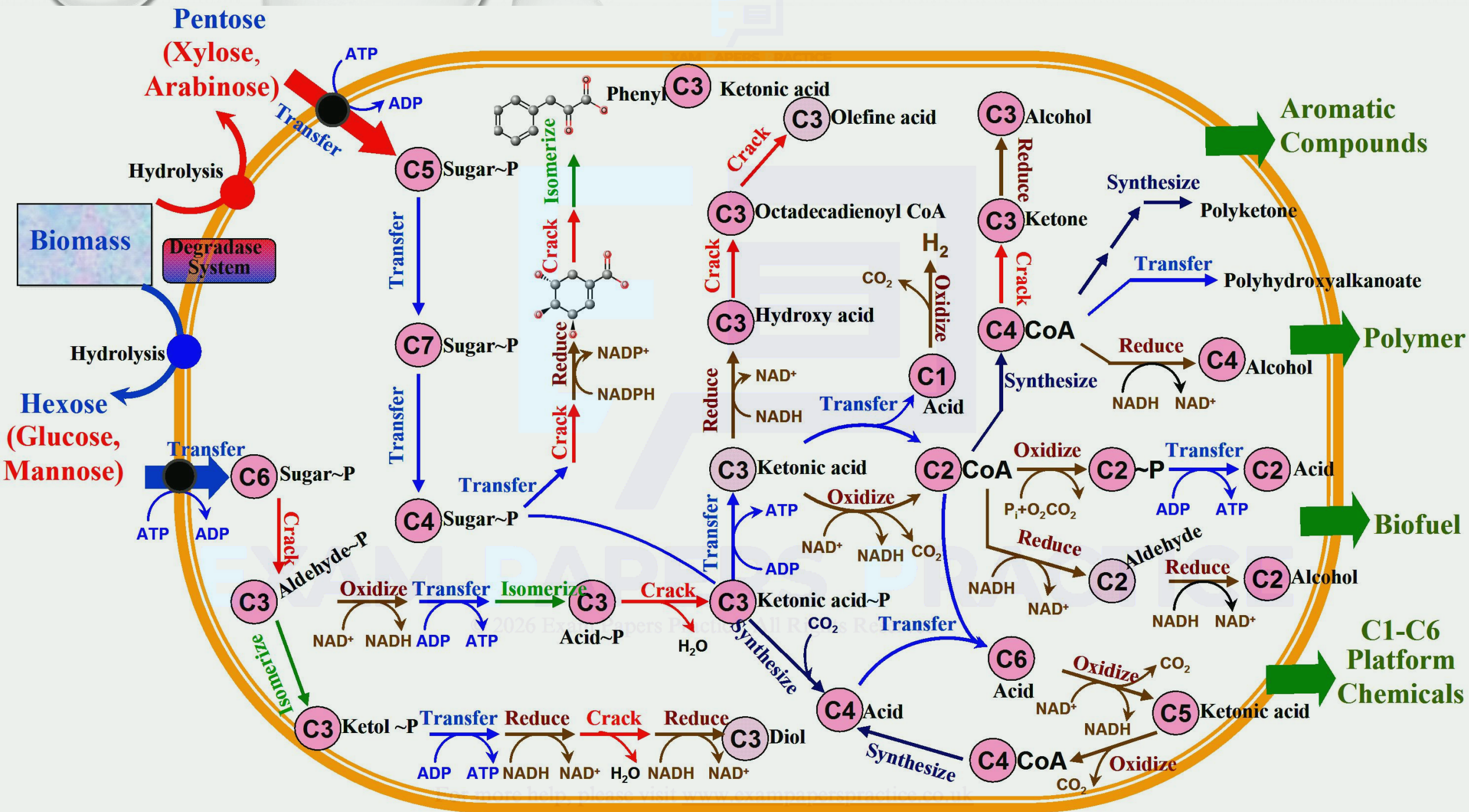




# Enzymes

## Biological catalysts

### Metabolic reaction (metabolism)

chemical reactions in living organism.

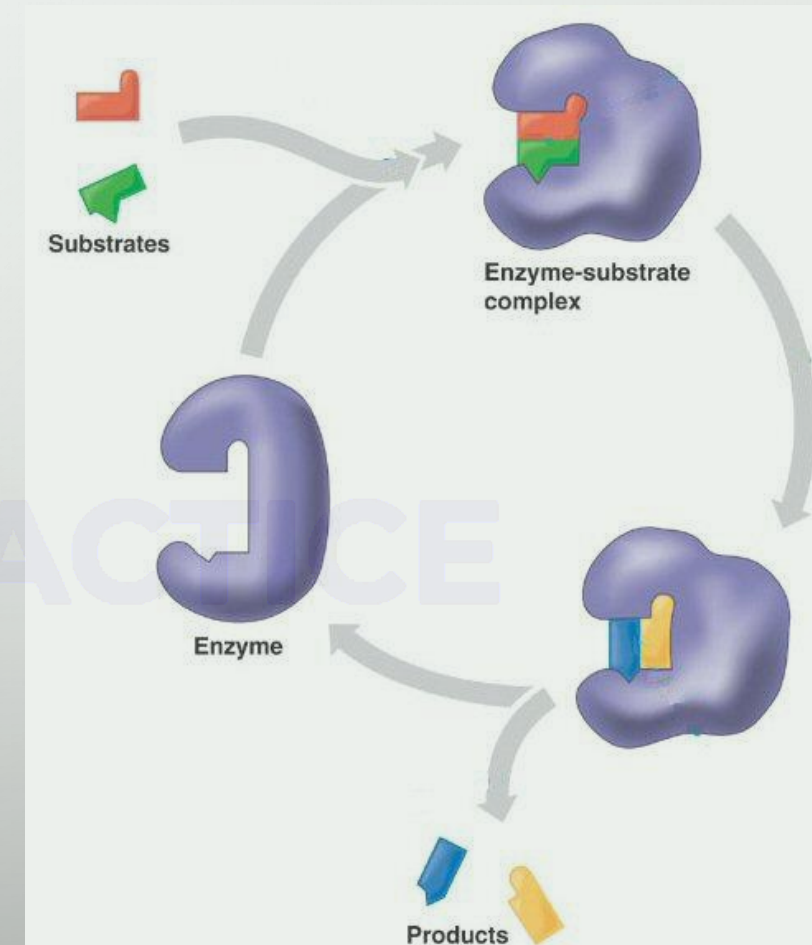
### catalyst

Some substances that **increase** the rate of the chemical reaction and **not changed** by the reaction.

