

Biology 12 - Digestion Study Guide

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1. a) What is digestion? b) What is the difference between digestion and absorption? c) Between chemical and mechanical digestion?
 a) Digestion: the mechanical and chemical breaking down of food into particles and then molecules small enough to enter the internal environment of the body.
 b) Absorption: is when these small molecules pass from the lumen (hollow tube) of the gut into the blood or lymph, which will then distribute them throughout the body.
 c) Mechanical Digestion: is the physical breaking down of ingested food by the action of such things like teeth and churning muscles of the stomach.
 Chemical Digestion: is using chemicals like Hydrolytic enzymes and HCl to break down food.
 2. Compare the composition of the food we eat with the molecules that our cells actually use. Food is composed mainly of large macromolecule like proteins, lipids and carbohydrates (starch, cellulose, glycogen, sugars). Our cells actually use the much smaller sub unit molecules that make up these macromolecules, such as amino acids, glucose, lipoproteins (from the fatty acids and glycerol), nucleotides, etc.
 3. a) How many teeth do adults have? b) What are the four types of teeth and their functions?
 a) Adults have 32 teeth.
 b) -8 incisors for cutting/biting
 -4 canines for tearing
 -8 premolars for grinding
 -12 molars for crushing
 4. Use your tongue to locate at least one of the salivary enzymes on the inside of your mouth. How many pairs of salivary glands do you have?
 3 Pairs of salivary glands: 2 parotid (below ears)
 2 sublingual (below tongue)
 2 submandibular (below lower jaw)
 5. a) What is a hydrolytic enzyme? b) What is the enzyme in saliva?
 a) Hydrolytic Enzyme: an enzyme that breaks down a macromolecule by adding water (H^+ and OH^-) to the ends of the 2 'new' smaller sub unit molecules.
 b) Salivary Amylase is the enzyme in saliva.
 6. a) What is the substrate of this enzyme? b) What are the products? c) Write the overall reaction as a chemical equation.
 a) Substrate of salivary amylase is starch.
 b) Products are maltose (a disaccharide)
 c) salivary amylase
 Starch + $H_2O \rightarrow$ maltose
 7. Differentiate between what gets mechanically digested in the mouth and what gets chemically digested.
 Mechanical Digestion: all solid food gets mechanically digested in the mouth by the chewing action of the teeth and tongue.
 Chemical Digestion in the mouth: the starch component of foods is the only thing that gets chemically digested in the mouth.
 8. List the three main events that occur during swallowing. Help your explanation by using a labeled diagram.
 3 Events of swallowing:
 1) Soft palate moves back to cover the nasopharyngeal openings (openings to the nose).
 2) Larynx (Adam's Apple) which is at the upper part of the trachea (windpipe), moves up to close the glottis (opening to the larynx).
 3) As the bolus moves down the pharynx, it pushes the epiglottis down to cover the glottis.
 9. Describe the process of **peristalsis** in the esophagus? How can a combination of circular and longitudinal muscles cause this action? Again, using a diagram will help your explanation.
 Peristalsis: is the rhythmic waves of muscle contraction that pushes food down the esophagus (and the rest of the digestive tract). Circular muscles contract to make the section of the esophagus (or other part of the digestive tract) just 'upstream' of the food (called the bolus just after swallowing) to become smaller in diameter, this squeezing the bolus further down the esophagus. Longitudinal muscles act in opposition and will now contract allowing that same section causing the esophagus to increase in diameter (and shortened in length). This process repeats continually along the length of the esophagus in waves of contraction causing the bolus to be pushed to the stomach.
 10. What are the functions of the stomach? Be specific!

Name: _____

Date: _____

Functions of Stomach:

- 1) It stores food until small intestine is ready for another small quantity. This allows us to eat a large quantity of food in a short time and then digest and absorb it over the period of hours.
- 2) Its 3 layers of muscles churn the food, mixing it with gastric secretions and creating a pasty material called chyme (acidic)
- 3) It produces gastric juice containing:
- a) HCl which: -kills most bacteria
-breaks down connective tissue of meat
-creates an acidic environment which activates the digestive enzyme Pepsin
 - b) Pepsin which: comes from the precursor pepsinogen breaks down protein into peptides
- Pepsin
Protein + H₂O → peptides

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11. a) What is gastric juice? b) Where exactly is it produced? c) List the three main ingredients of gastric juice d) How is it activated?

Gastric Juice: a) Gastric means stomach therefore "juices of the stomach"

-are stomach secretions designed to kill bacteria and breakdown proteins into peptides.

b) Gastric juice is created by cells of the gastric gland which is located in the wall of the stomach

c) Gastric juices consists of:

i) HCl

ii) Pepsinogen (becomes Pepsin in presence of HCl)

iii) Water

d) Is activated when HCl mixes with Pepsinogen to produce the active enzyme Pepsin.

