



The Human Digestive System

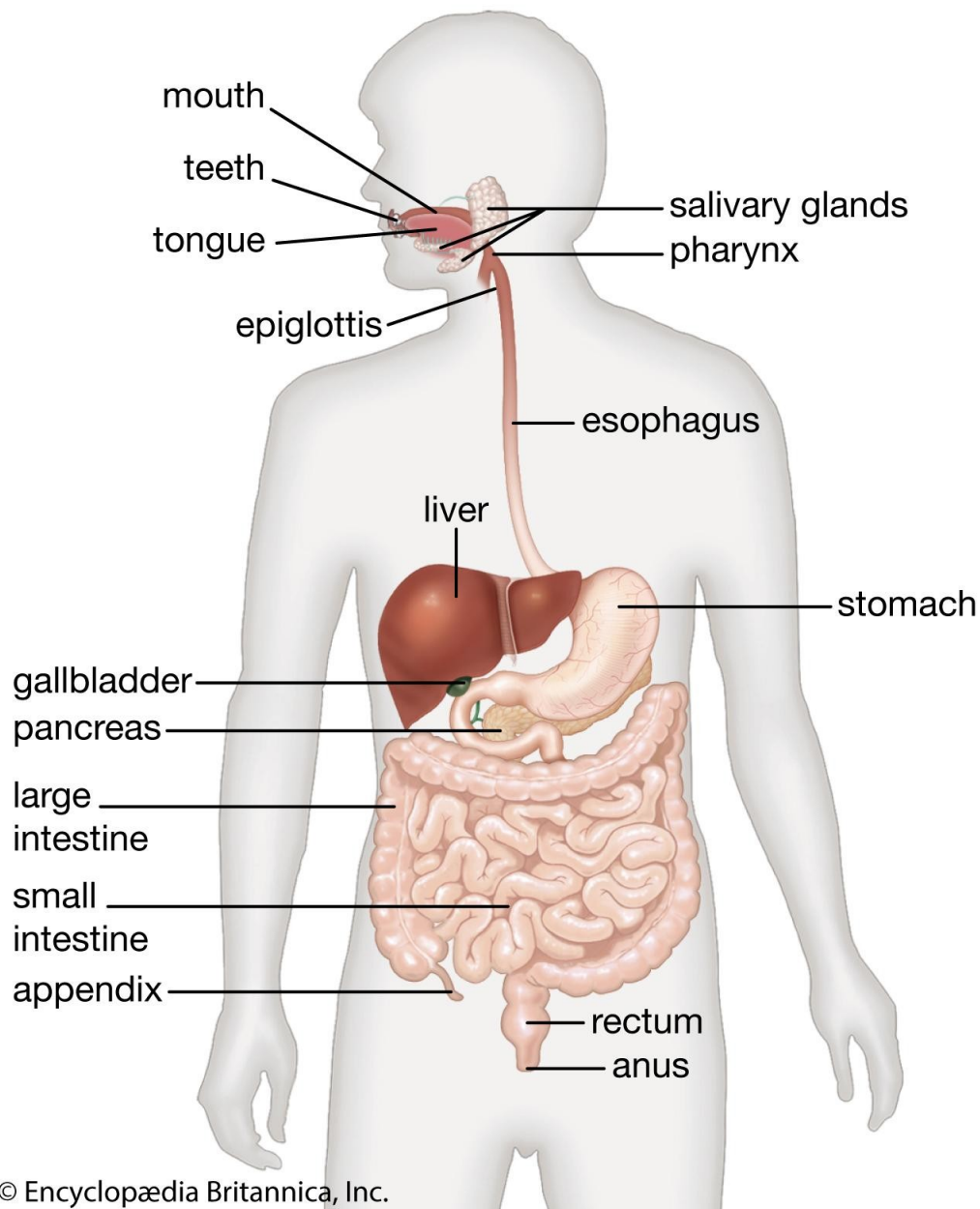
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OVERVIEW:

Our bodies are like machines, with sophisticated systems that work together to perform easily overlooked acts like blinking, walking, and chewing. The digestive system is one of the largest and most sophisticated systems we have, and it is divided into two sections: the alimentary tract and accessory organs. The mouth, oesophagus, stomach, small and large intestines, rectum, and anus make up the alimentary tract of the digestive system. The salivary glands, liver, gallbladder, and pancreas are all accessory organs that are connected to the digestive tract (Regions of the Digestive System | SEER Training, n.d.).