### enzyme

**Proteins** that function as **biological catalysts**.

catalyst 催化剂  
catalyze 催化



# Enzymes

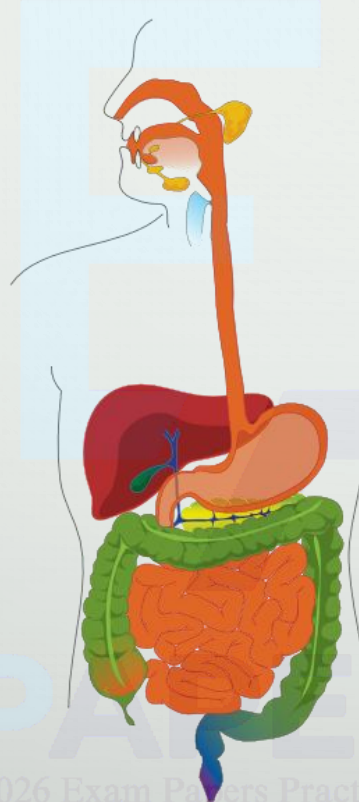
## Biological catalysts

**amylase**

Starch → maltose

**protease**

protein → amino acid



**Germination**  
(How a plant grows from a seed)



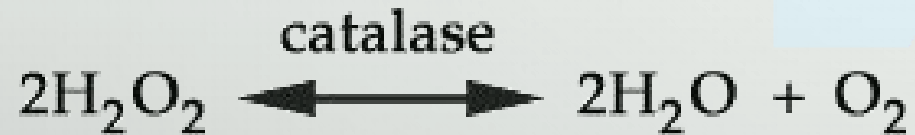
amylase 淀粉酶

# Enzymes

## Biological catalysts

hydrogen peroxide

catalase



**HYDROGEN PEROXIDE**

EXAM PAPERS PRACTICE

© 2026 Exam Papers Practice. All Rights Reserved

hydrogen peroxide 过氧化氢  
catalase 过氧化氢酶

# Enzymes

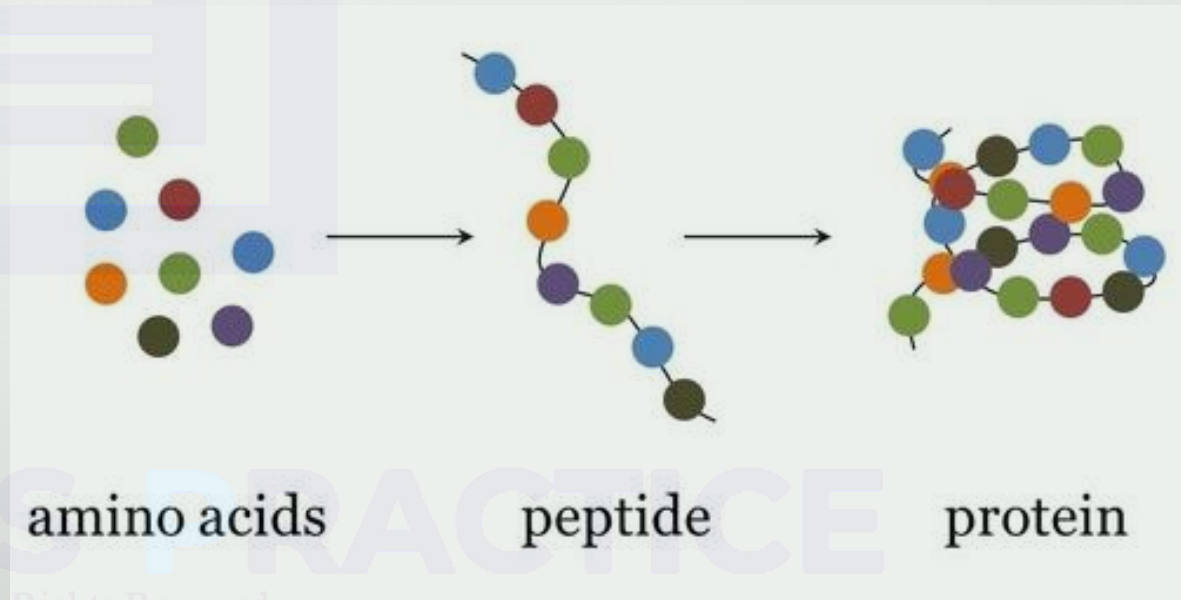
## Biological catalysts

enzymes

large molecules → → → small molecules

enzymes

small molecules → → → large molecules



© 2026 Exam Papers Practice. All Rights Reserved

# Enzymes

# Biological catalysts

## Naming enzymes

carbohydrase → catalyse the breakdown of carbohydrates

proteases → catalyse the breakdown of proteins

lipases → catalyse the breakdown of fats (lipids)

amylase → catalyse the breakdown of starch

maltase → catalyse the breakdown of maltose

sucrase → catalyse the breakdown of sucrose

|              |        |
|--------------|--------|
| amylase      | 淀粉酶    |
| carbohydrase | 碳水化合物酶 |
| protease     | 蛋白酶    |
| lipase       | 酯酶     |
| maltase      | 麦芽糖酶   |
| sucrase      | 蔗糖酶    |

# Enzymes

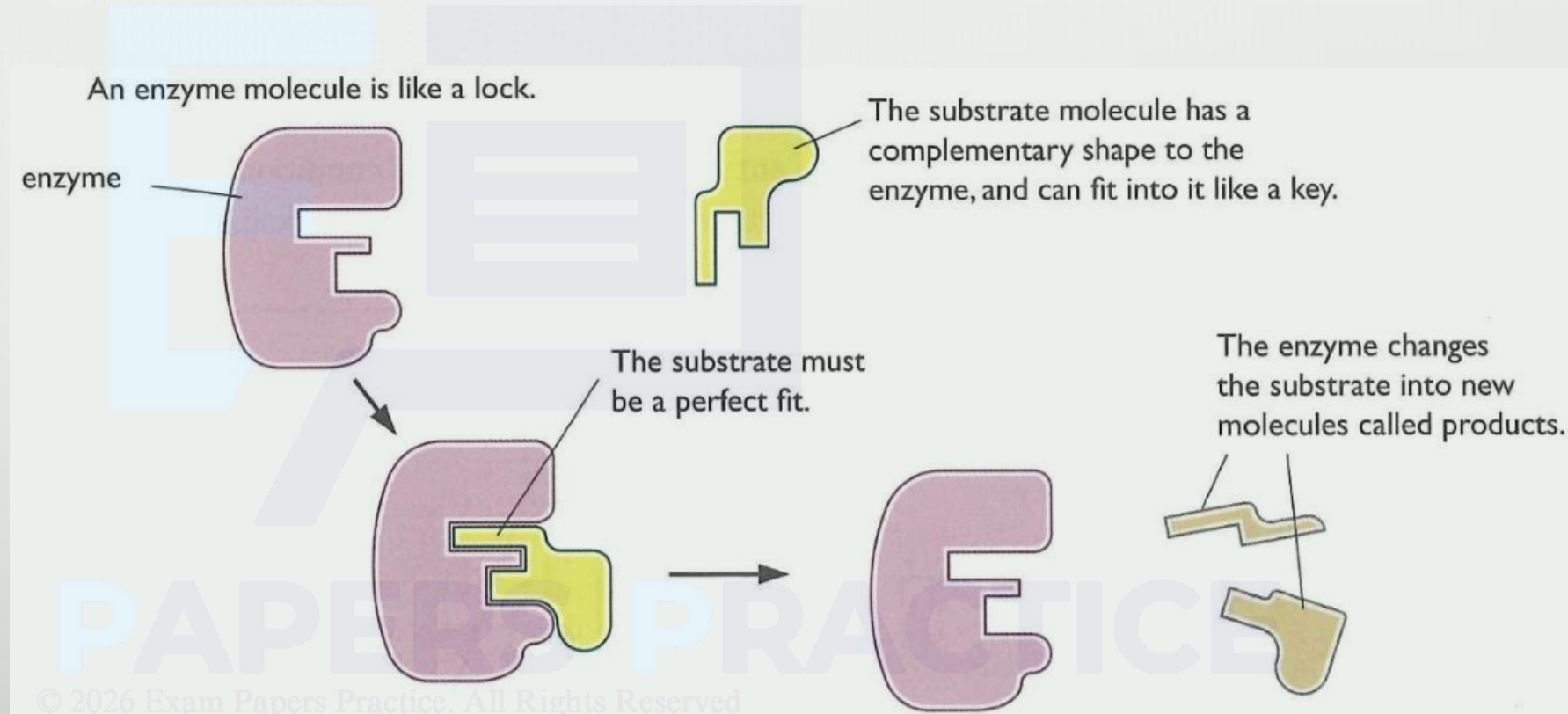
## Biological catalysts

### The lock and key mechanism

enzyme — lock

substrate — key

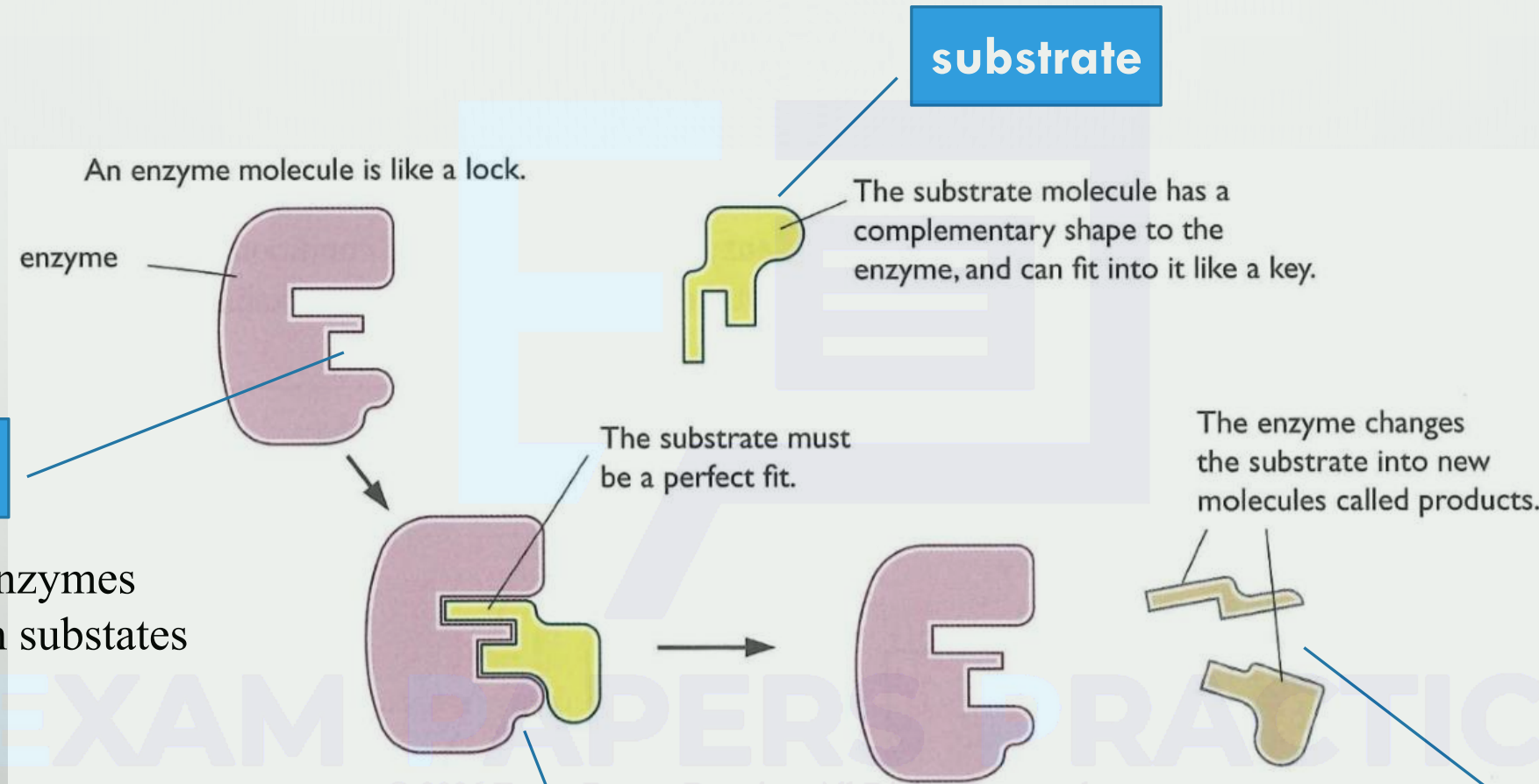
The shape of the enzyme and the shape of the substrate are complementary.