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12. What is the function of the following in digestion: a) pepsin b) water

a) Pepsin breaks protein down into peptides in the presence of water.

Pepsin

Protein + H₂O → peptides

b) Water: acts to mix the food, pepsin and HCl together.

-Also it provides the H⁺ and OH⁻ that are 'tacked onto the resulting peptides after hydrolysis of Protein.

13. a) How come, if your stomach is full of acid and protein-digesting enzymes, doesn't it digest itself? b) What is an ulcer, and what causes them?

a) Even though stomach is full of HCl (pH3) it doesn't digest itself because specialized cells in the gastric gland produce a thick mucus that protects the walls of the stomach because HCl can't penetrate through the mucus.

b) An Ulcer is an open sore in the wall of the stomach. Caused by an over secretion of gastric juice due to too much nervous stimulation and for a bacterial infection that impairs the ability of cells to make the protective mucus.

14. How is the **structure** of the stomach **related** to its **function**?

Stomach structure related to function:

-3 layers of muscle to churn the food

-deep inward folds that allow the stomach to stretch expand for food storage

-millions of gastric pits that lead to the gastric juice producing gastric glands

-has 2 sphincters, cardiac and pyloric, that control food/chyme entering and leaving the stomach respectively

-mucus secreting cells protect stomach from HCl

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15. Give a one sentence description, using your own words, of the function of the following digestive components:

Name	Function
1. mouth	Mechanical digestion, chemical digestion of starch and tasting
2. pharynx	Region between mouth and esophagus where swallowing occurs
3. epiglottis	A flap of tissue that covers the opening to the trachea (glottis) during swallowing
4. cardiac sphincter	Circular muscle that can open and close the control movement of food into stomach from esophagus
5. esophagus	Line with mucus membrane, a long muscular tube uses peristalsis to send food from mouth to stomach
6. pepsinogen	A precursor molecule of gastric juice that forms Pepsin when mixed with HCl

16. Where does the majority of digestion take place?

Name: _____

Date: _____

The majority of digestion occurs in the duodenum, which is the 1st 25 cm of the small intestine.

17. Describe the structure of the small intestine, including the following words:

DIGESTION BASICS	
1. Majority of digestion takes place in this organ	Small intestine (Duodenum)
2. Length of this organ.	6m (20 ft)
3. Three parts of this organ are called:	1 duodenum
	2 jejunum
	3 ileum
4. How long is duodenum?	25 cm (10")
5. What controls flow of material into duodenum?	Pyloric sphincter at bottom of stomach opens periodically to empty some chyme into duodenum
6. What is this material that enters the duodenum called?	Chyme
7. What is main role of duodenum in digestion?	Secretions from liver and pancreas break down fats and peptides
8. What two organs produce secretions that end up in duodenum?	1 liver 2 pancreas
9. Liver produces what?	Bile
10. Why is it greenish in color?	Byproducts of hemoglobin breakdown (bilirubin and biliverdin)
11. Where is this substance stored?	Gall bladder
12. What does an emulsifying agent do?	Break fat into fat droplets
13. What do bile salts do?	Are the emulsifying agent for fat break up
14. What sodium compound does pancreatic juice contain?	Sodium bicarbonate (NaHCO ₃)
15. What does this substance do?	Neutralize acid chyme and makes small intestine pH basic
16. What 3 important enzymes does pancreatic juice contains	Name: Pancreatic amylase Function: digests starch to maltose
	Name: Trypsin Function: digests pepsin to peptides
	Name: Lipase Function: digests fat to fat acid and glycerol
17. What produces the intestinal juices in the small intestine?	Intestinal glands as in the walls of the small intestine
18. Where are these glands located?	In the walls
19. Two important intestinal juice enzymes and their functions are:	Name: Peptidases Function: digests pepsin to amino acids
	Name: Maltase Function: digests maltose to glucose
20. Draw a villus, and show the blood and lymph vessels within.	
21. Where does absorption take place?	Across the wall of each villus into blood and lymph vessels
22. Is this absorption passive? What does it require?	-can happen passively or when activated -active transport requires ATP
23. Where do sugars and amino acids go?	Into the blood via capillaries
24. Where do glycerol and fatty acids go?	Absorbed across microvilli, recombined into lipids and enter lacteal (leads to lymph system)

Name: _____

Date: _____

25.	What is the function of the hepatic portal vein?	Blood vessels from villi merge to hepatic portal vein which carries nutrients to the liver
26.	In your own words, list 6 functions of the liver.	1produces bile 2keeps blood (glucose) constant (glucose <-> glycogen conversion) 3removes toxins from blood 4destroys old red blood cells (bilirubin and biliverdin produced) 5produces Urea (deamination of amino acids) 6makes blood proteins (ie.fibrinogen) from amino acids

18. Explain how the large intestine is **structurally** and **functionally** different from the small intestine. What is the composition of **feces**?

