NAME _____ LAB TIME/DATE _____

REVIEW SHEET
exercise
39A

Chemical and Physical Processes of Digestion: Wet Lab

Chemical Digestion of Foodstuffs: Enzymatic Action

1. Match the following definitions with the proper choices from the key.

Key: a. catalyst b. control c. enzyme d. substrate

a; catalyst 1. increases the rate of a chemical reaction without becoming part of the product

b; control 2. provides a standard of comparison for test results

c; enzyme 3. biologic catalyst; protein in nature

d; substrate 4. substance on which a catalyst works

2. List the three characteristics of enzymes. *Specificity (act on one or a small number of substrates); temperature specific; pH specific.*

3. The enzymes of the digestive system are classified as hydrolases. What does this mean?

Hydrolases break down organic food molecules by adding water to the molecular bonds, thus cleaving the bonds between the subunits or monomers.

4. Fill in the following chart about the various digestive system enzymes encountered in this exercise.

Enzyme	Organ producing it	Site of action	Substrate(s)	Optimal pH
Salivary amylase	*salivary glands*	*oral cavity*	*starch*	*6.7–7.0*
Trypsin	*pancreas*	*small intestine*	*proteins*	*8.0*
Lipase (pancreatic)	*pancreas*	*small intestine*	*starch, fats, proteins, etc.*	*7.4–8.0*

5. Name the end products of digestion for the following types of foods.

proteins: *amino acids* carbohydrates: *simple sugars*

fats: *fatty acids* and *glycerol (monoglycerides)*

6. You used several indicators or tests in the laboratory to determine the presence or absence of certain substances. Choose the correct test or indicator from the key to correspond to the condition described below.

Key: a. IKI (Lugol's iodine) b. Benedict's solution c. litmus d. BAPNA

d 1. used to test for protein hydrolysis, which was indicated by a yellow color

a 2. used to test for the presence of starch, which was indicated by blue-black color

c 3. used to test for the presence of fatty acids, which was evidenced by a color change from blue to pink

b 4. used to test for the presence of reducing sugars (maltose, sucrose, glucose) as indicated by a blue to green color change

7. What conclusions can you draw when an experimental sample gives both a positive starch test and a positive maltose test after incubation? *Starch digestion is partial (incomplete).*

Why was 37°C the optimal incubation temperature? *It is body temperature.*

Why did very little, if any, starch digestion occur in test tube 4A? *The enzyme was destroyed by boiling.*

If starch was incubated with amylase at 0°C, would you expect to see any starch digestion? *no*

Why or why not? *Amylase has an optimal temperature closer to that of the human body. At 0°C, the rate of enzyme activity and diffusion of enzymes and substrate has slowed to near zero.*

Assume you have made the statement to a group of your peers that amylase is capable of starch hydrolysis to maltose. If you had not done control tube 1A, what objection to your statement could be raised? *A positive maltose test could also result from maltose contamination of the starting amylase solution.*

What if you had not done tube 2A? *#2A proves that we started with starch, and it was not contaminated with maltose.*

8. In the exercise concerning trypsin function, why was an enzyme assay like Benedict's or Lugol's IKI (which test for the presence of a reaction product) not necessary? *The enzyme assay is "built in" to the substrate BAPNA. Peptide bond cleavage results in a yellow color.*

Why was tube 1T necessary? *Tube 1T was a control to prove that trypsin did not turn yellow by itself.*

Why was tube 2T necessary? *Tube 2T proved that BAPNA did not turn yellow by itself.*

Trypsin is a protease similar to pepsin, the protein-digesting enzyme in the stomach. Would trypsin work well in the stomach? *No* Why? *The pH optimum for trypsin is slightly basic; the pH optimum for pepsin is acidic (stomach is acidic).*

9. In the procedure concerning pancreatic lipase digestion of fats and the action of bile salts, how did the appearance of tubes 1E and 2E differ? *1E—2 layers; oil over water. 2E—fat droplets dispersed.*

Can you explain the difference? *Bile, present in tube 2E, acted to emulsify the fat.*

Why did the litmus indicator change from blue to pink during fat hydrolysis? *Fatty acids decreased the pH. Litmus cream is an indicator that changes from blue to red as the pH changes from alkaline to basic conditions.*

Why is bile not considered an enzyme? *Bile only physically separates the fat droplets. It does not break the molecular bonds as do the digestive enzymes.*

How did the tubes containing bile compare with those not containing bile? *The tubes containing bile showed more hydrolysis than those not containing bile.*

What role does bile play in fat digestion? *Emulsification of fat by bile increases the surface area for lipase activity.*

10. The three-dimensional structure of a functional protein is altered by intense heat or nonphysiological pH even though peptide bonds may not break. Such inactivation is called denaturation, and denatured enzymes are nonfunctional. Explain why.

Their three-dimensional structures and active sites are necessary for their activity. If their structures are changed, they are inactivated.

What specific experimental conditions resulted in denatured enzymes? *Boiling the enzyme solution in all experiments denatured the enzymes.*

11. Pancreatic and intestinal enzymes operate optimally at a pH that is slightly alkaline, yet the chyme entering the duodenum from the stomach is very acid. How is the proper pH for the functioning of the pancreatic-intestinal enzymes ensured?