substrate底物  
complementary互补的

# Enzymes

# Biological catalysts



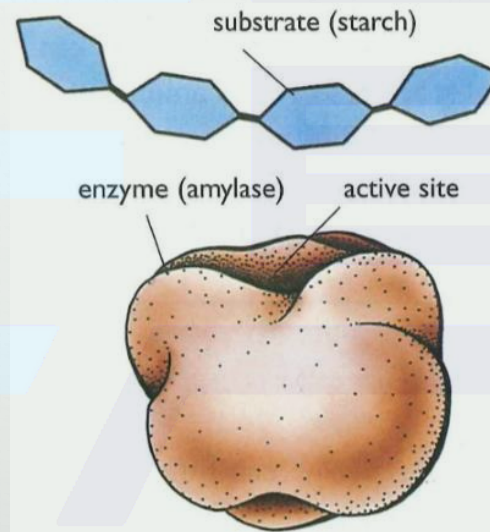
substrate底物  
product产物  
complex复合物  
active site活性位点

# Enzymes

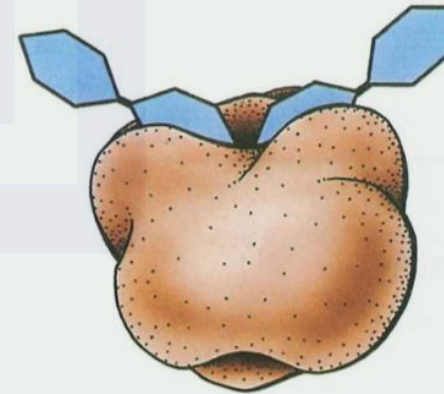
## Biological catalysts

Each enzyme has an active site that exactly fits its substrate.

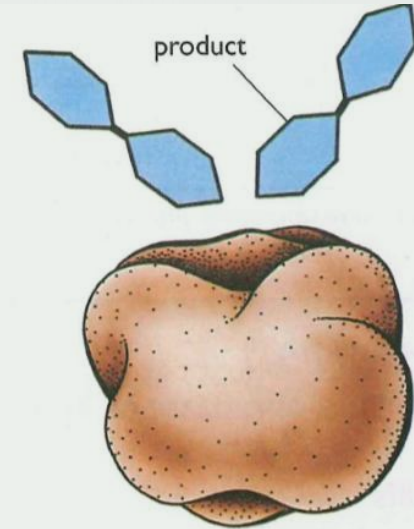
Each enzymes can only act on a particular kind of substrate.



The substrate molecule (starch in this case) slots into the active site.



Each enzyme has an active site into which its substrate molecule fits exactly. This enzyme is amylase, and its active site is just the right size and shape for a starch molecule.



The starch is split into maltose molecules. The enzyme is unaltered, and ready to accept another part of the starch molecule.

© 2026 Exam Papers Practice. All Rights Reserved

# Enzymes

## Biological catalysts

What is a catalyst?

What are the catalysts inside a living organism called?

Which kinds of reaction inside a living organism are controlled by enzymes?

What is meant by a carbohydrase?

Give one example of a carbohydrase?

Name the substrate and product of a reaction involving a carbohydrase?

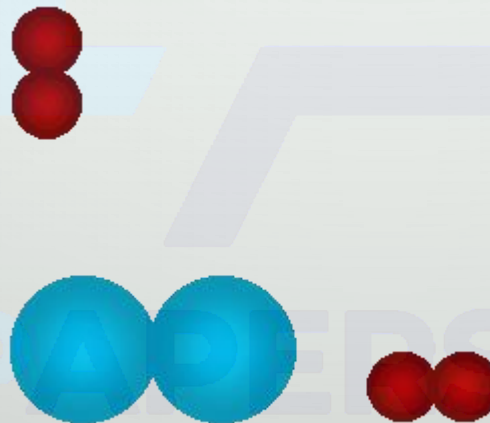
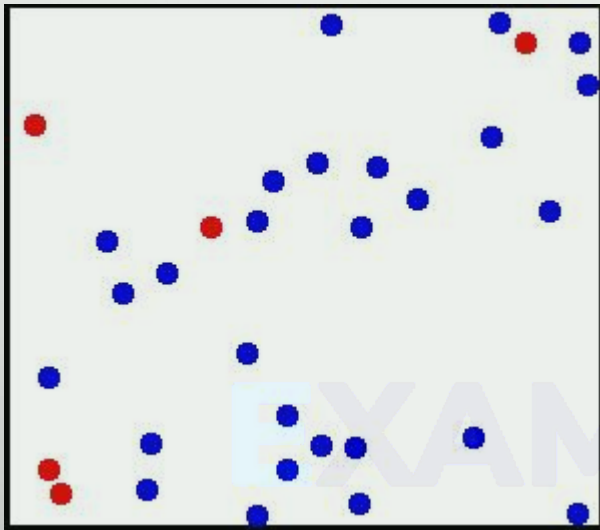
© 2026 Exam Papers Practice. All Rights Reserved

# Enzymes

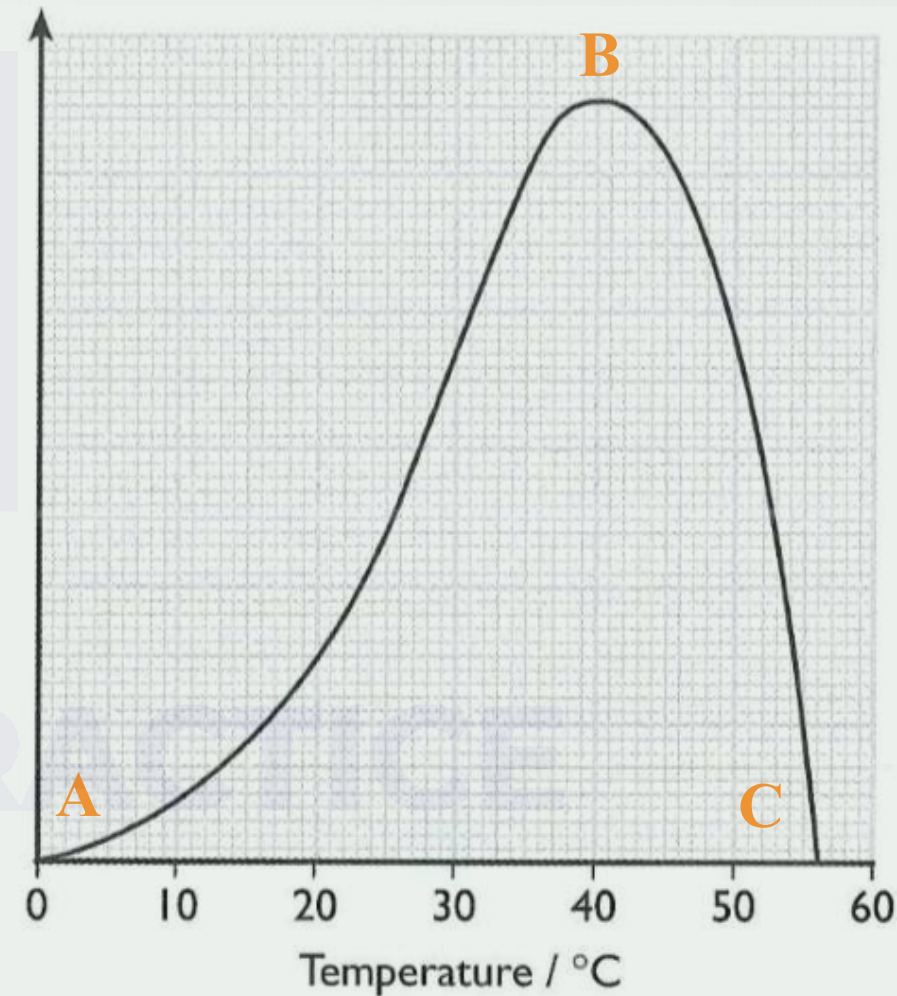
## Properties of enzymes

### Properties of enzymes

- ◆ all enzymes are **proteins**



Rate of  
reaction



Higher temperature → more kinetic energy → more energy when molecules hit each other / more frequently when molecules bump each other → reaction is more likely to take place