Figure 1

Human Digestive System



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To better understand the system, we'll follow the path that food travels once it enters the mouth.

The Mouth:

When food initially enters the mouth, it is mashed and combined with saliva, produced by the salivary glands, into a bolus with the tongue and teeth. There are four types of teeth: canines for ripping; incisors for cutting; premolars for crushing; and molars for grinding (Mosca & Chen, 2016). With the food in smaller bits, amylase, a salivary enzyme, breaks down the carbohydrates from starch to sugar, with any leftovers being digested by pancreatic amylase in the small intestine. The bolus is then transported to the rear of the mouth and combined with additional saliva before being swallowed.



According to Oliver and Wells (2015), saliva also includes lysozyme, an enzyme that assists in the destruction of bacteria and viruses. It's one of the immune system's protective mechanisms!

The Esophagus:

During swallowing, the pharynx, commonly known as the throat, drives the bolus from the mouth to the esophagus. The bolus is propelled to the stomach by a series of contractions induced by the sphincter muscles in a wave-like pattern called peristalsis. The epiglottis is a tiny flap that covers the opening of the larynx and closes as food passes down and opens when air passes through to prevent food from entering the lungs. According to Mittal et al.'s 2020 study, this procedure should take about 12 seconds to complete as the length of the esophagus is approximately 25 cm. Now that the bolus has reached the cardiac sphincter also known as the lower esophageal sphincter, which is a set of muscles that allow substances to enter the stomach while relaxed but prevent the stomach acid from coming back up when constricted.



The condition known as gastroesophageal reflux disease (GERD) happens when stomach acid often travels up into the esophagus due to weak lower esophageal sphincter muscles (Shiina & Shimizu, 2012). That acid flowing back up is commonly referred to as acid reflux, and such actions irritate the lining of the esophageal tube, resulting in the burning sensation in the chest known as heartburn.

The Stomach:

The food now reaches the stomach, a muscular sac-like organ where it will be held while being digested or broken down into a paste by enzymes and stomach acid for digestion and absorption in the small intestine. To do so, the stomach will go through peristalsis, which involves combining and squeezing the food in order for it to combine with the acid. Since the pH of the acid is so low, it denatures any enzymes that may break down carbohydrates and

lipids into their constituents. However, digestive secretions transform them into a liquid, and an enzyme called lipase breaks lipids down to fatty acids at a considerably slower pace than in the small intestine (Miftahof, 2017). Although, in order to be turned into pepsin, a special enzyme called pepsinogen must be in a very acidic environment to undergo activation. To put it simply, pepsin, a protease, is a sort of digestive enzyme that aids in protein digestion by splitting their bonds with water molecules to form smaller polypeptides (amino acids). Following this, the pyloric sphincter relaxes, enabling the food to flow into the small intestine.



Did you know that the stomach is the body's most acidic organ? Its pH is generally 2.5, but it can drop as low as 1.5! This high pH normally keeps dangerous microorganisms out of the stomach, but acidophiles, which are bacteria that live in extremely low pH settings, are an exception. To keep the acid from hurting the stomach, the stomach secretes mucus, which forms the mucosal lining and keeps the acid from dissolving away the stomach's lumen (Johansson et al., 2013).

The Small Intestines and Accessory Organs:

The majority of digestion and absorption takes place in the small intestines, with the aid of secretions generated by the accessory organs. Enzymes from the pancreas and liver, as well as bile from the gall bladder, will further chemically break down the organic matter in this long organ, allowing basic nutrients to be absorbed through villi, which are small, finger-like projections on the intestine's walls that aid absorption by increasing surface area. It has 3 sections: the duodenum, jejunum, and ileum and each play a different role as peristalsis moves it throughout the small intestine. The duodenum is primarily responsible for the ongoing breakdown process, whereas the jejunum and ileum are mostly responsible for nutritional absorption.

The duodenum, the shortest portion of the small intestine, contains ducts from the pancreas, liver, and gallbladder that mingle with chyme from the stomach via peristalsis. This mixing prepares the chyme for absorption, which happens mostly in the jejunum.