The pancreas delivers its enzymes to the small intestine in an alkaline-rich (HCO_3^-) fluid.

12. Assume you have been chewing a piece of bread for 5 or 6 minutes. How would you expect its taste to change during this interval? *The bread would begin to taste sweet.*

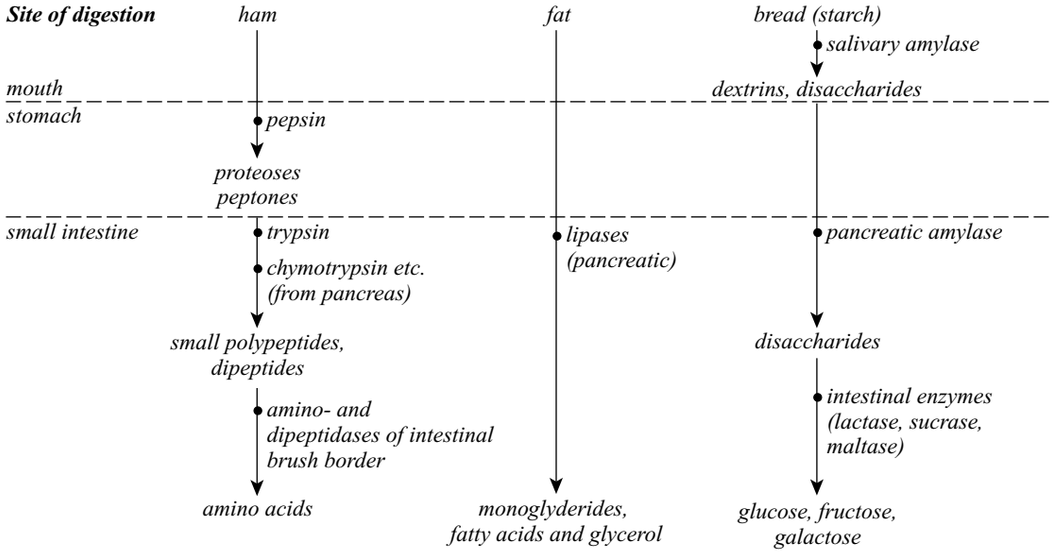
Why? *Starch is broken down to glucose by amylase.*

13. Note the mechanism of absorption (passive or active transport) of the following food breakdown products, and indicate by a check mark (✓) whether the absorption would result in their movement into the blood capillaries or the lymph capillaries (lacteals).

Substance	Mechanism of absorption	Blood	Lymph
Monosaccharides	*Most by active transport*	✓	
Fatty acids and glycerol	*Diffusion*	*Some*	*Most*
Amino acids	*Active transport*	✓	
Water	*Osmosis (diffusion)*	✓	
Na^+, Cl^-, Ca^{2+}	*Na^+, Ca^{2+} active transport; Cl^- diffusion*	✓	

14. People on a strict diet to lose weight begin to metabolize stored fats at an accelerated rate. How does this condition affect blood pH? *It would become acidic (decreased pH).*

15. Using a flow chart, trace the pathway of a ham sandwich (ham = protein and fat; bread = starch) from the mouth to the site of absorption of its breakdown products, noting where digestion occurs and what specific enzymes are involved.



16. Some of the digestive organs have groups of secretory cells that liberate hormones (parahormones) into the blood. These exert an effect on the digestive process by acting on other cells or structures and causing them to release digestive enzymes, expel bile, or increase the mobility of the digestive tract. For each hormone below, note the organ producing the hormone and its effects on the digestive process. Include the target organs affected.

Hormone	Produced by	Target organ(s) and effects
Secretin	*intestinal mucosa*	*It stimulates (1) the pancreas to release bicarbonate-rich fluid, and (2) the liver to secrete bile.*
Gastrin	*stomach cells*	*Gastrin acts on the stomach glands to increase their secretory activity (particularly of HCl).*
Cholecystokinin	*intestinal cells*	*It stimulates release of enzymes from the pancreas, causes gall bladder contraction, and inhibits gastric secretion.*

Physical Processes: Mechanisms of Food Propulsion and Mixing

17. Complete the following statements.

Swallowing, or__1__, occurs in two phases—the__2__and__3__. One of these phases, the__4__phase, is voluntary. During the voluntary phase, the__5__is used to push the food into the back of the throat. During swallowing, the__6__rises to ensure that its passageway is covered by the epiglottis so that the ingested substances don't enter the respiratory passageways. It is possible to swallow water while standing on your head because the water is carried along the esophagus involuntarily by the process of__7__. The pressure exerted by the foodstuffs on the__8__sphincter causes it to open, allowing the foodstuffs to enter the stomach.

The two major types of propulsive movements that occur in the small intestine are__9__and__10__. One of these movements, the__11__, acts to continually mix the foods and to increase the absorption rate by moving different parts of the chyme mass over the intestinal mucosa, but has less of a role in moving foods along the digestive tract.

1. *deglutition*
2. *buccal*
3. *pharyngeal-esophageal*
4. *buccal*
5. *tongue*
6. *larynx*
7. *peristalsis*
8. *gastroesophageal*
9. *peristaltic*
10. *segmental*
11. *segmental*