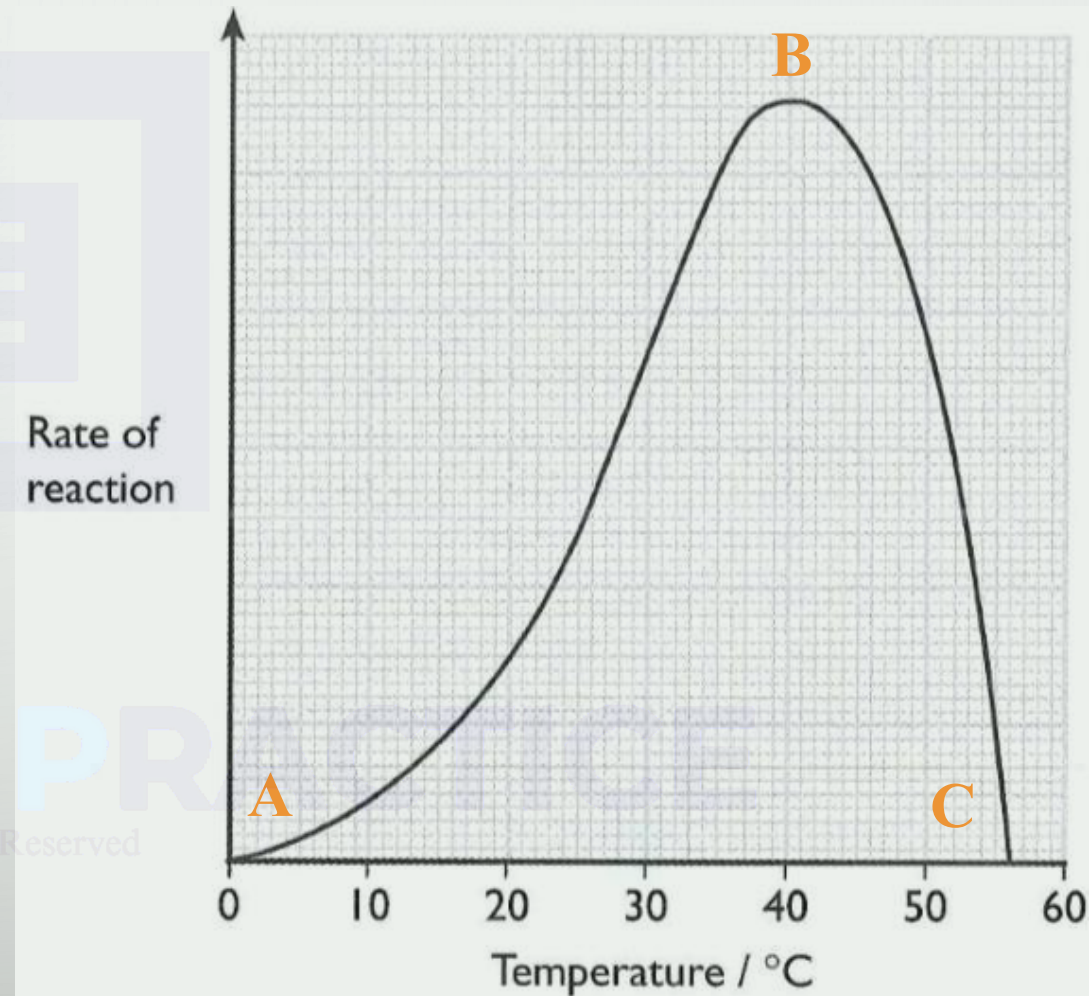
# Enzymes

## Properties of enzymes

### Properties of enzymes

- ◆ all enzymes are **proteins**
- ◆ enzymes work best at a particular temperature (**optimum temperature**)

enzymes from **human body** —  $37^{\circ}\text{C}$   
enzymes from **plants** —  $28^{\circ}\text{C} \sim 30^{\circ}\text{C}$   
enzymes from **bacteria (hot springs)** —  $75^{\circ}\text{C}$