Structurally the large intestine is shorter in length but larger in diameter (6.5 cm compared to 2.5 cm) than the small intestine. The colon has 3 parts: ascending, transverse and descending. Last 20 cm is rectum which opens at the anus.

Functionally unlike the small intestine, the large intestine doesn't digest food and absorb nutrients, rather it reabsorbs water from feces and absorbs certain vitamins, amino acids and other growth factors.

Feces is composed of indigestible food matter, water, bile pigments (gives it color), heavy metals and billions of E. coli bacteria (gives it its smell).

19. What is the name of the **main bacteria** present in the large intestine? What is its **function**?

Main bacteria present in large intestine is E. coli who's function is to produce some vitamins needed by our bodies and to break down non-digestible material

20. Make a table that explains how **hormones** control the release of digestive enzymes in the digestive system. Use the following as a template.

Hormone	Released by What Part, and in response to what?	Acts on What Part?	What does it do?
GASTRIN	-released by sensory cells in lower stomach -in response to stomach distending and protein in stomach	-cells of gastric gland in upper stomach	-secretion of gastric juices (i.e. Pepsinogen and HCl)
SECRETIN	-released by small intestine -in response to acid chyme from the stomach	-pancreas	-secretion of NaHCO ₃ to change chyme from acid to basic
CHOLECYSTOKININ	-released by small intestine -in response to amino acids and/or fatty acids in acid chyme	-pancreas and liver/gall bladder	-pancreas secretes pancreatic juice (i.e. pancreatic amylase, trypsin, lipase) -gall bladder contracts to release bile -liver increases output of bile
GIP	-released by small intestine -in response to fat rich acid chyme	-stomach	-inhibits stomach peristalsis and gastric gland secretion

21. List what Carbohydrates, fats, and proteins are ultimately broken down into.

Molecule Type	Where Digested	Broken Down Into
Carbohydrates	Mouth, small intestine	Glucose
Fats	Small intestine	Glycerol and fatty acids
Proteins	Stomach, small intestine	Amino acids

Name: _____

Date: _____

22. **Make a table** that lists the following information:

Enzyme	Secreted by:	Site of secretion	Optimum pH	Reactants	Product
Salivary Amylase	Salivary glands	Mouth	Neutral	Starch	Maltose
Maltase	Small intestine	Duodenum of small intestine	Alkaline (8.5)	Maltose	Glucose
Pepsin	(gastric glands) stomach	Stomach	Acidic (3)	Protein	Peptides
Pancreatic Amylase	Pancreas	Duodenum of small intestine	Alkaline	Starch	Maltose
Nucleases	Pancreas	Duodenum of small intestine	Alkaline	(DNA/RNA) nucleic acids	Nucleotides
Trypsin	Pancreas	Duodenum of small intestine	Alkaline	Protein	Peptides
Lipase	Pancreas	Duodenum of small intestine	Alkaline	Lipids (fat)	Glycerol and fatty acids

23. **Briefly** summarize the roles of the following molecules in human nutrition:

a. carbohydrates	b. proteins	c. fats
d. vitamins	e. minerals	

a) Carbohydrates: primary source of energy for cells; only fuel brain will use

b) Proteins: for development of

- structural tissue (e.g. muscle, skin, hair, nails)
- hemoglobin and plasma proteins
- enzymes
- hormones

- not ordinarily used as an energy source

c) Fats:

- phospholipid production
- padding around internal organs
- insulation
- long term storage of food energy

d) Vitamins:

- many are parts of coenzymes and thus help catalyze metabolic reactions (e.g. niacin is part of coenzyme NAD)
- organic compounds body can't make and therefore must be ingested with food

e) Minerals: Macronutrients have generalized important uses

i.e. Calcium makes up structural component of bone

Micronutrients have specific uses

i.e. Iron required for hemoglobin

24. List 4 **fat soluble** vitamins. Why is it **not** a good idea to ingest too much of these vitamins?

4 Fat Soluble Vitamins: Vitamins A, D, E, and K

- ingesting too much of these fat soluble vitamins can cause dangerous levels to build up in body's lipids. For e.g., too much vitamin A can cause hair loss, bone/joint pains and loss of appetite.

25. List 11 **water soluble vitamins**. Why are vitamins only needed in small amounts?

9 Water Soluble Vitamins:

- B Types include: B1 (Thiamine)
 B2 (Riboflavin)
 B3 (Niacin)
 B6 (Pyridoxine)
 B12 (Cobalamin)
 Folic Acid
 Pantothenic Acid
 Biotin

Vitamin C (Ascorbic Acid)

FAT - FAT

(B, C)