

Answers to Review for Unit Test: The Digestive System

1. Know the meaning of these terms:

heterotrophs	digestion	peristalsis	microvilli
autotrophs	chemical digestion	chyme	lacteal
intracellular digestion	physical digestion	enzymes	nutrients
extracellular digestion	absorption	sphincter	macromolecule
pouch digestive system	egestion	rugae	enzyme
tube digestive system	bolus	villi	substrate

2. Know the location and function of the following parts of the human digestive system:

Part	Location	Function
salivary glands	under tongue and at the back of the mouth	secrete saliva during chewing
pharynx	back of mouth and top of throat	where nasal passage and back of mouth join, entrance to the top of the esophagus
esophagus	tube connecting the pharynx to the stomach	delivers food by peristalsis from the mouth into the stomach
epiglottis	covers the opening to the trachea	folds over to cover the trachea during swallowing to prevent food and liquids from getting into the lungs
stomach	behind breastbone (sternum), below the diaphragm	<ul style="list-style-type: none"> • stores food • 'kneads' food, breaking it down (physical digestion) and mixing it with stomach secretions, making chyme • acts as a site where stomach acid and enzymes can be added to food to continue chemical digestion
cardiac sphincter	bottom of esophagus/top of stomach	keeps stomach contents from being squeezed back up into the esophagus (regurgitated) when the stomach muscles contract
pyloric sphincter	bottom of stomach/ beginning of duodenum	keeps stomach contents in the stomach long enough to mix well with acid and enzymes and be broken down physically by the stomach's kneading action
bile duct	between the gall bladder and duodenum	delivers bile from the gall bladder to the start of the duodenum, also joins with the pancreatic duct so that bile can mix with pancreatic secretions
liver	right side of abdomen, just behind the ribs and below the diaphragm	<ul style="list-style-type: none"> • makes bile, which is stored in the gall bladder • absorbs glucose from the blood and stores it as glycogen • absorbs and destroys toxins (poisons) in food such as alcohol and many medications/drugs • breaks down old RBCs and hemoglobin • stores fat soluble vitamins (A, D, E & K)
gall bladder	in between the lobes of the liver	stores bile and releases it into the duodenum when it is signalled by the hormone cholecystokinin
duodenum	first section of the small intestine, connects to stomach	<ul style="list-style-type: none"> • receives chyme from the stomach • major site of chemical digestion of food • secretes its own enzymes to digest chyme • secretes secretin to stimulate the pancreas and cholecystokinin (CCK) to stimulate the gall bladder to release bile into the duodenum • begins absorption of nutrients into the blood
pancreas	in the loop between the bottom of the stomach and the first loop of the duodenum	<ul style="list-style-type: none"> • secretes carbonate/bicarbonate into the duodenum to neutralize the acidic chyme • secretes digestive enzymes that act in the duodenum • secretes insulin into the blood stream to increase the uptake of glucose out of the blood by muscle and fat (adipose) cells

2. Know the location and function of the following parts of the human digestive system:

Part (continued)	Location	Function
jejunum	middle section of the small intestine	<ul style="list-style-type: none"> • digestion finishes here • major site of absorption of nutrients into the blood, and fat into the lymph
ileum	last section of the small intestine, joins to the large intestine	<ul style="list-style-type: none"> • absorption is completed here • pushes indigestible wastes left in the small intestine into the large intestine • some bacteria live here and produce vitamins B12 and K which the body uses
ileoocaecal valve	sphincter between the small intestine (ileum) and large intestine (caecum)	<ul style="list-style-type: none"> • controls the movement of indigestible material from the small intestine into the large intestine
caecum	bulge at the beginning of the large intestine	<ul style="list-style-type: none"> • the 'blind end' of the large intestine • in some herbivores (horses, rabbits and others) the caecum is large and holds bacteria that help to digest some plant material in the large intestine
appendix	hangs off the caecum	<ul style="list-style-type: none"> • does not have a role in digestion • may have a function in the immune system, but we don't know for sure (you can survive very nicely without one)
large intestine (the colon)	starts in the lower right-side of the abdomen, loops up the right side, across behind the stomach and down the left side of the abdomen, then joins the rectum	<ul style="list-style-type: none"> • major site for the absorption of water and minerals from the indigestible material, forming feces • bacteria live in the large intestine which digest some of the fecal material and also produce vitamins which are absorbed and used
rectum	a short section of the large intestine, just before the anus	<ul style="list-style-type: none"> • stores feces until there are enough wastes to be eliminated (egested) out of the body
anus	a sphincter at the end of the rectum	<ul style="list-style-type: none"> • controls the passage of feces out of the body