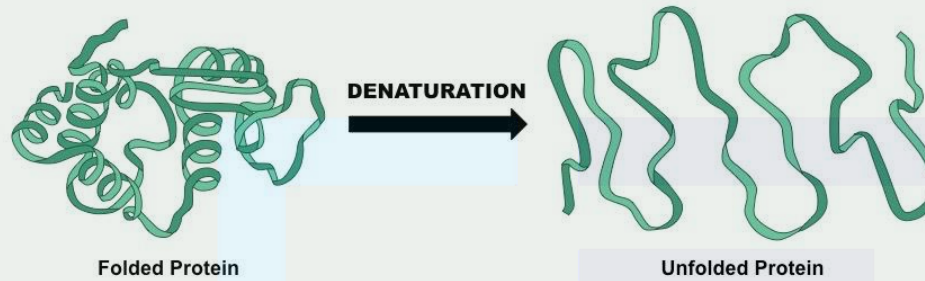


**optimum temperature** 最适温度

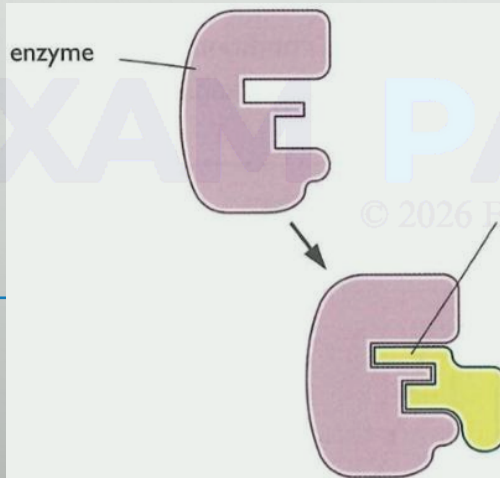
# Enzymes

# Properties of enzymes

## Properties of enzymes

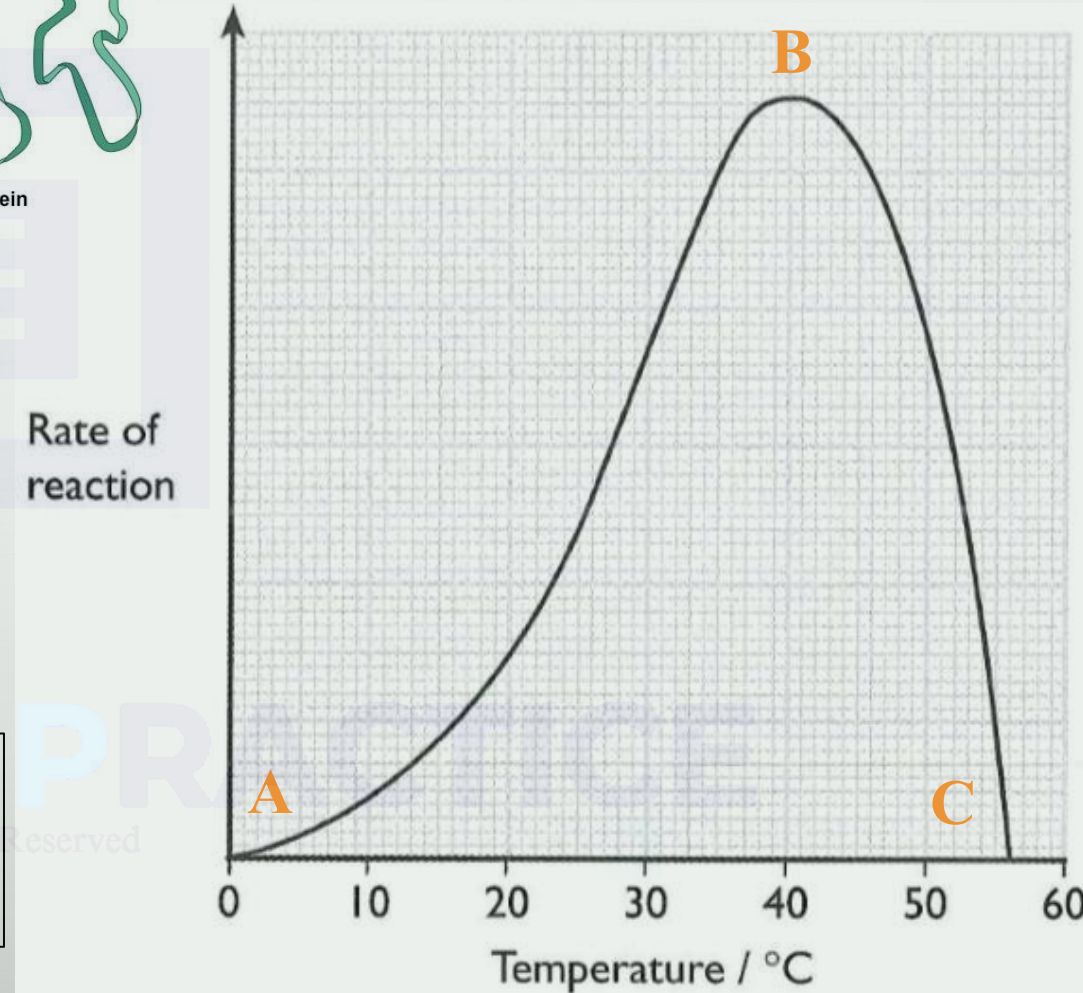


**Denaturation:** proteins lose their shape



active site no longer fits perfectly with the substrate.

denaturation 变性  
denature 变性  
denatured 变性的

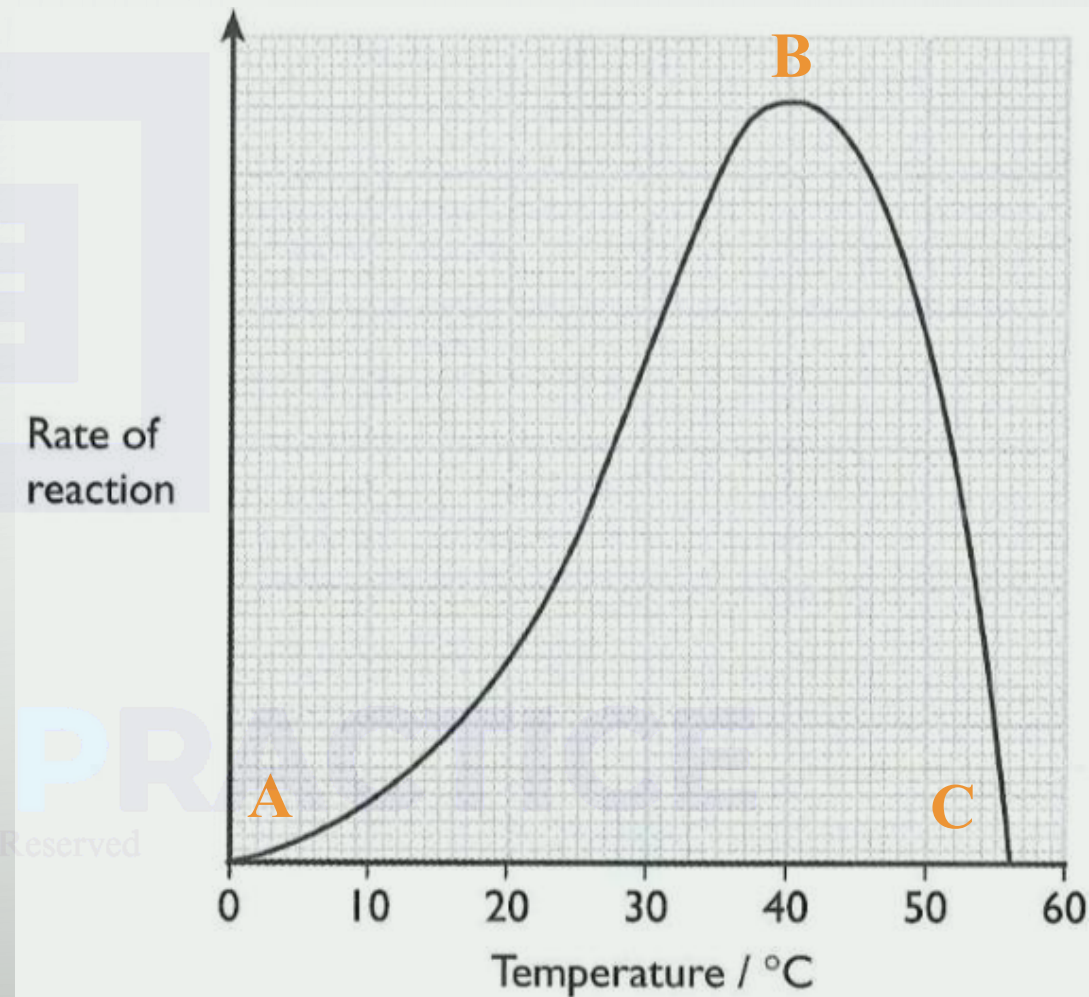


# Enzymes

## Properties of enzymes

### Properties of enzymes

- ◆ all enzymes are **proteins**
- ◆ enzymes work best at a particular temperature (**optimum temperature**)
- ◆ enzymes are made **inactive** by high temperature. (**denaturation**)



# Enzymes

## Properties of enzymes

### Properties of enzymes

- ◆ enzymes work best at a **particular pH** (**optimum pH**)

optimum pH of **most enzymes** — **about 7**

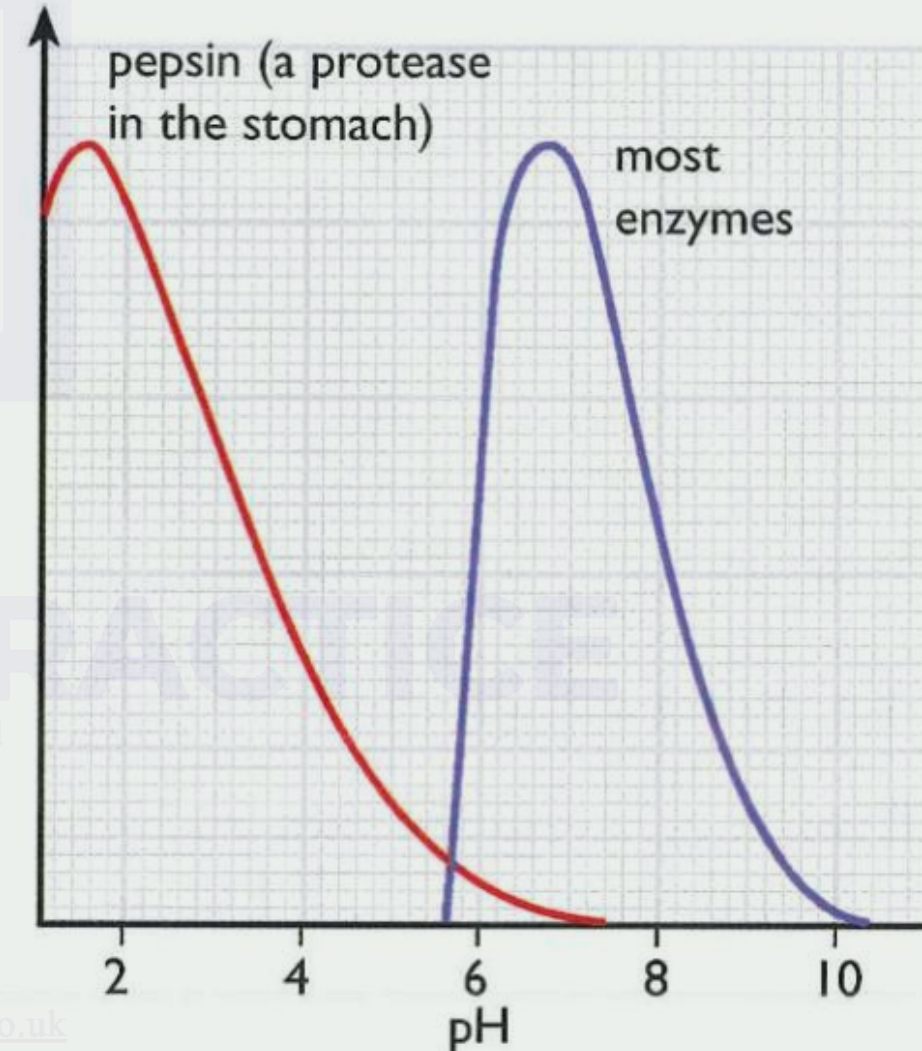
**Pepsin** (a protease enzyme in human stomach/ hydrochloric acid) — **about 2**

- ◆ enzymes are **catalysts**
- ◆ enzymes are **specific**

**pepsin** 胃蛋白酶

Strong acid or strong alkali → denaturation

Rate of  
reaction



What is meant by an optimum temperature?

