

Environmental Impacts on Enzyme Function

Learning objective 3.2.A Explain how environmental factors — temperature, pH and concentration — affect the structure and function of an enzyme.

Name: _____

Date: _____

Period: _____

Use the tool **Push It Too Far**. Part 1 and Part 2 use the **Temperature and pH** tab, Part 3 uses **Concentration**, and Parts 4 and 5 use **Two inhibitors**. Every claim in this topic is the shape of a graph, so sketch the shape **before** you write the sentence.

Part 1 • Where each enzyme works fastest

Select each enzyme in turn. Use **Fetch a fresh batch of enzyme** between enzymes so you always start with an intact sample, then read the rate at each condition in the table.

Enzyme	Optimum temperature	Rate at 37 °C	Rate at pH 7	Rate at pH 2
A human enzyme				
Pepsin				
Hot-spring enzyme				

1. Describe the shape of the rate-against-temperature graph, from well below the optimum to well above it.

2. Pepsin and the human enzyme have the same optimum temperature but very different optimum pH values. Explain why there is no single pH that is best for enzymes in general.

Part 2 · What comes back and what does not

Select **A human enzyme** and press **Fetch a fresh batch of enzyme**. Carry out each row of the table in order, using a fresh batch at the start of every row.

What you do	Rate at the end	Site intact or denatured?
Set the temperature to 47 °C		
...then back to 37 °C		
Fresh batch, then 57 °C		
...then back to 37 °C		
Fresh batch, then pH 12		
...then back to pH 7		

3. Two of the rows above returned to a working rate and two did not. State what separates them.

4. Explain, in terms of protein structure, why cooling a denatured enzyme back to its optimum temperature does not restore the reaction.

5. A student heats an enzyme to 60 °C, sees the reaction stop, cools it to 37 °C and predicts the reaction will restart. Evaluate the prediction.

Part 3 · Two things that raise the rate, and one ceiling

Switch to **Concentration** with **1× enzyme** selected. Move the substrate slider to each value and record the rate and the gain the readout shows.

[S]	Rate	Gain from the last +25	Share of the maximum
25			
50			
100			
200			
400			

6. Describe what happens to the size of each gain as substrate is added, and explain why.

7. Leave the substrate slider at 400 and switch to 2× enzyme. State what happened to the rate and to the maximum rate available, and explain the difference between this change and the one in question 6.

8. A reaction has levelled off although substrate is still being added. State what is limiting the rate and describe one change that would raise it.

Part 4 · Two inhibitors, one experiment

Switch to **Two inhibitors**. Press **Set [S] to 25** and record the top row, then press **Flood it with substrate** and record the bottom row.

Substrate	No inhibitor	Competitive	Non-competitive
[S] = 25			
[S] = 600			

9. Explain why a single rate measurement at $[S] = 25$ cannot tell you which inhibitor is present.

10. Describe an experiment that would distinguish the two, and state the result that would indicate each.

Part 5 · Identify three flasks

Use **Identify the inhibitor**. Work three flasks. For each one, record the two rates you are given, your answer, and — in one sentence — the reason.

Flask	Rate at ordinary [S]	Rate when flooded	Your answer	Reason
1				
2				
3				

11. State the single number you relied on most, and explain why that one is decisive.

12. A competitive inhibitor is present. Predict what would happen to the reaction rate if the substrate concentration were doubled, and explain your prediction.

The three enzymes are representative rather than measured. Pepsin's optimum pH of about 2 and its inactivation near neutral pH are real; the hot-spring enzyme stands in for the thermostable enzymes of thermophilic bacteria.