surgeries were performed in 2007 than 2001?			
<b>Peptic Ulcers</b>			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
What age group of women is most at-risk for peptic ulcers?			
<b>Colon Diseases (Choose 2)</b>			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
In 2006, what region in the U.S. had the highest incidence rate of colorectal cancer? Why do you think this was?			



## Station 6: Digestive Lab Tests

There are many different types of diagnostic tests that can be used to identify possible digestive disorders. One of the most common tests is the fecal occult blood test to search for trace amounts of blood in the stool. A healthy individual will normally have a small amount of blood loss into the stool daily, but a primary symptom of many digestive disorders is chronic bleeding in the GI tract. Blood in the stool may be indicative of ulcers, polyps, cancer, anal fissures, infection, hemorrhoids, diverticulitis, colitis, and esophageal bleeding just as a few examples.

Since chronic bleeding indicates a bigger issue, it is more useful to perform several fecal occult blood tests over a period of time rather than just accept the results from a single test. In this activity, you will be testing 2 samples collected from a patient who has been experiencing abdominal cramping over a period of several months. Sample A is the initial sample and Sample B was collected 3 days after Sample A.

### Directions

✓ when complete

<b>Step 1</b>	Obtain a Q-tip and a fecal occult test sheet. DO NOT TOUCH the circle test area with your fingers!	
<b>Step 2</b>	Open the stool sample container for Sample A and remove a very small amount of the sample with the Q-tip. Replace the lid on the sample container.	
<b>Step 3</b>	Rub the sample from the Q-tip on the test area of the fecal occult test sheet. Spread the stool sample out as thin as possible.	
<b>Step 4</b>	If the test is positive, the fecal occult test sheet will turn pink/purple. Even a small change indicates a positive test result indicating the presence of blood in the stool sample.	
<b>Step 5</b>	Record the results in Table 6 below. Discard Q-tip and test sheet in the trash.	
<b>Step 6</b>	Repeat Steps 1 – 5 for Sample B that was collected 3 days after Sample A.	

<b>Table 6</b>	Sample A	Sample B
Fecal Occult Test Results (+ or -)		

### Analysis Questions - on a separate sheet of paper complete the following

#### Station 1

1. What are the accessory organs of the digestive system that are not actually part of the GI tract?
2. What are the three parts of the small intestine?
3. What valve separates the esophagus and stomach? The stomach and the duodenum?
4. What valve separates the ileum from the colon?
5. What are the three parts of the large intestine or colon?
6. What are the functions of the liver and gallbladder?
7. What is the function of the pancreas?

#### Station 2

8. What is the longest part of the GI tract?
9. Why do you think the small intestine is so much longer than the large intestine?
10. Did the length of any portions of the GI tract surprise you? Why or why not?

*Continued on next page...*

## Analysis Questions – *continued....*

### Station 3

11. What would pass through the lumen of the esophagus?
12. What is the importance of the gastric lumen and gastric pits in the stomach?
13. What is the importance of the villus in the small intestine?
14. What is the importance of the goblet cells in the large intestine?

### Station 4

15. What was the difference between the speed of water through the esophagus standing and laying down?
16. According to this experiment, was the speed of water through the esophagus affected by gravity?
17. What valve were you listening to in this experiment?
18. What was the purpose of performing multiple trials?

### Station 5

19. What were the common causes & risk factors found between the majority of the digestive disorders?
20. What were the common symptoms found between the majority of the digestive disorders?

### Station 6

21. What is the purpose of the fecal occult blood test?
22. Why is it important to perform multiple fecal occult blood tests over a period of time?
23. What digestive disorders can the fecal occult blood test indicate?
24. Why was it important not to touch the test area with our fingers prior to performing the experiment?
25. **CONCLUSION:** In 1-2 paragraphs summarize the procedure and results of this lab.

## Review Questions - *on a separate sheet of paper complete the following*

1. What is the function of the digestive system?
2. What is the one-way track through the digestive system called?
3. What are the organs of the GI tract?
4. What is the function of the mucosa tissue layer?
5. What is the function of the muscularis mucosae tissue layer?
6. What is peristalsis?
7. Summarize each step in the digestion process.
8. Where does carbohydrate/starch digestion occur?
9. Where does protein digestion occur?
10. Where does lipid digestion occur?
11. Where does absorption of nutrients occur?
12. How much was spent on healthcare costs for digestive disorders in the U.S. in 2004?
13. Which digestive disorder was the most prevalent in 2004?
14. Which digestive disorder caused the most healthcare & hospital visits in the U.S. in 2004?
15. Which digestive disorder had the highest mortality rate in the U.S. in 2004?
16. Which digestive disorder had the lowest mortality rate in the U.S. in 2004?
17. What is the difference between a colonoscopy and an esophagogastroduodenoscopy?
18. What is an upper and lower GI series?