What is the optimum temperature for the enzyme in figure 5.4?

Why are enzymes damaged by high temperatures?

EXAM PAPERS PRACTICE

© 2026 Exam Papers Practice. All Rights Reserved



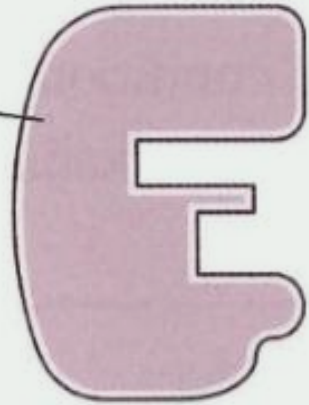
# EXAM PAPERS PRACTICE

© 2026 Exam Papers Practice. All Rights Reserved

For more help, please visit [www.exampaperspractice.co.uk](http://www.exampaperspractice.co.uk)

An enzyme molecule is like a lock.

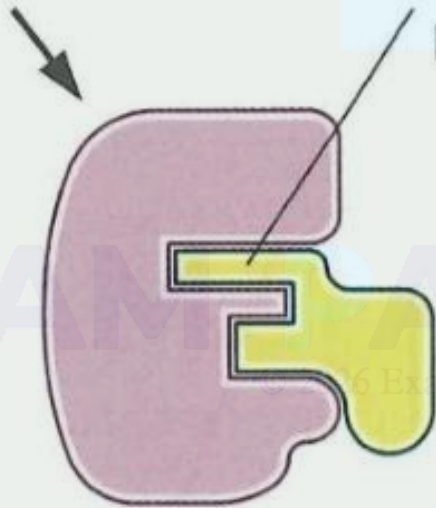
enzyme



The substrate molecule has a complementary shape to the enzyme, and can fit into it like a key.



The substrate must be a perfect fit.



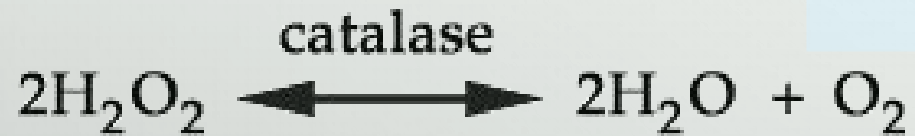
The enzyme changes the substrate into new molecules called products.



# Enzymes

## Activity 5.1- the effect of catalase on hydrogen peroxide

Catalase is found in **almost every kind of living cell**.



- some chopped raw potato ✓
- some chopped boiled potato ✗
- some fruit juice ✓
- a small piece of liver ✓
- some yeast suspension ✓

Wear **eye protection** if available.  
Hydrogen peroxide is a **powerful bleach**.  
Wash it off with **plenty of water** if you get it on you skin.

# Enzymes

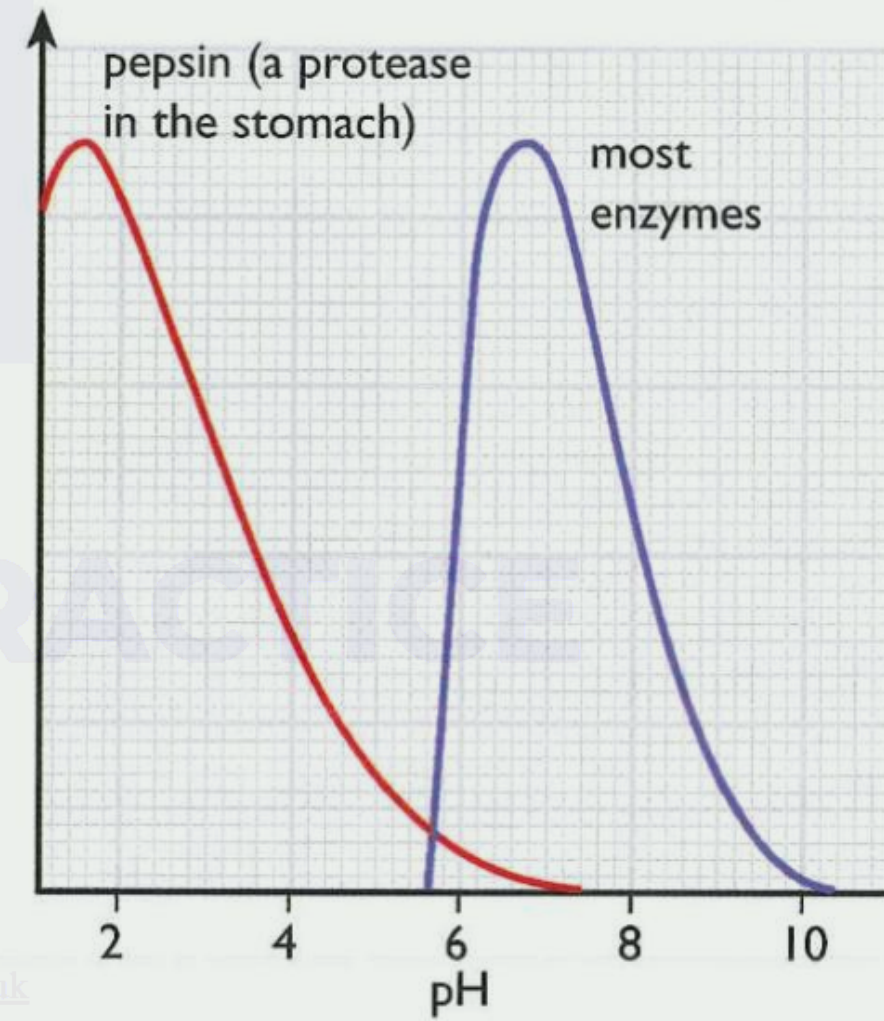
## Activity 5.2- investigating the effect of pH on the activity of catalase

Independent variable

Dependent variable

Irrelevant variable

Rate of  
reaction



© 2026 Exam Papers Practice. All Rights Reserved

For more help, please visit [www.exampaperspractice.co.uk](http://www.exampaperspractice.co.uk)

# Enzymes

## Activity 5.2- investigating the effect of pH on the activity of catalase

3% hydrogen peroxide

buffer solution



5.6



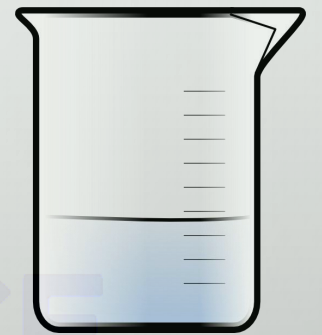
6.2



6.8



7.4



8.0

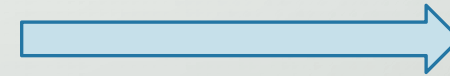
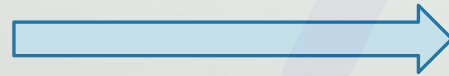
beaker 烧杯

buffer solution 缓冲液

A buffer solution keeps the pH constant at a

# Enzymes

## Activity 5.2- investigating the effect of pH on the activity of catalase



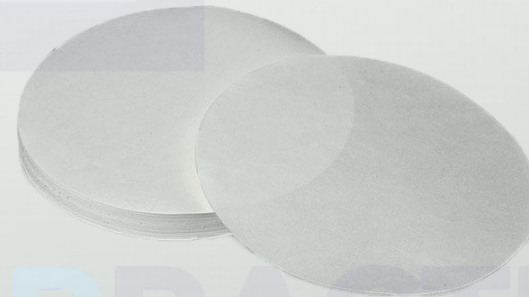
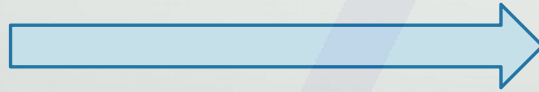
A leaf contains *catalase*.



pestle 杵  
mortar 臼, 研钵  
extract 提取, 提取液  
settle 沉淀

# Enzymes

## Activity 5.2- investigating the effect of pH on the activity of catalase



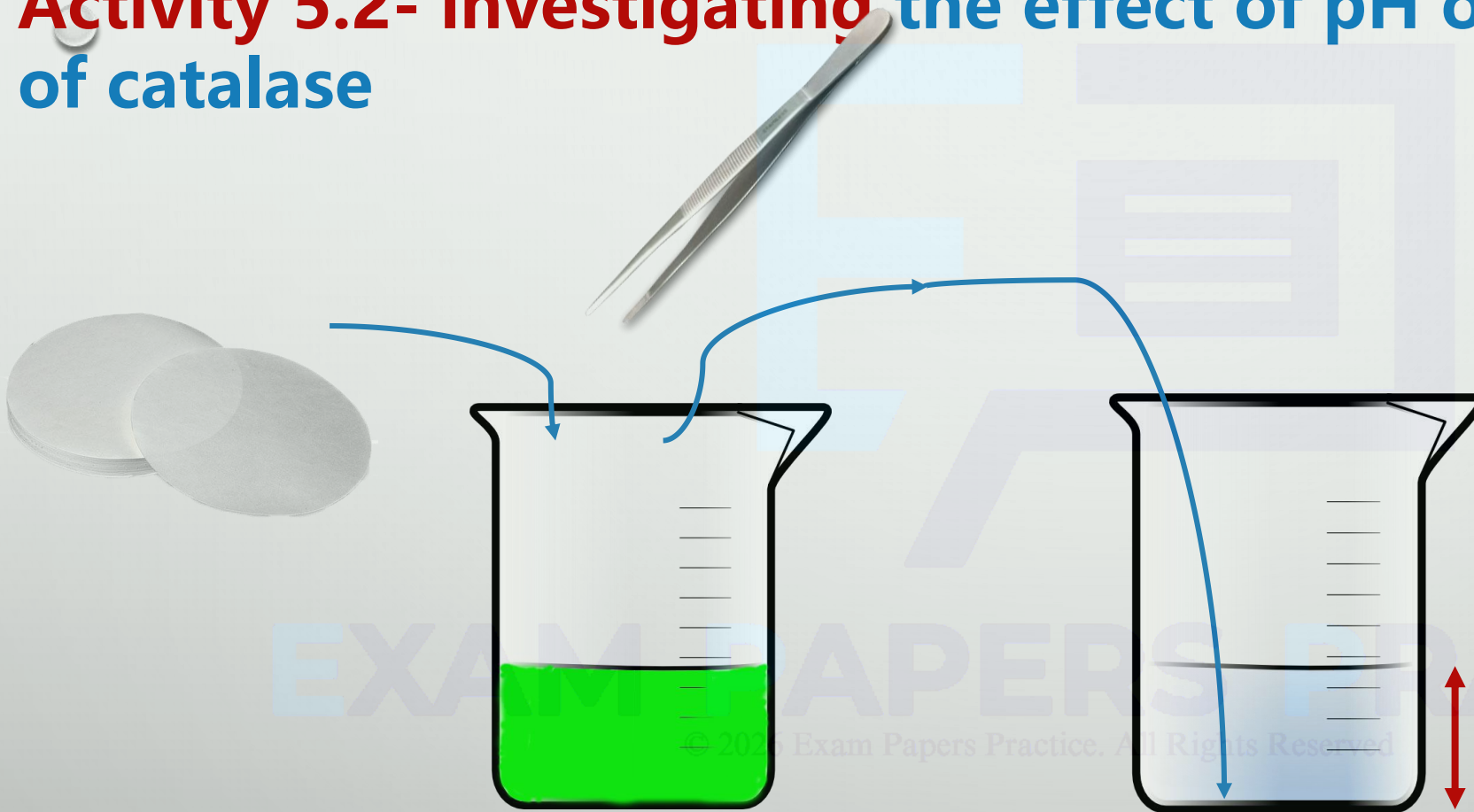
hole punch 打孔机  
filter paper 滤纸

© 2026 Exam Papers Practice. All Rights Reserved

For more help, please visit [www.exampaperspractice.co.uk](http://www.exampaperspractice.co.uk)

# Enzymes

## Activity 5.2- investigating the effect of pH on the activity of catalase



Record **time**  
**duration** from  
the **bottom** up to  
**surface** when the  
paper floats.

forceps/ tweezers 镊子  
stopwatch 停表

# Enzymes

## Activity 5.2- investigating the effect of pH on the activity of catalase

|                | Time taken for paper to float in seconds |     |     |     |     |
|----------------|------------------------------------------|-----|-----|-----|-----|
| pH             | 5.6                                      | 6.2 | 6.8 | 7.4 | 8.0 |
| Tests 1        |                                          |     |     |     |     |
| 2              |                                          |     |     |     |     |
| 3              |                                          |     |     |     |     |
| Mean           |                                          |     |     |     |     |
| Boiled extract |                                          |     |     |     |     |



# EXAM PAPERS PRACTICE

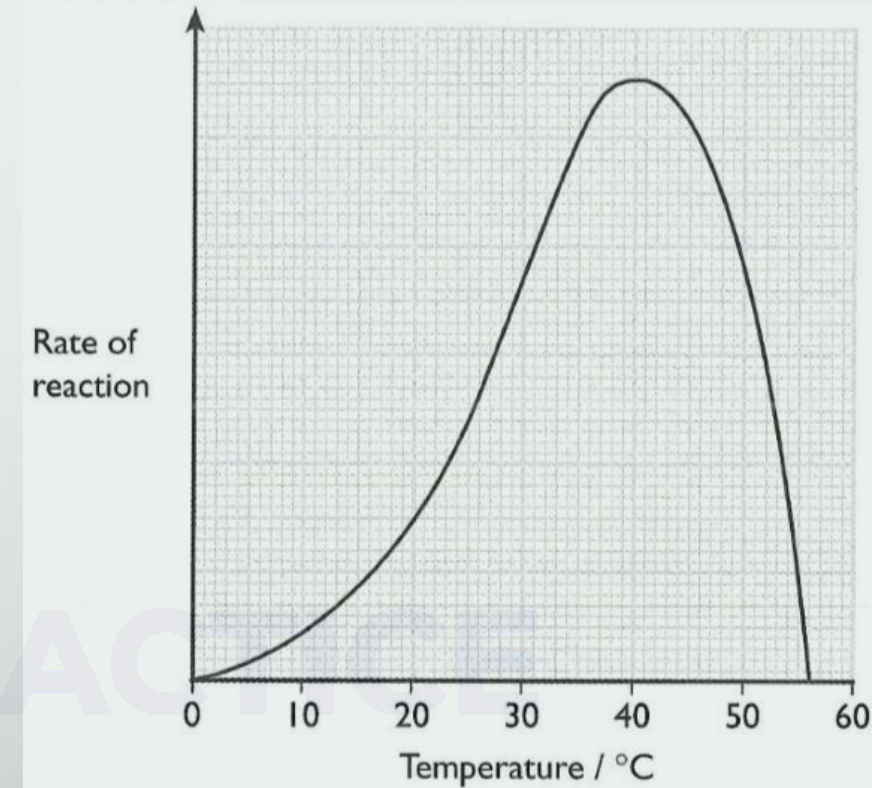
© 2026 Exam Papers Practice. All Rights Reserved

For more help, please visit [www.exampaperspractice.co.uk](http://www.exampaperspractice.co.uk)

# Enzymes

## Activity 5.2- investigating the effect of temperature on the activity of amylase

- ♠ what is the hypothesis you are going to test ?
- ♠ what apparatus and other materials will you need for your experiment?
- ♠ what will you vary in your experiment? How will you vary it?
- ♠ what will you keep the same in all the tubes or beakers in your experiment ? How will you do this ?
- ♠ what will you measure in your experiment? How will you measure it? when will you measure it? will you do repeat measurements and calculate a mean?

