Enzymes on the Move

Follow a meal through changing pH conditions

HAP.13.5 "Research and analyze the activity of digestive enzymes within different organs of the digestive tract, connecting enzyme function to environmental factors such as pH."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each digestive enzyme, circle the pH near where it works, and number the organs in the order food reaches them. Use your marks to track how changing conditions affect digestion.

One Meal, Three Environments

1. Imagine eating a bite of bread topped with egg and olive oil. In the mouth, chewing mixes the food with saliva. Salivary amylase begins breaking starch in the bread into smaller sugars. This enzyme works well near pH 7, about the pH of saliva, but it does not digest egg protein or oil. Swallowing carries the same mixture into the stomach, where gastric juice has a pH near 2. Acid stops most salivary amylase activity. As a result, an enzyme that was useful seconds earlier contributes little to starch digestion in the stomach.

2. The stomach releases pepsin as an inactive precursor, pepsinogen. Stomach acid helps turn pepsinogen into pepsin, which cuts proteins such as those in egg into shorter chains. Pepsin is most active in strongly acidic conditions, around pH 2; near pH 7, its activity is very low. The stomach's mucus layer helps protect its lining from acid and enzymes. These observations show why the same acidic setting can shut down one digestive enzyme while supporting another. Although the food contains oil, pepsin does not break fats apart: an enzyme must encounter a suitable molecule as well as suitable conditions.

3. When the meal moves into the small intestine, pancreatic juice supplies bicarbonate that raises the pH of the partly digested food to roughly 7 to 8. Pancreatic amylase continues starch digestion, pancreatic lipase breaks fats into fatty acids and other smaller products, and trypsin cuts protein chains into shorter pieces. These enzymes function best at about neutral to slightly alkaline pH. If stomach acid were not neutralized, their activity would fall. To compare enzymes fairly in a laboratory, researchers can place equal amounts of an enzyme and its food molecule in samples with different pH values, then measure product formed over the same time.

2 ANSWER WITH EVIDENCE

Use the passage

1. Why does starch in the bread begin breaking down in the mouth but break down more slowly after it enters the stomach?

2. As egg protein moves from the stomach to the small intestine, how do the pH and the enzymes that digest it change?

3. Why can pancreatic lipase help digest the olive oil in the small intestine while pepsin cannot digest it in the stomach? Include both pH and what each enzyme acts on.

4. A student tests pancreatic amylase with starch at pH 2 and pH 8. Which sample should form more sugar? Name two conditions to keep the same for a fair test.

3 YOUR TURN

Your own words

Design a brief test to find out whether stomach-like or small-intestine-like pH is better for a protein-digesting enzyme you choose from the passage. Name the enzyme and protein sample, the two pH conditions, one condition you would keep the same, what you would measure, and your predicted result with a reason.

Enzymes on the Move

PART 1 · READ AND MARK

Underline each digestive enzyme, circle the pH near where it works, and number the organs in the order food reaches them. Use your marks to track how changing conditions affect digestion. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Why does starch in the bread begin breaking down in the mouth but break down more slowly after it enters the stomach?	**Salivary amylase digests starch near the mouth's pH of 7, but the stomach's pH near 2 stops most of its activity.**
2	As egg protein moves from the stomach to the small intestine, how do the pH and the enzymes that digest it change?	**In the acidic stomach, pepsin cuts the protein into shorter chains. In the small intestine, bicarbonate raises the pH to about 7 to 8, where trypsin cuts protein chains further.**
3	Why can pancreatic lipase help digest the olive oil in the small intestine while pepsin cannot digest it in the stomach? Include both pH and what each enzyme acts on.	**Pancreatic lipase acts on fats such as olive oil at the small intestine's roughly neutral to slightly alkaline pH. Pepsin works in the stomach's acidic pH, but it acts on proteins, not fats.**
4	A student tests pancreatic amylase with starch at pH 2 and pH 8. Which sample should form more sugar? Name two conditions to keep the same for a fair test.	**The pH 8 sample should form more sugar. Keep the amounts of pancreatic amylase and starch the same, and measure both after the same amount of time.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would put equal amounts of pepsin into two samples containing equal amounts of egg protein. I would set one sample to pH 2 and the other to pH 8, then keep both at the same temperature. After 20 minutes, I would measure how much protein had been broken into shorter chains. I predict more protein digestion at pH 2 because pepsin is most active in the stomach's strongly acidic conditions.

Accept either pepsin or trypsin in the proposed test if the predicted pH effect matches the passage. A valid plan compares pH while keeping at least one other condition constant and measuring protein digestion.