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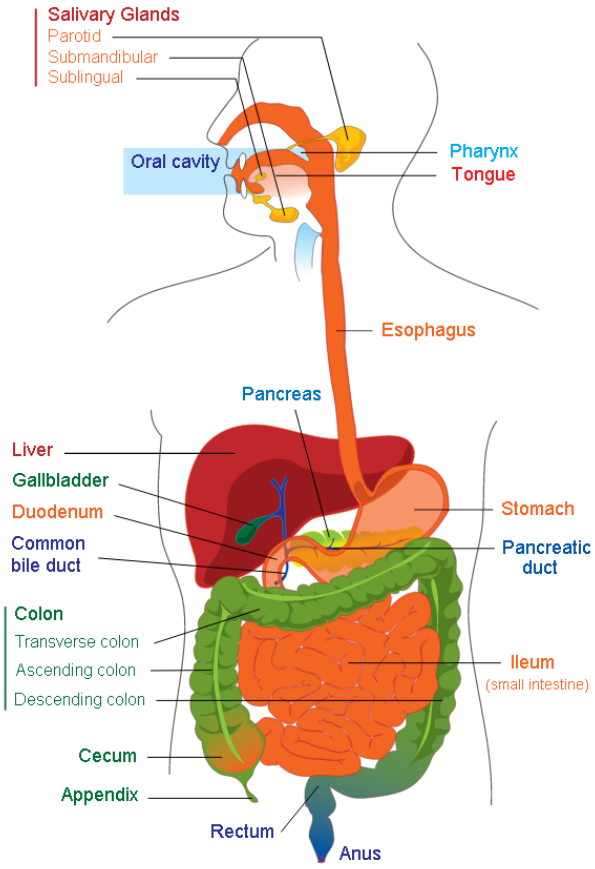
Review Sheet: Enzymes, the Digestive System, and Nutrition

Be able to label a diagram of the digestive system.



You need to know the function(s) of each part of the digestive system and its accessory organs (salivary glands, pancreas, liver, gall bladder). Since structure fits function, also consider and be able to describe how the structure of these organs allows them to perform their functions well.

Part	Function	Form/Structure	Other
mouth (oral cavity)	ingestion		first part of digestive system
- teeth	mechanical breakdown	strong incisors for holding on molars for grinding food canines for tearing food	depends on food
- tongue	physical digestion moving the bolus	4 intrinsic and 4 extrinsic muscles to change shape and move	some consider it the strongest muscle
- salivary glands	release saliva		three pairs begins secreting upon

			sensing food parotid, sublingual, and submandible glands
- saliva	digestion moistening	amylase: breaking down starch lysozyme: kill bacteria glycoproteins: lubricate foods buffers: neutralize acids in the foods, prevent cavities	first chemical digestion
pharynx (throat)	food passes through here		leads into mouth, nose, eyes, ears, esophagus, and trachea
- larynx (voicebox)	moves up when swallowing, triggers epiglottis		
- epiglottis	moves down to prevent food from going down the trachea	a flap at the back of the throat	
esophagus	carries food from mouth to stomach	mucus: lubricate food circular smooth muscles move food by peristalsis long, skinny elastic: to allow food to pass muscular: to push food by peristalsis	25 centimeters long first area with peristalsis
stomach	store food mix food kill bacteria break down proteins	pepsin: breaks down proteins HCl: activate pepsinogen to pepsin, kill bacteria, break down foods mucus: protect stomach lining muscular sac	food called chyme now does most of the mechanical break down two sphincters are called cardiac and pyloric sphincters
intestines	chemically break down and absorb food		three sections: duodenum, ileum, and jejunum
small intestine	break down and absorb food	2.5cm wide 6m long	99% of digestion happens here (digestion and absorption- and some in the large intestine and the stomach and mouth as well)
duodenum	do most of the chemical breakdown of foods	enzymes, bases from pancreas bile from liver and	short

