SCIENCE FOUNDATIONS

Enzymes

Difficulty level: Intermediate

Science Foundations

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Overview of the concept

This is how your body digests lunch in minutes instead of hours, because enzymes speed up the chemical reactions inside you without being used up themselves. A laundry detergent uses enzymes to break down stains at a low wash temperature. A brewer uses enzymes to turn starch into the sugars that yeast can ferment. Knowing enzymes tells you why your body can run thousands of reactions quickly at body temperature, and what happens when an enzyme stops working properly.



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Rule

Enzymes: an enzyme is a biological catalyst that speeds up a reaction, by lowering the activation energy, the energy a reaction needs to get started, without being used up, so the same enzyme can be used again.

It works because its active site has a shape that fits its substrate, the substance the enzyme works on, and anything that changes that shape, like heat or extreme pH, very acidic or very alkaline conditions, stops it working.

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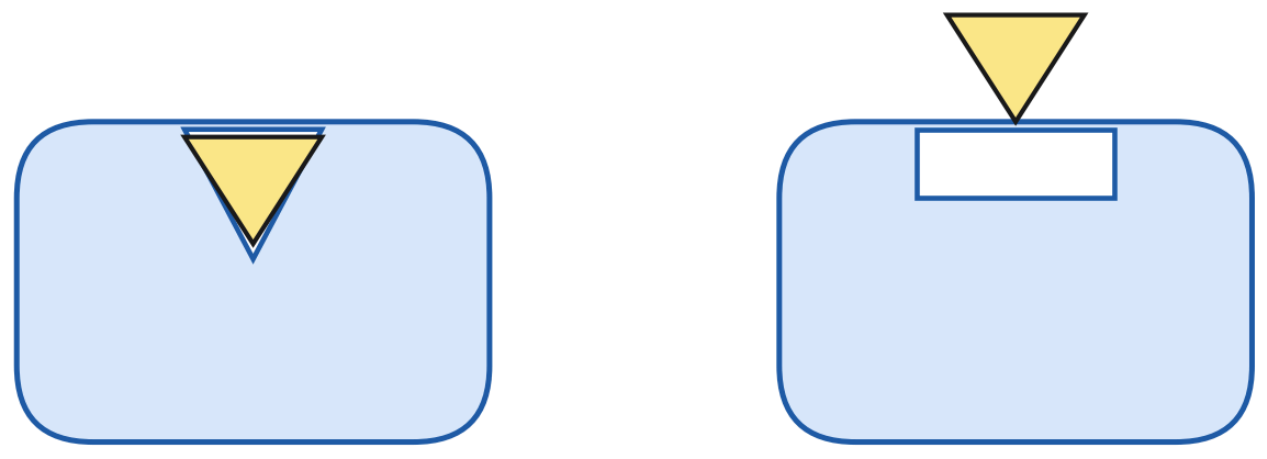
Worked examples

EXAMPLE 1

Q Why does heating an enzyme too much stop it working?



SOLUTION

Recall the shape rule: the active site shape must fit the substrate.

Heating denatures the enzyme: its shape changes.

Conclude: the substrate no longer fits, so the reaction stops.

Result: denatured enzyme, reaction stops.

This fit is often described as lock and key, or as induced fit, where the active site moulds itself around the substrate.

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EXAMPLE 2

Q An enzyme speeds a reaction. Is it used up?

SOLUTION

Recall the catalyst rule: catalysts are not used up.

Enzymes are biological catalysts.

Conclude: no, it can be reused.

The result is no, the enzyme is not used up.

Practice questions

1 A washing powder enzyme works well at 40 degrees C, but in near-boiling water the stains stay. Why did the hot water stop the enzyme working?

- **A** Heating denatured the enzyme, so the substrate no longer fits
- **B** The enzyme was used up in the wash
- **C** The hot water changed the stains
- **D** The enzyme dissolved in the hot water

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Lowering the activation energy does what to the speed of a reaction?

A Speeds it up

B Slows it down

C Stops it

D Does nothing

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3

One enzyme molecule helps 100 reactions happen, one after another. Is the enzyme used up?

A No, it can be reused

B Yes, it is used up after 100 reactions

C Yes, each reaction uses up one enzyme

D No, it turns into the product

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4 What is a substrate?

- A The substance the enzyme works on
- B The product of the reaction
- C The part of the enzyme that fits
- D The energy needed to start a reaction

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5 Enzymes are what kind of catalyst?

- A Biological catalysts
- B Reactants
- C Products
- D Substrates

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6 Active site definition?

A The part that fits the substrate

B The entire surface of the enzyme

C The substrate itself

D The product of the reaction

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7 What fits the active site?

A The substrate

B The product

C The enzyme

D The active site

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Extreme pH does what to an enzyme?

A Denatures it

B Speeds it up

C Uses it up

D Turns it into a substrate

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9

What does an enzyme lower?

A Activation energy

B The energy of the products

C The temperature of the reaction

D The amount of substrate

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Can one enzyme work on any substrate?

A No, each is specific

B Yes, any enzyme works on any substrate

C No, enzymes never work

D Yes, all enzymes are the same

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ANSWER KEY

1. Heating denatured the enzyme, so the substrate no longer fits
2. Speeds it up
3. No, it can be reused
4. The substance the enzyme works on
5. Biological catalysts
6. The part that fits the substrate
7. The substrate
8. Denatures it
9. Activation energy
10. No, each is specific

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