The bile salt, which is generated by the liver but stored and released by the gall bladder, emulsifies fat globules in their undigested condition into fat droplets, making them simpler for pancreatic lipase to digest. Lipolysis is now taking place, with pancreatic lipase playing a crucial role in breaking down these fat droplets into fatty acids and monoglycerides (Collins et al., 2021). They are eventually taken to the liver, where they might be converted into energy or stored as triglycerides. Sugars are also broken down in the jejunum by the enzymes maltase, lactase, and sucrase into glucose, galactose, and sucrose, which are subsequently absorbed into the circulation via the villi.

Food takes the longest time being digested in the ileum, the last and largest portion of the small intestine, while water is reabsorbed into the circulation. Chymotrypsin, an active version of chymotrypsinogen produced by the pancreas, degrades leftover proteins in the stomach into amino acids, which are then taken into circulation. Through the villi, the ileum absorbs bile acids, cholesterol, electrolytes, and vitamins (Kastl et al., 2020), while the excess

of these deaminate into the urea in the liver and removed by the kidneys. As part of bowel movement, any residual waste is pushed into the large intestine by peristalsis.



Bile salts also aid in the absorption of fat-soluble vitamins A, D, E, and K by emulsifying them and making them minuscule enough to pass through the gastrointestinal walls (De Aguiar Vallim et al., 2013).

The Large Intestine, Rectum and Anus:

The caecum, appendix, colon, and rectum make up the large intestine. Egestion, or the elimination of undigested food collected from the small intestines, happens in the large intestine. The majority of the water remaining in the chyme is absorbed in the colon, but a little percentage is kept to aid excretion, which is the removal of metabolic waste from the body, in this instance stool. The faeces passes from the colon to the rectum by peristalsis, which takes around 36 hours. As fibre aids in the elimination process, health specialists continuously encourage its consumption in a regular diet. Fibre may absorb water from liquid waste in the large intestine while also decreasing the time it takes for this solid stool to reach the rectum, giving the large intestine more time to absorb the water. It also cleans the colon by driving any leftover putrefying bacteria, which helped in decomposition, and wastes in the intestine towards the rectum and binds them together by bulking up the excrement (*Fiber and Digestion Problems*, 2010). When the end of the colon is full of excrement, it deposits it into the rectum, an 8-inch compartment that links the colon and anus. When stool or waste gases reach the rectum, the receptors on the rectum wall transmit a signal to the brain that the excretion process may begin, where the muscles of the rectal sphincter loosen and the rectum can contract to release its waste (Sensoy, 2021).



The appendix is a four-inch long tube located in the lower right abdomen at the end of the large intestine. There have been many theories about it, whether it is a vestigial organ, which are organs that may have lost their primary function during evolution, or whether it is a storage for good bacteria that can balance the digestive system after gastric illnesses (Hoffman, 2008).

ACTIVITY 1:

The Mouth, Esophagus, and Stomach

Name: _____

Date: _____

Part I: Easy

Circle the correct answer for each question below.

1. How many types of teeth are in the mouth and what are their names?
 - A. 5: canines, incisors, vomerines and molars
 - B. 4: canines, incisors, premolars and molars
 - C. 6: premolars, molars, vomerines, precanines and canines
 - D. 3: molars, incisors and canines
2. What is the movement that carries food to the stomach?
 - A. wavealasis
 - B. vasoconstriction
 - C. peristalsis
 - D. anastalsis
3. What is the name of the enzyme that breaks down lipids?
 - A. lipase
 - B. liptidase
 - C. peptidase
 - D. liposuction
4. What is the pH range of the acid in the stomach?
 - A. 5.5 to 7.0
 - B. 1.5 to 3.5
 - C. 11.5 to 13.5
 - D. 2.0 to 4.0

5. What is the correct movement of the cardiac sphincter when swallowing?

- A. tightens
- B. relaxes
- C. both in a wave-like motion
- D. neither because it has a flap that moves instead

Part II: Medium

Fill in the blank with the missing word. Some words may be used once, twice or none at all.

upper	inner	Lysozyme	Amylase
Premolars	25	Molars	lower
pyloric	esophageal	3	small
outer	36	Canines	small
12	Lipase	large	cardiac

6. _____ are the type of teeth used for grinding food when chewing.
7. _____ is an enzyme found in saliva that helps to destroy bacteria.
8. The length of the esophagus is approximately _____ cm.
9. When it tightens, the _____ sphincter prevents stomach acid from coming up the esophagus.
10. The _____ sphincter relaxes to allow the partially digested food to enter the _____ intestine..