		gallbladder enzymes from lining (disaccharide enzymes: maltase, sucrase, lactase)	
liver	produce bile regulate blood nutrients after being absorbed	bile: emulsify fats	in a “strategic position” between the intestines and the heart - so it can supply enzymes and bile to the duodenum and absorb nutrients from the ileum, jejunum, and large intestine has over 500 functions in the human body (digestion is just a little bit) largest gland in the body, with multiple lobes that function differently
gallbladder	store bile concentrate bile secrete bile (along with liver)		connected to liver and duodenum (with bile duct)
pancreas	produce digestive enzymes produce bases produce hormones to regulate blood sugar	most enzymes- to break down all four basic macromolecules (amylase, trypsin, ghinotrypsin, peptidases, nucleases, lipase) sodium bicarbonate: neutralize stomach acid glucagon and insulin: regulate blood sugar (glucagon to increase blood sugar, insulin to store blood sugar (deficiency is called diabetes))	
ileum and jejunum	absorb most nutrients to the body	covered in waves, covered in villi, covered in microvilli, and has many capillaries and lymph vessels inside it	absorbs all molecules small enough; the liver detoxifies and filters out unneeded / harmful molecules absorption happens often through diffusion, but sometimes transport proteins (“pumps” to force nutrients in when the concentration inside is higher than outside)

villi	absorb nutrients (in ileum and jejunum)	have microvilli have capillaries have lacteals	cells in villi reassemble lipids before moving them away
microvilli	absorb nutrients (on villi)	the nutrients actually land in here wavy so that nutrients can get trapped	where the absorption happens absorbed nutrients move by diffusion
capillary	carry nutrients away		most macromolecules and absorbed materials go into here (e.g. amino acids, monosaccharides, nucleic acids) eventually empty into venuoles -> hepatic portal vein -> liver -> heart -> body
lacteal	carry lipids away		only lipids go into here (too large when assembled to fit in the capillaries) eventually empty into the hepatic portal vein
large intestine (colon)	absorb water create nutrients		much wider than small intestine
cecum	houses digestive bacteria		short in humans long in vegetarians food is called feces by now separated into the ascending, transverse, and descending colon
- appendix	houses digestive bacteria (in cecum)	E. coli: break down cellulose, create vitamin K (more prominent in herbivores; eat probiotics to help; antibiotics kill it and can cause diarrhea; need these to live in baby when it is newborn) white blood cells: part of our immune system, contribute to immunity	a vestigial structure in humans now prone to infection from food getting stuck in it
rectum	stores feces		
anus	expel waste (feces)	has a sphincter	the only sphincter we can control

You need to know the vocabulary of the digestive process (e.g., bolus, chyme, peristalsis, sphincters, mechanical/physical digestion, chemical digestion, ducts, villi, microvilli, lacteals, capillaries, ingestion, digestion, elimination, alkaline, gastrin, chief cells, parietal cells, etc).

Term	**Definition**
herbivore	an organism that can eat plants and plant products only
carnivore	an organisms that can eat animals and products only
omnivore	an organism that can eat both categories of food (meat and vegetables)
alimentary canal	a digestive tract with two openings, an anus and a mouth
crop	pouch-like organ that stores and softens food
stomach	a muscular sac that churns and grinds food
gizzard	a specialized stomach that uses the help of abrasive materials, especially rocks and dirt
accessory organ	an organ that aids in the digestion of food , but does not have food pass through it, typically by secreting enzymes or other digestive fluids
bolus	food after it leaves the mouth (mixed with saliva, chewed up)
chyme	food after it leaves the stomach (proteins broken down, mixed more)
feces	waste products without nutrients (food after it leaves the large intestine)
peristalsis	a wavelike, involuntary contraction of smooth muscle to move food through the digestive tract
sphincter	a circular ring of muscle that contracts most of the time but opens for short amounts of time to let food pass; a weak sphincter may cause problems such as acid reflux
mechanical digestion	the physical breakdown of food into smaller particles, but not changing the type of molecule
chemical digestion	the chemical breakdown of food into smaller molecules, changing the molecule and having a chemical reaction; usually happens through hydrolysis
duct	a tube that carries a fluid (typically a certain secretion, such as bile) from one bodily part/organ to another
villi	a projection inside the ileum and jejunum that absorbs nutrients to capillaries and lacteals