3. Know the secretions that are involved in digestion, including where they are made, where they act and what each secretion does:

Secretion	Where it is Made and Acts	What it Does
saliva	Made in salivary glands in mouth. Acts in the mouth as food is being chewed.	<ul style="list-style-type: none"> • moistens and lubricates food to assist with swallowing • contains amylase to begin the chemical digestion of starch • contains lysozyme to kill bacteria in food
mucus (mucin)	Made in cells lining the esophagus and stomach Acts in the esophagus and stomach	<ul style="list-style-type: none"> • lubricates the esophagus to assist swallowing • a thick layer of mucus in the stomach protects the stomach from being digested by stomach acid and enzymes
hydrochloric acid (HCl)	Made in cells lining the stomach Acts in the stomach	<ul style="list-style-type: none"> • chemically digests some nutrients, especially protein • kills bacteria • activates some enzymes (eg pepsinogen to pepsin) and provides the correct conditions for these enzymes to work
gastric enzymes	Made in cells lining the stomach Act in the stomach (and some act in the small intestine)	<ul style="list-style-type: none"> • lipases, carbohydrases and proteases continue the chemical digestion of macromolecules that was started in the mouth

sodium bicarbonate	Made in the pancreas Acts in the duodenum	<ul style="list-style-type: none"> secreted into the duodenum to neutralize the acidic chyme and create the correct pH for the optimal functioning of pancreatic enzymes
pancreatic enzymes	Made in the pancreas Acts in the duodenum and jejunum	<ul style="list-style-type: none"> lipases, carbohydrases and proteases continue the chemical digestion of macromolecules that was started in the mouth and stomach
bile	Made in the liver Stored in the gall bladder Acts in the duodenum	<ul style="list-style-type: none"> secreted into the duodenum to help neutralize the acidic chyme and create the correct pH for the optimal functioning of pancreatic enzymes emulsifies fat to create tiny fat droplets and increase their surface area to improve digestion and absorption
intestinal enzymes	Made in the walls of the duodenum Act in the duodenum	<ul style="list-style-type: none"> intestinal enzymes continue the chemical digestion of macromolecules that was started in the mouth and stomach

4. Know the macromolecules and their subunits, including:
 - a) proteins: made of amino acids
 - b) triglycerides: made of glycerol and three fatty acids
 - c) three different polysaccharides and their subunits: glycogen, starch and cellulose
 - all are made of glucose (subunit)
 - d) three different monosaccharides: glucose, fructose and galactose
 - e) three different disaccharides: sucrose (glucose + fructose), maltose (glucose + glucose) and lactose (glucose and galactose)

5. Review the chemical tests for starch, simple sugars, proteins and fats. What indicators are used for each? Describe the appearance of a positive result.
 - a) starch: add Lugol's iodine solution; if starch is present Lugol's iodine will turn from yellow to black
 - b) simple sugars: add Benedict's solution and heat for three minutes; if simple sugars are present Benedict's will turn from blue to orange
 - c) proteins: add Biuret solution; if protein is present, Biuret will turn from blue to violet
 - d) fats: rub onto plain paper and let dry; if fat is present the paper will turn from opaque to translucent

6. How is the digestive system of an earthworm superior to that of a Cnidaria (jellyfish or sea anemone)?

Cnidaria have a pouch-like digestive system with just one opening that acts as both a mouth and an anus

- food and wastes mix in the internal cavity so digestion is inefficient
- there are no grinding organs to increase surface area, digestion is simply chemical
- the surface area of the internal cavity is not that large, so absorption of nutrients is inefficient
- when wastes are expelled, some valuable food may also be expelled with it

Earthworms have a tube-like digestive system with both a mouth and an anus

- food moves one way through the tube, so food and wastes are not mixed
- the earthworm has a crop where food can be stored and a muscular gizzard which grinds up soil (sand) and organic material to increase the surface area
- the long tube allows food to pass slowly for complete digestion before wastes are egested
- the long tube provides a relatively large surface area where absorption can take place

7. Compare and contrast:

a) intracellular and extracellular digestion

Similarities:

- both involve digestive enzymes and exocytosis
- both are carried out primarily by eukaryotic cells