Part III: Hard

Answer each question in the space provided.

11. What is the name of the digestive enzyme found in the mouth and what does it break down?

12. What is the epiglottis?

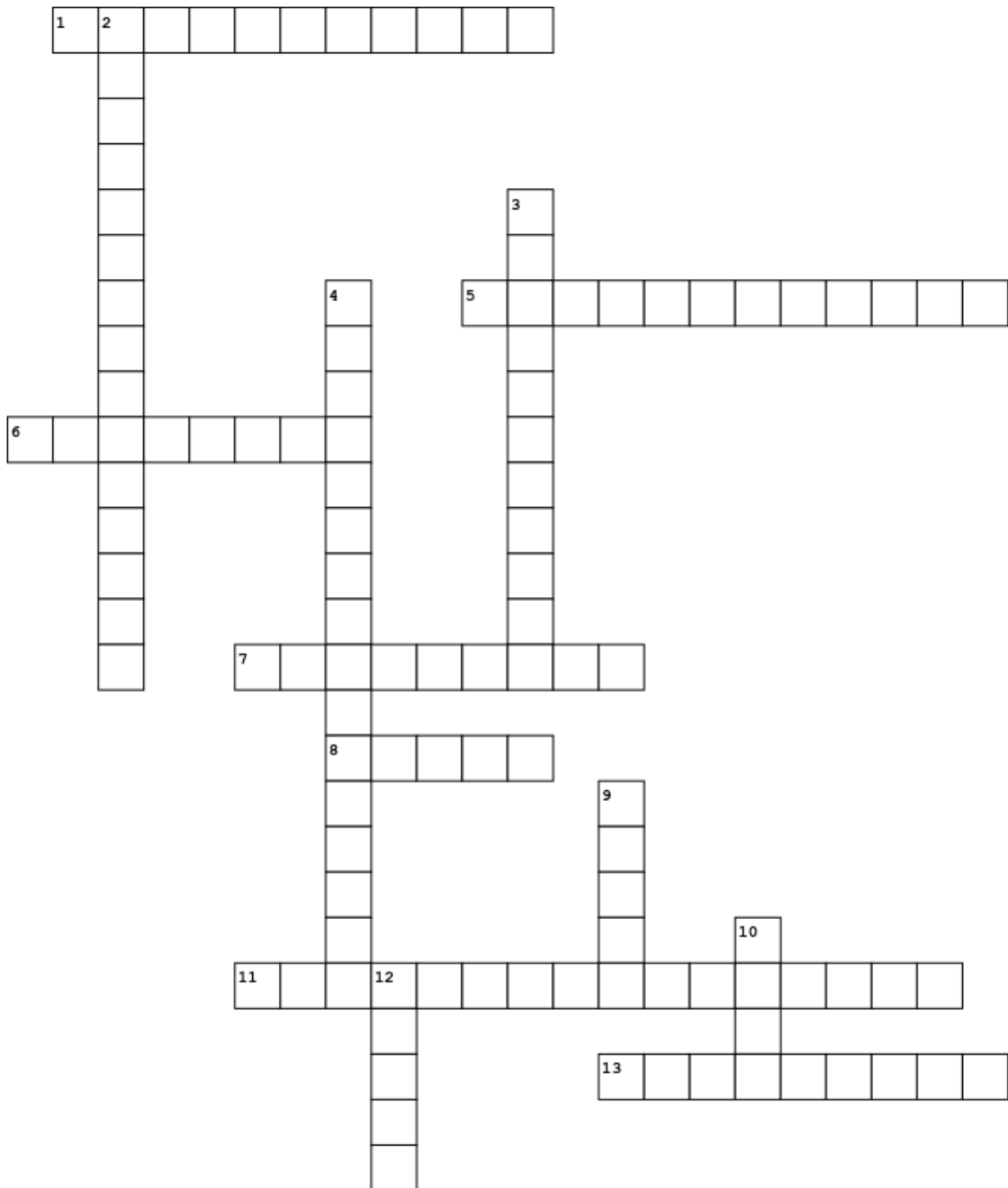
13. What causes gastroesophageal reflux disease (GERD)?

14. How does the stomach prevent the acid it produces from burning itself?

15. Describe pepsin's travel through the stomach. Be sure to specify the chemical's parent compound, activation conditions, and stomach function.

ACTIVITY 2:

The Small Intestine



Across

1. Oh, how vile! They melt me with all this bile! Why must I get any smaller?
5. Whee! Down the slide and to the liver! Sometimes I'm stored as fat, so you don't shiver!
6. I am the quickest part of the journey because I'm so short.
7. Yum yum yum! Some fat droplets in my tum! For you, breaking down would be digestion but for me I have a different suggestion. What's the word for making fatty acids from fat?
8. Slow and steady wins the race! I make take the longest to absorb but this is only because I'm so large!
11. Thank you bile for all this work! Now I must spend my days making something tiny and acidic, but at least I won't deplete, which seems to be this job's only perk!
13. I'm like a shrink ray for vitamins you eat! Making them small enough to fit through the walls, then my work is complete!

Down

2. We're the side characters of the alimentary tract but our roles are just as big
3. Food has no legs so this is where I come in! I help food to travel through the tube by squeezing and releasing like a caterpillar or a wave.
4. Shh, I'm sleeping! Be careful not to wake me up! Because when I'm awake, I'll get angry and eat these amino acids up!
9. I'm tiny and love to wave! I'm like a sidekick to a hero because I help the small intestine save!
10. I only move twice in my whole life: once from where I was born and again from where I was kept until it was time to work in the jejunum.
12. Ah, I'm melting! As horrible and squishy as I am, my name reminds me of the wind and looks like rhyme.

ACTIVITY 3:

The Large Intestine

Name: _____

Date: _____

Unscramble and match the word on the left side to its definition on the right side.

1. _____sotieneg

2. _____epanpxdi

3. _____trcmue

4. _____rtschnelpaert_ci

5. _____hcyem

6. _____anis_vorlgaiegt

7. _____cnloo

8. _____efbri

9. _____rcertsope

A. Sweeps leftover wastes out the colon

B. An organ located within the system but relies on external factors in order to work

C. Transmits a signal to the brain to begin excretion

D. The process of eliminating metabolic waste from the body

E. Contains putrefying bacteria

F. 7-inch long tube

G. partially digested food

H. An organ whose original function may have been lost throughout evolution

I. 8-inch long tube

J. ring of muscle at the end of the anus

K. The process of food entering the large intestine

L. 4-inch long tube

M. The process through which undigested food from the small intestines is eliminated.

N. 4.5-inch long tube

ACTIVITY 4:

The Digestive System

E	S	O	P	H	A	G	E	A	L	T	U	B	E
X	C	S	U	E	L	L	Y	S	O	Z	Y	M	E
U	H	N	E	P	I	G	L	O	T	T	I	S	F
L	Y	I	N	A	P	P	E	N	D	I	X	G	I
F	M	D	D	U	O	D	E	N	U	M	B	T	I
E	O	P	O	L	Y	P	E	P	T	I	D	E	S
R	T	G	S	N	O	I	C	N	O	L	O	C	G
D	R	E	M	M	C	L	I	N	C	I	N	O	E
I	Y	M	B	U	U	P	L	C	P	P	U	N	R
C	P	Y	O	N	U	D	E	O	A	A	E	O	D
A	S	H	L	U	S	J	U	E	I	S	T	I	L
L	I	C	U	J	T	S	M	M	U	E	C	A	C
S	N	S	S	E	T	P	X	Y	R	A	S	E	P
I	H	A	P	J	L	B	P	H	A	R	Y	N	X

- POLYPEPTIDES
- JEJUNUM
- LIPASE
- EPIGLOTTIS
- LYSOZYME
- ESOPHAGEAL TUBE
- APPENDIX
- ILEUM
- DUODENUM
- CHYMOTRYPSIN
- PHARYNX
- COLON
- CACEUM
- BOLUS
- ACID REFLUX
- GERD
- CHYME

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