AP BIOLOGY · UNIT 3 · TOPIC 3.1

Enzymes · The Active Site

Learning objective 3.1.A Explain how enzymes catalyze reactions, and how the structure of an enzyme determines which reaction it catalyzes.

Name: Date: Period:

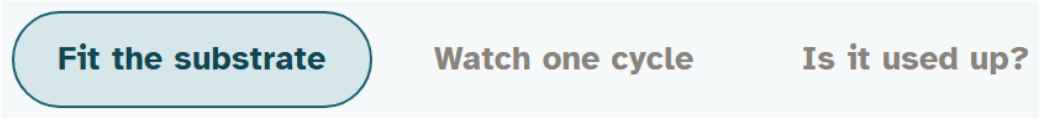
Use the tool **The Shape of the Site**. Work on the **Fit the substrate** tab for Parts 1 and 2, **Watch one cycle** for Part 3, and **Is it used up?** for Part 4. Drag each substrate into the active site, and look closely at the ones that nearly fit.

switch tab *scroll down* *predict first*

record from the tool *score yourself*

The purple bar in the margin names the AP science practice a question uses.

Part 1 · Which substrate goes in



Use the **Fit the substrate** tab. It is the one showing when the tool opens.

Select **Enzyme A** and select each of the six substrates in turn. Drag each one into the active site. Record the shape and chemistry of each substrate and whether it bound.

Substrate	**Shape**	**Chemistry**	**Binds to Enzyme A?** *circle one*
Substrate 1			yes / no
Substrate 2			yes / no
Substrate 3			yes / no
Substrate 4			yes / no
Substrate 5			yes / no
Substrate 6			yes / no

1. The active site of Enzyme A is wedge-shaped and polar.
(a) Identify the substrate that bound to Enzyme A.

(b) Explain why only this substrate bound to Enzyme A.

Part 2 · The two ways a substrate can fail

Stay on the **Fit the substrate** tab.

Still with Enzyme A, select Substrate 2, drag it into the active site again, and read the tool's message. Do the same for Substrate 6. These are the two substrates that **nearly** worked. Record what was right and what was wrong about each one.

Substrate	**What was right about it**	**What was wrong**	**Did it bind?** *circle one*
Substrate 2			yes / no
Substrate 6			yes / no

2. Substrate 2 has the same wedge shape as the active site of Enzyme A but does not bind to it. Explain why Substrate 2 does not bind.

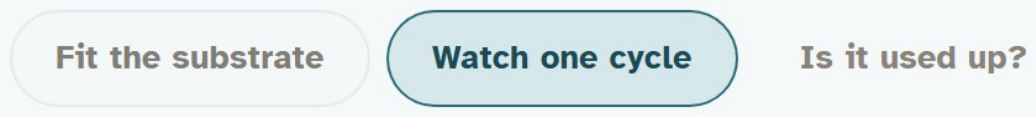
3. (a) Describe the active site of an enzyme.

(b) Describe what determines which substrate an enzyme acts on.

SP 6 · ARGUMENTATION

4. Open “Every possible site, and what it accepts” in the tool. Each of the nine possible active sites accepts exactly one substrate profile. Explain what this observation shows about the source of enzyme specificity.

Part 3 · One substrate, start to finish



Click the **Watch one cycle** tab at the top of the tool.

Read step 1, then press Next step to move through steps 2 to 5. Record what happens, the Substrate bound? readout and the **site opening** readout at every step.

Step	What happens	Substrate bound? *circle one*	Site opening
1		yes / no	
2		yes / no	
3		yes / no	
4		yes / no	
5		yes / no	

SP 1 · CONCEPT EXPLANATION

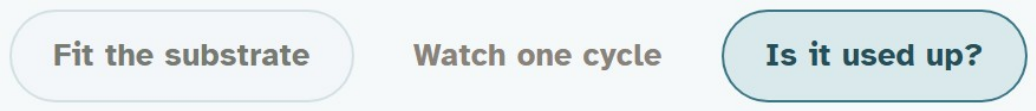
5. Identify the term for an enzyme together with the substrate bound in its active site.

6. (a) Describe the change in the shape of the enzyme when the substrate binds.

(b) Identify the term for this change.

7. The substrate stays bound in the active site through steps 2 to 4, but the product leaves at step 5. Explain why the product leaves the active site.

Part 4 · Is the enzyme used up?



Click the **Is it used up?** tab at the top of the tool.

Set the Enzyme molecules slider to 2 and the Substrate molecules slider to 24. Before you press any button, write in the Prediction row whether you predict the Enzyme readout will change. Then record the start row. Press Run one round and record the 1 round row, then press it twice more and record the 3 rounds row. Press Run to completion and record the all rounds row. In the Rounds run row, write the Rounds run readout.

After…	Enzyme	Substrate left	Product	Substrate + product
the start				
1 round				
3 rounds				
all rounds				
Prediction				
Rounds run				

8. In the Part 4 table, two columns have the same value in every row.
(a) Identify the two columns.

(b) Explain what the unchanging Enzyme column shows about the role of an enzyme in a reaction.

9. Set the Enzyme molecules slider to 6, leave the Substrate molecules slider at 24, and press Run to completion. Read the Rounds run readout.
(a) Describe the effect of increasing the enzyme from 2 to 6 molecules on the number of rounds needed to finish.

(b) Describe the effect of increasing the enzyme on the final amount of product.

(c) Explain why more enzyme changed the number of rounds but not the final amount of product.

10. Explain why one enzyme molecule can catalyze many reactions.

Part 5 · Learning check self-report

Scroll down to the **Learning check** at the bottom of the tool. Type an answer to each question, check it against the rubric, and check off the points you earned. Then record your score here and, for every point you did not earn, write what the rubric asked for that your answer left out.

Question	Points possible	Points I earned	Missed opportunities (what the rubric wanted that I left out)
1	2		
2	2		
3	2		
4	2		
Total	**8**		

What the model simplifies

An active site is drawn as a shape with a color for its chemical character. A real active site is a pocket formed by particular amino acid side groups, and its chemistry is the sum of all of them.

Binding here is all-or-nothing. Real binding varies in strength, and an enzyme will often act slowly on a substrate that is a poor but not impossible fit.

Induced fit is shown as the site closing by a fixed amount. The real change is small, continuous, and different for every enzyme.

Each enzyme completes one reaction per round, so all of them work at the same speed. Real enzymes differ enormously in how fast they cycle, and Topic 3.2 is about what changes that speed.

The CED places the specific chemical structures of individual enzymes and their substrates beyond the scope of the exam, so this tool deliberately models shape and chemical properties rather than real molecules.