Intracellular digestion takes place inside the cell

- food is engulfed and brought into the cell by endocytosis where it forms a food vacuole
- lysosomes join to the food vacuole and release their digestive enzymes into the vacuole where they digest the food
- nutrients pass out of the food vacuole into the cytoplasm by diffusion
- indigestible material passes out of the cell by exocytosis

Extracellular digestion takes place outside of the cell

- enzymes are secreted out of the cell by exocytosis, into the cell's environment
- enzymes digest whatever they encounter outside the cell
- digested molecules (subunits) are absorbed into the cell by diffusion and wastes remain outside of the cell

b) physical and chemical digestion

Similarities:

- both break down large particles of food and macromolecules into smaller subunits
- both take place in the mouth, in the stomach and in the small intestine

Differences:

- physical digestion breaks down food particles into smaller food particles, while chemical digestion breaks down macromolecules into smaller subunits
- physical digestion does not break chemical bonds, chemical digestion does
- physical digestion does not involve acids or enzymes which chemical digestion does

c) the large intestine and the small intestine

Similarities:

- both are involved in digestion and absorption
- both are found in the abdomen
- both have chyme/wastes move through them by contraction of smooth muscles

Differences:

- small intestine does peristalsis (regular rhythmic waves) while the large intestine does not have such regular wave-like motion
- small intestine has villi and microvilli for absorption of nutrients while the large intestine does not have villi or microvilli
- small intestine is very long with a smaller diameter while the large intestine is shorter with a larger diameter
- small intestine is the major site of digestion and absorption of all nutrients, while the large intestine is basically for the absorption of water and minerals
- the small intestine does not have as many bacteria living in it as the large intestine does

d) ingestion and digestion

Similarities:

- both are part of the digestive process
- the mouth is involved in both

Differences:

- ingestion refers to the intake of food
- digestion refers to the breakdown of food once it is inside the organism

e) the trachea and the esophagus

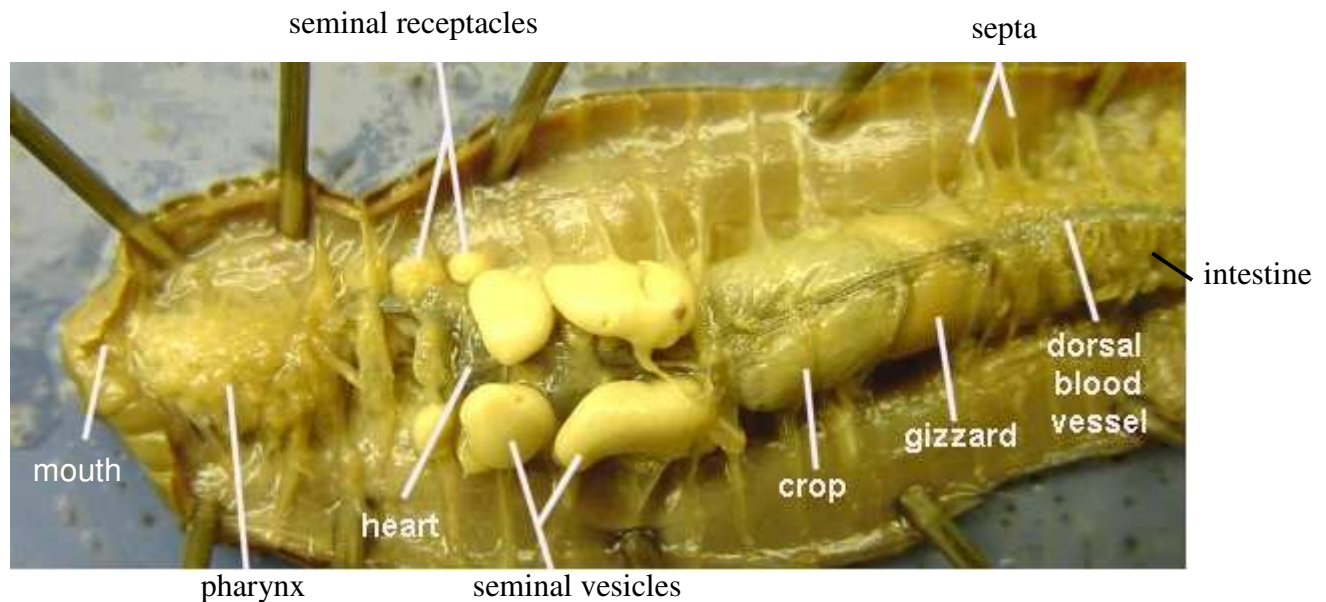
Similarities:

- both are tubes that start at the pharynx (back of the mouth, top of the throat)
- both are involved in bringing materials into the body
- both have mucus along their lining

Differences:

- the trachea is the ‘windpipe’ – it transports air into and out of the lungs while the esophagus transports food from the mouth to the stomach
- the trachea has cartilage rings to hold it open and is not surrounded by smooth muscle so it does not contract
- the esophagus has no cartilage rings so it is closed unless food is moving through it; it is surrounded by two layers of smooth muscle which contract to push food along
- the trachea is not designed to have liquids or food in it, only air while the esophagus is designed to carry liquids and food but not air

8. Be able to label a diagram of an earthworm. Know the function of each of the major parts of the **digestive system** of the earthworm (crop, gizzard and intestine). The ‘hearts’ are really aortic arches. (see dissection sheet)



9. Know the six types of nutrients required by the human body. For each nutrient:
- a) state whether or not it needs to be digested in order to be absorbed
 - b) if it is digested, what are its breakdown products (subunits)

Refer to your answers to the Question sheet on the Nutrients. You may ask questions in class.

10. Fibre is known as the “essential non-nutrient”. Why is fibre important for good health?
- fiber refers to the cellulose and other indigestible material in our food
 - it is not digested or absorbed, so it remains in the digestive system
 - fiber slows down the absorption of sugars from the small intestine and helps to prevent “sugar spikes” after eating a meal
 - fiber is good for health because it holds water in the large intestine, keeping the feces softer and preventing constipation
 - fiber adds “bulk” to the feces so it stimulates the large intestine to move wastes more quickly through the colon and this helps to remove toxins from the body and may decrease the risk of cancer
 - fiber binds fat and cholesterol and helps to move it out of the body, lowering the amount of lipids in the blood
 - fiber ‘sweeps’ its way along the colon, taking bacteria along with it, preventing the overgrowth of bacteria in the colon

11. Review the material from the “Introduction to Nutrients” question page. Some of this material is review from our first unit on macromolecules. Know the function(s) of:
- two minerals
 - two vitamins
 - proteins (know 4 functions)
 - lipids (know 4 functions of fats and 4 functions of cholesterol) and
 - carbohydrates (know one function in animals)

12. Review the function of enzymes and how they work.

- a) What is the role of enzymes in digestion?

Macromolecules in food (proteins, starch and triglycerides) are too large to be absorbed into cells. Digestive enzymes break the chemical bonds between the subunits of macromolecules, separating the subunits from one another. The subunits are small enough to be absorbed into the cells.

- b) What factors affect how well an enzyme functions?

Enzymes are proteins that are folded in a particular way to create the active site where the substrate fits. Enzymes work best at a certain pH, salt concentration and temperature so these must be maintained in order for enzymes to function at their best.

13. Mucus has different functions in different parts of the body. What is the function of mucus in the:

- nasal cavity and respiratory system: traps dirt and pathogens in the mucus so they can be coughed up out of the trachea or blown out of the nose and nasal cavity (sinuses)
- esophagus: lubricates and helps the bolus of food move through the esophagus more easily
- stomach: a thick layer of mucus protects the cells lining the stomach from being digested by stomach acid and enzymes

14. Pathogens may enter the digestive system along with food and water.

- What enzyme is found in saliva that kills bacteria in the mouth? **lysozyme**
- What secretion(s) of the stomach kill bacteria? **hydrochloric acid**

15. What happens in the following disorders of the digestive system:

- gastric ulcers: the mucus lining of the stomach is too thin in places (or the acidity is too high), so the stomach acid and enzymes start to digest the stomach lining, creating an ulcer
- ‘heartburn’ (acid reflux aka GERD: gastroesophageal reflux disease): the cardiac sphincter does not hold the top of the stomach closed, so acidic chyme from the stomach moves up into the esophagus. The esophagus does not have a thick protective layer of mucus so the stomach acid irritates and starts to digest the lining of the esophagus, creating a burning sensation. Because the esophagus sits just in front of the heart, many people think that their “heart is burning” (but it isn’t)
- gallstones: the bile salts in the gall bladder form crystals which can grow quite large and create a gallstone. If the gallstone gets pushed down into the bile duct, it can block the bile duct and prevent bile from leaving the gall bladder. The bile backs up into the liver and can damage the liver. People can have their gall bladders removed; they just have to be careful not to eat too much fat at once because they no longer can squirt bile into the duodenum to emulsify fat for better digestion.