microvilli	smaller projections on the surface of the cells of villi that are the actual absorptive surface; nutrients move in here by diffusion
lacteal	a lymph vessel that absorbs lipids
capillary	a blood vessel that absorbs nutrients in the digestive system, leading to venuoles and the hepatic portal vein
ingestion	the first step of digestion; the act of eating, or moving food into the body
digestion	the second step of digestion; the act of breaking down food into pieces small enough for absorption
absorption	the third step of digestion; the act of transferring essential nutrients from the food into the body
elimination	the last step of digestion; the act of removing feces (unabsorbed and nutrient-poor waste from the food) from the body
alkaline	synonym of basic; pancreatic juice includes an alkaline substance, sodium bicarbonate, that helps neutralize stomach acid
gastrin	a hormone that is created when sensing food (either by the senses or in the stomach), and is sent out in the bloodstream to stimulate the creation of gastric juices; is stopped by a negative-feedback loop when the pH is below 3 in the stomach
gastric juice	the secretion of the lining of the stomach; includes mucus from the mucous cells, pepsinogen from the chief cells, and H^+ and Cl^- ions from the parietal cells
chief cells	secrete (inactive) pepsinogen into gastric lumen; will activate in the lumen
parietal cells	secrete H^+ and Cl^- ions into the gastric lumen; will combine in the lumen
mucous cells	secrete mucus into the gastric lumen
lumen	the cavity, or open space, of a certain body part (e.g. a stomach, blood vessel, small intestine)

Other Vocab

Term	**Definition**
artery	a blood vessel that carries blood away from the heart (usually oxygenated)
arteriole	a smaller branch of an artery

vein	a blood vessel that carries blood back from the heart (usually deoxygenated)
venuole	a smaller branch of a vein
hepatic portal vein	the vein that carries all the blood from the intestines straight to the liver (before the heart) so that it can be filtered and regulated first
capillary	a tiny blood vessel where the exchange of oxygen for waste materials takes place, and where nutrients are picked up in the intestines
extracellular / interstitial fluid	the fluid between cells - nutrients sometimes flow in here so that cells in a certain area (not always adjacent to the capillary) can exchange nutrients

Be able to describe common problems with our digestive systems (GERD, ulcers, diarrhea, constipation), what causes them, and treatments.

GERD (chronic acid reflux)

- caused by a weak cardiac sphincter
- stop smoking and drinking (weaken body as a whole)
- lose weight, eat small meals (less volume in stomach, so less likely to go up to esophagus)
- don't sleep after eating, sleep with head up (so gravity pulls stomach acid away from esophagus)
- medications to reduce stomach acidity
- medicines to impede acid production
- surgery to strengthen cardiac sphincter

(stomach) ulcers

- originally thought to be stress, aspirin, smoking, alcohol, coffee
- caused by H. pylori, which burrows into the stomach lining and affects the mucous cells
- cured with antibiotics and bismuth

diarrhea

- when food moves too quickly through the large intestine, because the body wants to get it out (usually because of infection), and not enough water is absorbed

constipation

- when water moves too slowly through the large intestine because peristalsis doesn't move it fast enough (not enough fiber in diet)

(extra) hemorrhoids

- swollen veins in the anal canal
- caused by excessive strain
- prevented with enough fiber
- can be removed by surgery

(extra) diverticulitis

- when bulging sacs in the large intestine (or anywhere in the digestive system) get swollen and infected

Be able to describe why organisms need to eat. What does food provide? Describe the three nutritional needs of all organisms.

food provides:

- energy
- building blocks
- other nutrients:

nutritional needs:

- macromolecules, organic molecules
- vitamins
- minerals

Be able to describe the four classes of essential nutrients. Distinguish between vitamins and minerals. Describe coenzymes as a link between vitamins and enzymes.

- essential fatty acids
    - fatty acids that we cannot create by ourselves but are still essential to our living
- essential amino acids
    - amino acids that we cannot create by ourselves but are still essential to our living
    - typically, single vegetables are "incomplete" - that is, not having all the essential amino acids. But sometimes a group of two vegetables (e.g. corn and beans) will have all of them (including histamine for infants)
- vitamins
    - organic, essential molecules that are essential to our health in very minute quantities
    - B vitamins function as coenzymes
    - B, C vitamins are water-soluble
    - A, D, E, K vitamins are fat-soluble
- minerals
    - inorganic elements necessary in our body in minute amounts

Describe the obesity epidemic in the United States. Explain how diet and exercise can influence the risks of cardiovascular disease and cancer. Include an explanation of the differences between HDL and LDL cholesterol.

More and more people are getting obese, meaning that they accumulate too much fat, in the U.S.A. and other developed countries. This can lead to many serious health problems and a lower standard of living. It has doubled to over 30% in the U.S. in the last two decades. There are a few causes for it: genetics; leptin deficiencies; and evolutionary adaptations to survive. Included in this epidemic are cholesterol. LDL cholesterol blocks arteries, increases the risk for cardiovascular disease, and increase blood pressure. People are eating too much trans and saturated fat, not exercising enough, and smoking too much, which cause the increase in LDL and lower HDL.

Be able to accurately and in detail answer all of the "You Should Now Be Able To" statements at the end of the Digestion and Nutrition PowerPoint.

Other

evolutionary adaptations of the digestive system

- size of stomach
    - carnivores have large, expandable stomachs - may not get to eat for days, must spend long time digesting the same food
    - herbivores have steady source of food, not large stomachs
- length of digestive tract
    - herbivores need to digest tough cellulose, have a much longer digestive tract than carnivores
    - meat is relatively easy to digest, and carnivores have shorter digestive tracts
- size of cecum
    - carnivores have small cecums, because they do not really need it - it stores food so that bacteria can digest the cellulose in it
- ruminants

    - some herbivores who eat a lot of tough plants, such as cows and grass, have multiple stomachs, and are called ruminants, which allow them to digest food multiple times, including digestion of the cellulose by the bacteria in their gut

feeders

- substrate
    - eat through their food
    - worms
    - maggots
- fluid
    - only drink nutritional rich substances
    - mosquitoes
    - hummingbirds
- bulk
    - eating large chunks at a time
    - humans
    - most animals
- suspension
    - strain a substance, usually water, for food
    - baleen whales

Heimlich maneuver

- use fist and press up into diaphragm
- will increase pressure into lungs and force air into the trachea, hopefully popping food out

feedback loops

- positive
    - continue a reaction indefinitely
    - end product stimulates the production of more end product, starting cycle over and over and over forevermore
    - pepsinogen turns into pepsin with the help of pepsin, which continues to activate pepsin proteins
- negative
    - stops the reaction
    - makes the reaction have a specific stopping point, once the reaction is finished, to achieve homeostasis- so that there is not too much of the reaction
    - gastrin is created to stimulate the stomach juice; when the acidity is too strong, the gastrin is affected by the acidity, and stops to function

Don Boone

- man who had his intestines sucked out by a change in pressure
- survived, but with nutrition problems
- 5 year-old girl had similar ordeal

another form of digestion

- within a cell, a food vacuole attaches to lysosome with enzymes that digest it
- happens in single-celled protists

functions of macromolecules

- fats help absorb fat-soluble vitamins (A, D, E, K)
- fats help regulate cells
- pectin is a form of starch, but is branched
- dietary fiber is the food (usually carbohydrates) that body cannot digest
    - (water-)soluble fibers
        - turn into a gel
        - let absorption take longer, slows it down

        - makes you feel full longer
        - oats, fruits
    - (water-)insoluble fibers
        - adds bulk to waste
        - allows food to move more easily throughout
        - grains, vegetables