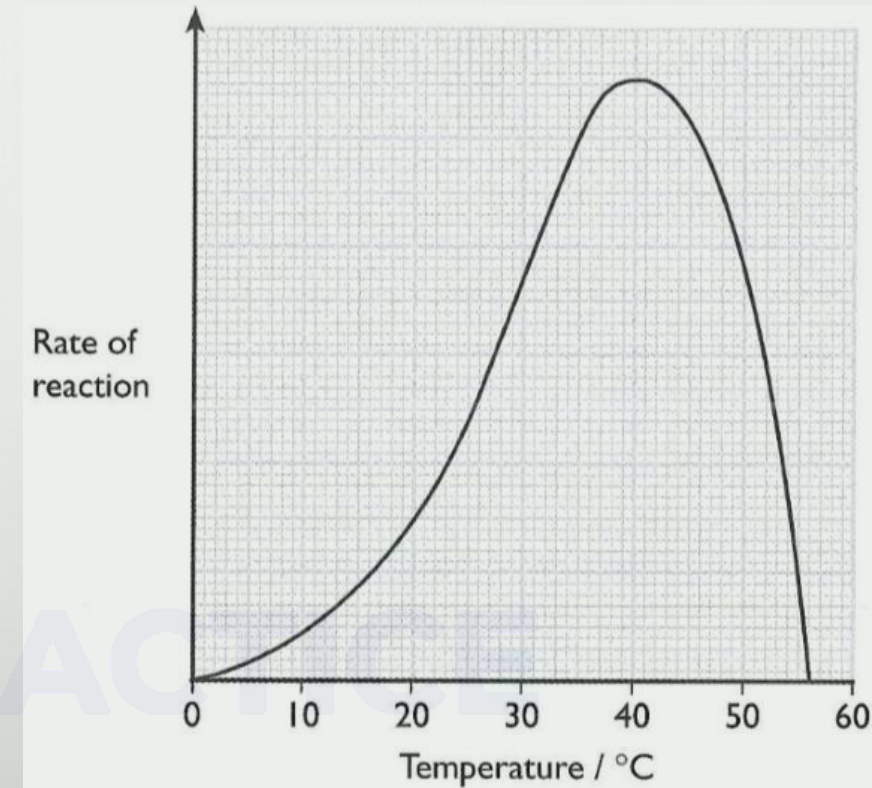


saliva 唾液  
apparatus 裝置

# Enzymes

## Activity 5.2- investigating the effect of temperature on the activity of amylase

- ♠ how will you record your results? (result chart/ table)
- ♠ how will you display your results?
- ♠ what will your results be if your hypothesis is correct?  
(sketch the shape of the graph)



saliva 唾液  
apparatus 裝置

# Enzymes

## Activity 5.2- investigating the effect of temperature on the activity of amylase

1 take five test tubes and label them A to E

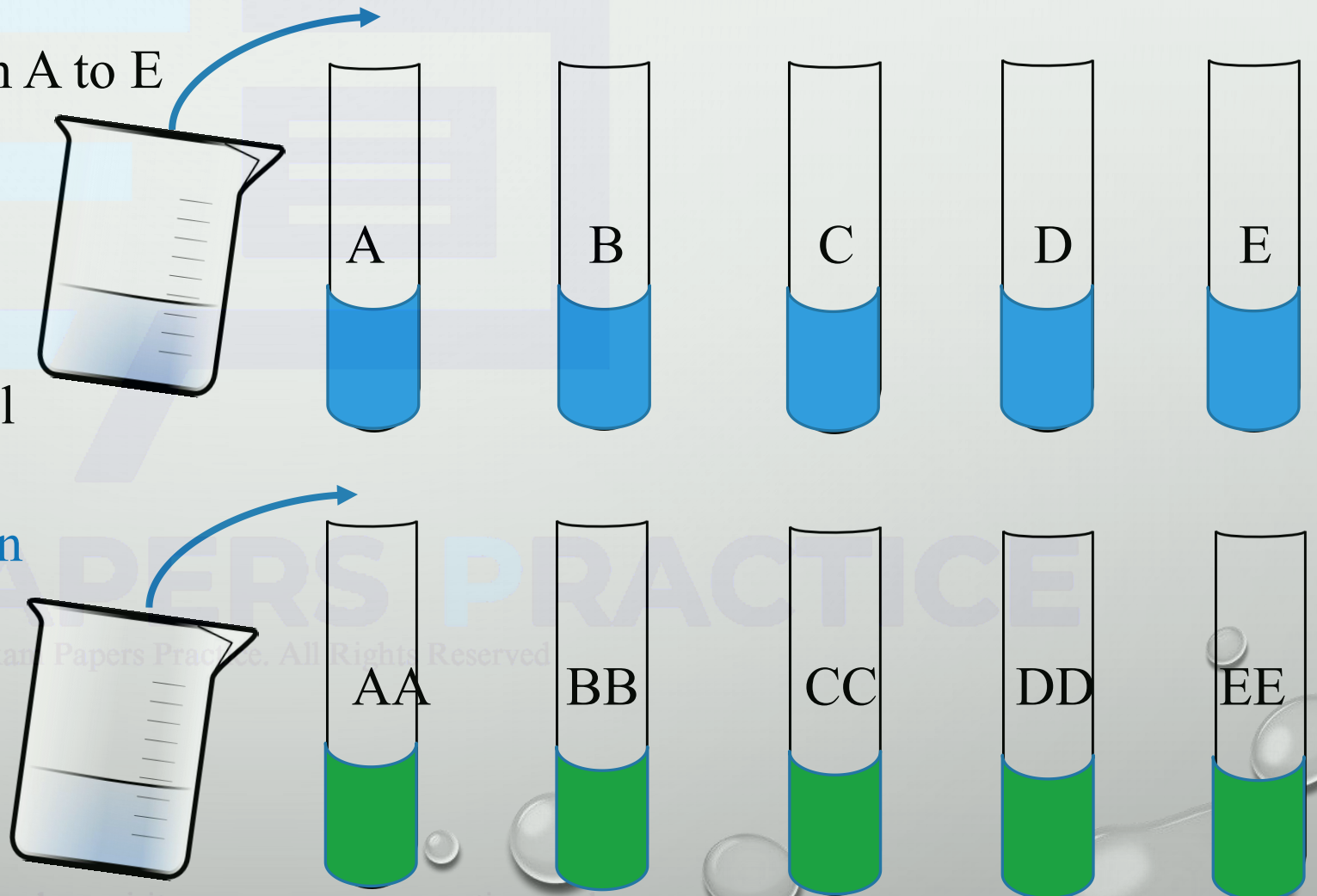
2 measure 5 cm<sup>3</sup> starch suspension into each test tube.

3 take five more test tubes and label them AA to EE.

4 measure 5 cm<sup>3</sup> of amylase solution into tubes AA to EE

5 place each pair of tubes in an environment at a different temperature

test tube



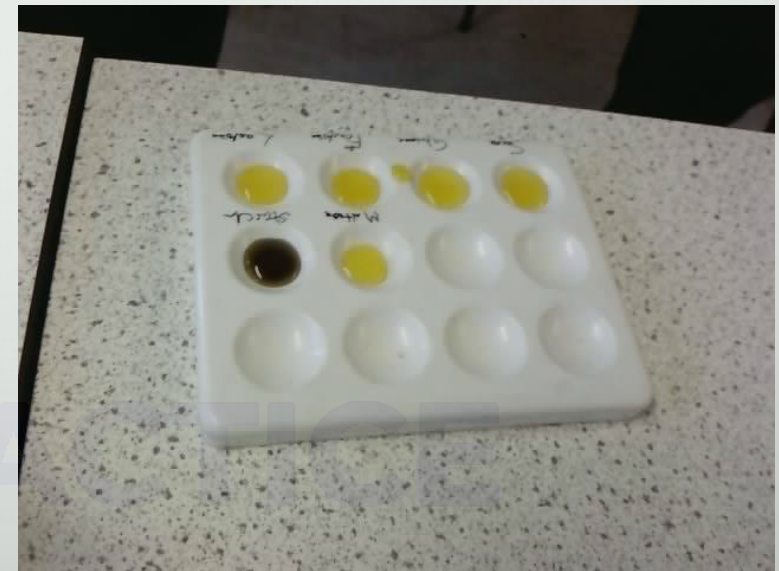
# Enzymes

## Activity 5.2- investigating the effect of temperature on the activity of amylase

6 collect a white dimple tile (or five of them if possible) and place a drop of iodine solution into each dimple

7 when you are absolutely ready, tip the contents of tube AA into tube A, and so on for each pair of tubes. Mix them well. Note the time, or start a stop watch.

8 after one minute, dip a glass rod into tube A and then dip the end of the rod into the first drop of iodine solution. Record the colour in the table. Repeat with the other four tubes, using a clean rod each time.



dimple tile

glass rod 玻璃棒

# Enzymes

## Activity 5.2- investigating the effect of temperature on the activity of amylase

8 after one minute, dip a glass rod into tube A and then dip the end of the rod into the first drop of iodine solution. Record the colour in the table. Repeat with the other four tubes, using a clean rod each time.

9 repeat step 8 every minute for ten minutes.

| Colour with Iodine after: | Tube         |              |              |              |              |
|---------------------------|--------------|--------------|--------------|--------------|--------------|
|                           | A/AA ____ °C | B/BB ____ °C | C/CC ____ °C | D/DD ____ °C | E/EE ____ °C |
| 1 minute                  |              |              |              |              |              |
| 2 minutes                 |              |              |              |              |              |
| 3 minutes                 |              |              |              |              |              |
| 4 minutes                 |              |              |              |              |              |
| 5 minutes                 |              |              |              |              |              |
| 6 minutes                 |              |              |              |              |              |
| 7 minutes                 |              |              |              |              |              |
| 8 minutes                 |              |              |              |              |              |
| 9 minutes                 |              |              |              |              |              |
| 10 minutes                |              |              |              |              |              |