16. Many aspects of digestion and absorption involve increasing surface area.

- Give four specific examples of where/when surface area is increased to improve digestion or absorption.
 - chewing/grinding food in the mouth increases the surface area of food particles so that digestive enzymes can work more efficiently
 - the kneading action of the stomach breaks down food particles into smaller pieces so that digestive enzymes can work more efficiently
 - bile emulsifies fats into small fat droplets to increase their surface area for more effective enzyme action
 - folds in the stomach called rugae increase the surface area of the stomach to increase the secretion of digestive enzymes and increase the surface area of absorption for a small number of molecules
 - folds, villi and microvilli in the small intestine increase the surface area of the intestine for more effective absorption of nutrients

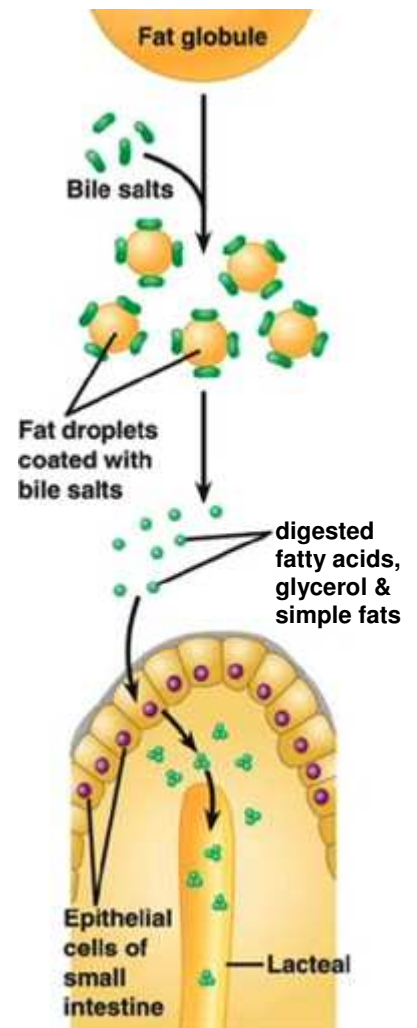
- b) Why is it so important to increase surface area?
- chemical reactions can only take place along the exposed surfaces of food particles so by increasing the surface area, the reaction rate increases, speeding up digestion
 - similarly, absorption can only take place along the surface of the small intestine, so a larger surface area makes absorption more efficient

17. A student has a plate of nachos for a snack after school. It has tortilla chips (fat and starch), chili (protein), cheese (fat and protein), onions and peppers (fiber).

- a) Beginning in the mouth, describe all of the different locations and ways that physical and chemical digestion occur.
- b) Describe where/how the subunits of digestion are absorbed and how wastes are eliminated.

The answer to this question is a combination of the material in questions 2 and 3 (above). Very briefly:

- the nachoes are taken into the mouth where they are chewed to increase the surface area of the food particles (physical digestion). Saliva is secreted into mouth where it mixes with the food to moisten and lubricate it for easier swallowing. Amylase in the saliva begins the chemical digestion of starch.
- the nachos move down the esophagus and into the stomach by peristalsis. In the stomach the food is mixed with hydrochloric acid, which kills bacteria and chemically digests proteins. Gastric (stomach) enzymes continue the chemical digestion while the kneading action of the stomach physically breaks down food particles and increases their surface area for digestion. The food plus gastric juices is called chyme.
- the chyme moves through the pyloric sphincter into the duodenum where it is mixed with bile. Bile emulsifies fat into tiny droplets, increasing the surface area for absorption (physical digestion). Pancreatic juice enters the duodenum where it neutralizes the chyme and provides the correct conditions for chemical digestion of protein, starch, fats and other macromolecules by pancreatic enzymes. The duodenum also secretes enzymes which contribute to chemical digestion of all nutrients.
- the chyme moves along to the jejunum where chemical digestion is completed and the majority of absorption takes place from the intestine into the blood. Subunits from the digestion of macromolecules (simple sugars, amino acids and some glycerol and fatty acids) are absorbed into the cells lining the small intestine by diffusion (simple or facilitated) and from there diffuse into the blood. Fat is absorbed into lacteals which carry the fat into the lymphatic system which later mixes with the blood. Absorption is completed in the ileum.
- the undigested matter passes into the large intestine where water and minerals are absorbed. The remaining fiber is compacted into feces and egested from the anus.



18. Label the parts of the digestive system:

