Glenlola Collegiate School

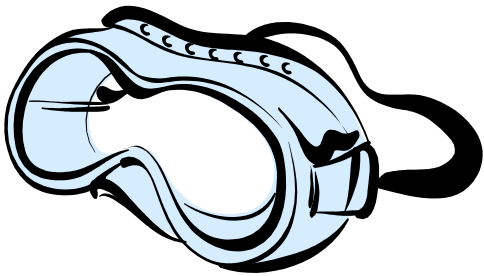
excellence through commitment, contribution and caring

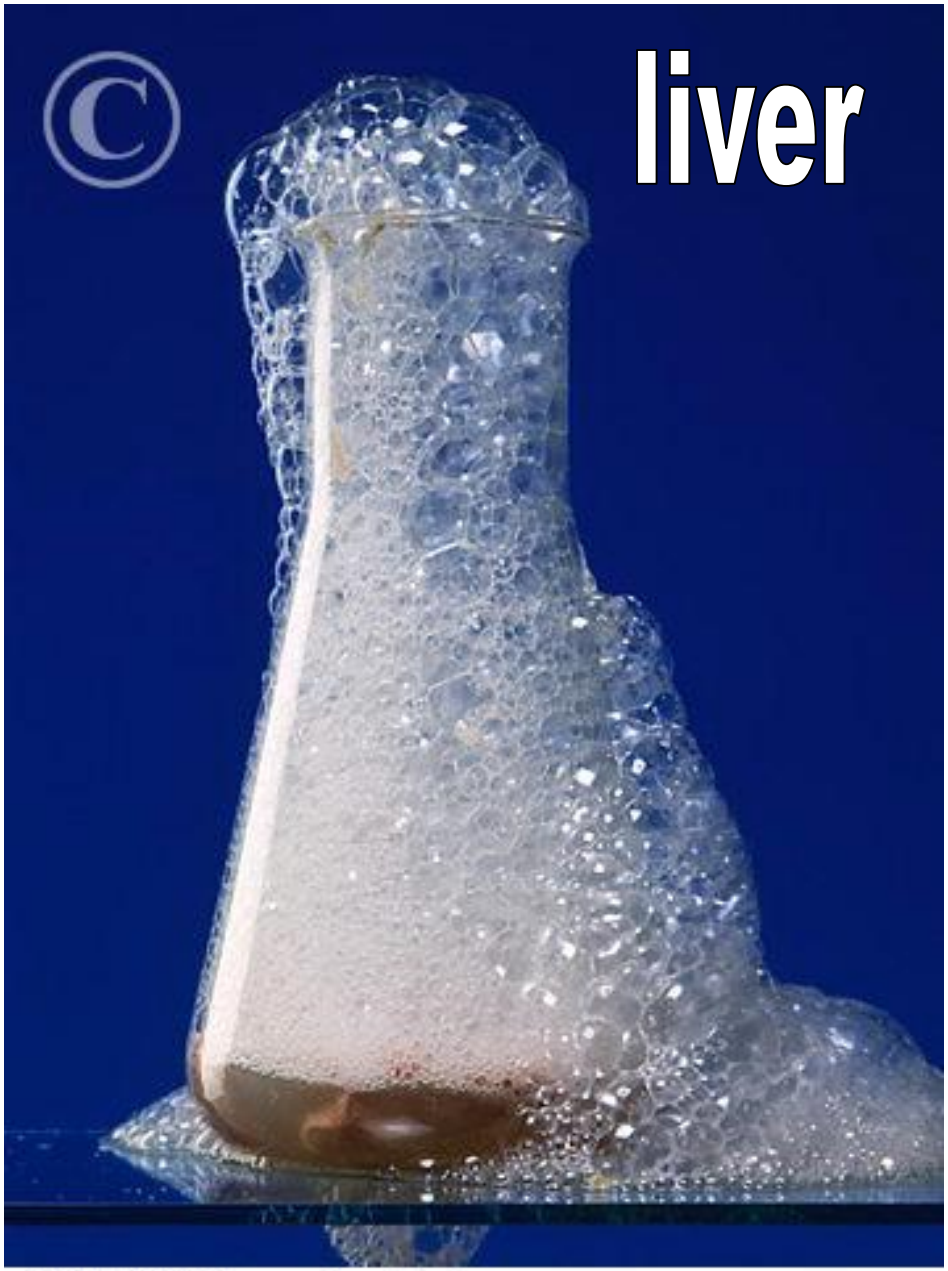
starter activity

- Carry out the following experiment and write your observations on a whiteboard

liver and hydrogen peroxide

1. Put on safety glasses.
2. Measure 20cm^3 hydrogen peroxide into a measuring cylinder and add to a 250cm^3 beaker.
3. Place the beaker in a tray.
4. Add a small piece of liver and observe.
5. Feel the side of the beaker during the reaction (be careful not to get solution on your hands – **wash it off if you do**)
6. Wash and dry all the equipment – put the liver in the bin NOT down the sink!
7. Wash and dry all apparatus.





potato

DISCUSSION/think

1. **Describe** what happened.

Bubbles / froth / gas

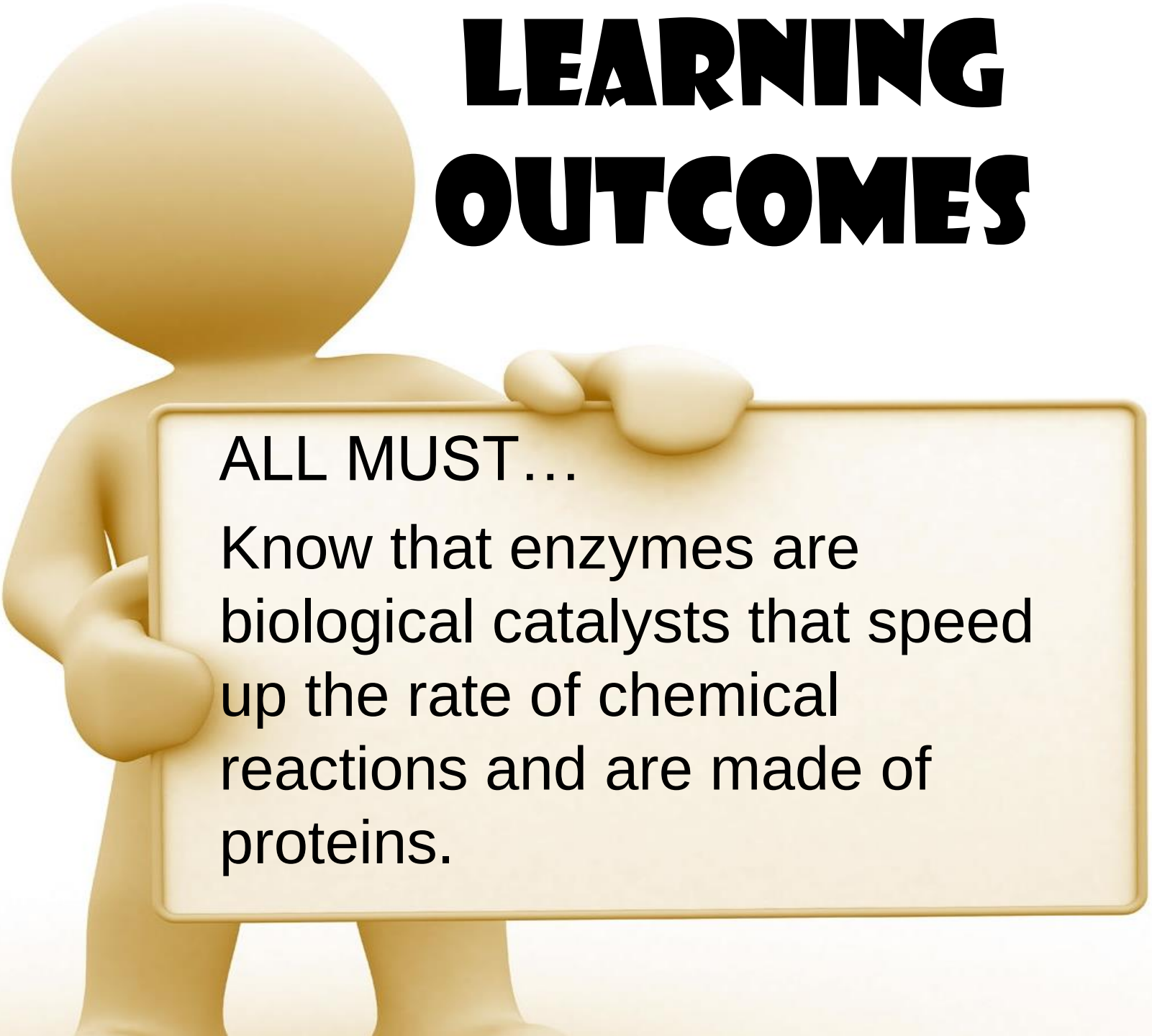
Flask heated up

2. **Explain** what happened.

Chemical reaction occurred

Something in the liver reacted with the hydrogen peroxide to produce the gas

LEARNING OUTCOMES



ALL MUST…

Know that enzymes are biological catalysts that speed up the rate of chemical reactions and are made of proteins.

WHAT IS AN ENZYME ?

A **biological catalyst**

that speeds up chemical reactions.

It is made of **protein**.

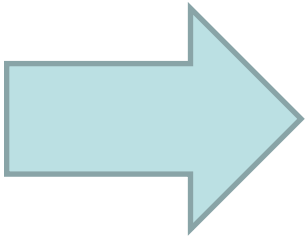
Enzymes **lower** the energy needed for chemical reactions to take place.

The enzyme is unchanged at the end of the reaction so can be **used again.**

The substance an enzyme breaks down is called its **substrate** and it produces a **product.**

substrate

+ enzyme



products

+ enzyme

Chemical Reactions in the Body

The chemical reactions that occur in the body are called

metabolic reactions.

There are 2 types of enzyme reactions:

Catabolic reactions

Break down/digest a substrate to form 2 or more products

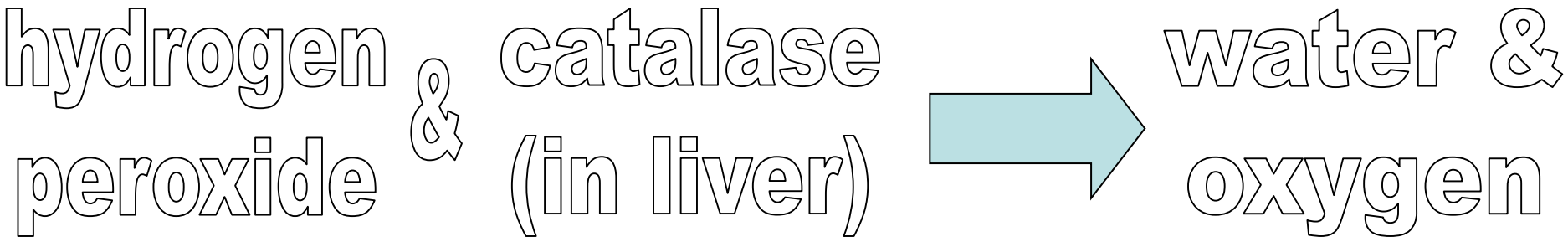
e.g. starch broken down into glucose

Anabolic reactions (synthesis)

Join together 2 or more substrates to form a single product

e.g. amino acids joined to form a protein

Liver contains the enzyme catalase which breaks down the **substrate hydrogen peroxide** and forms water and oxygen as its **products.**

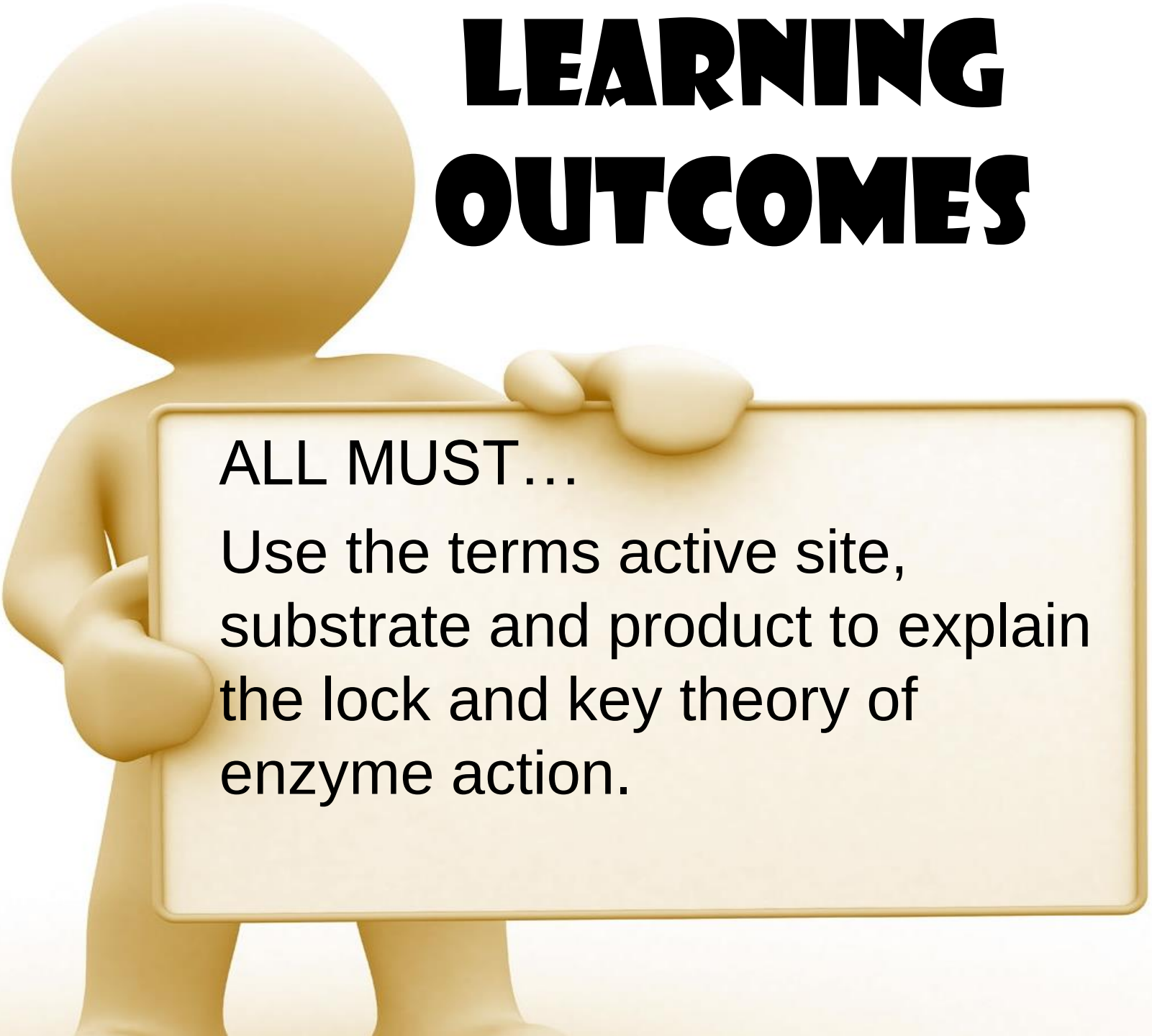


substrate **enzyme** **products**

Heat is produced during the reaction, showing that it is a

catabolic reaction.

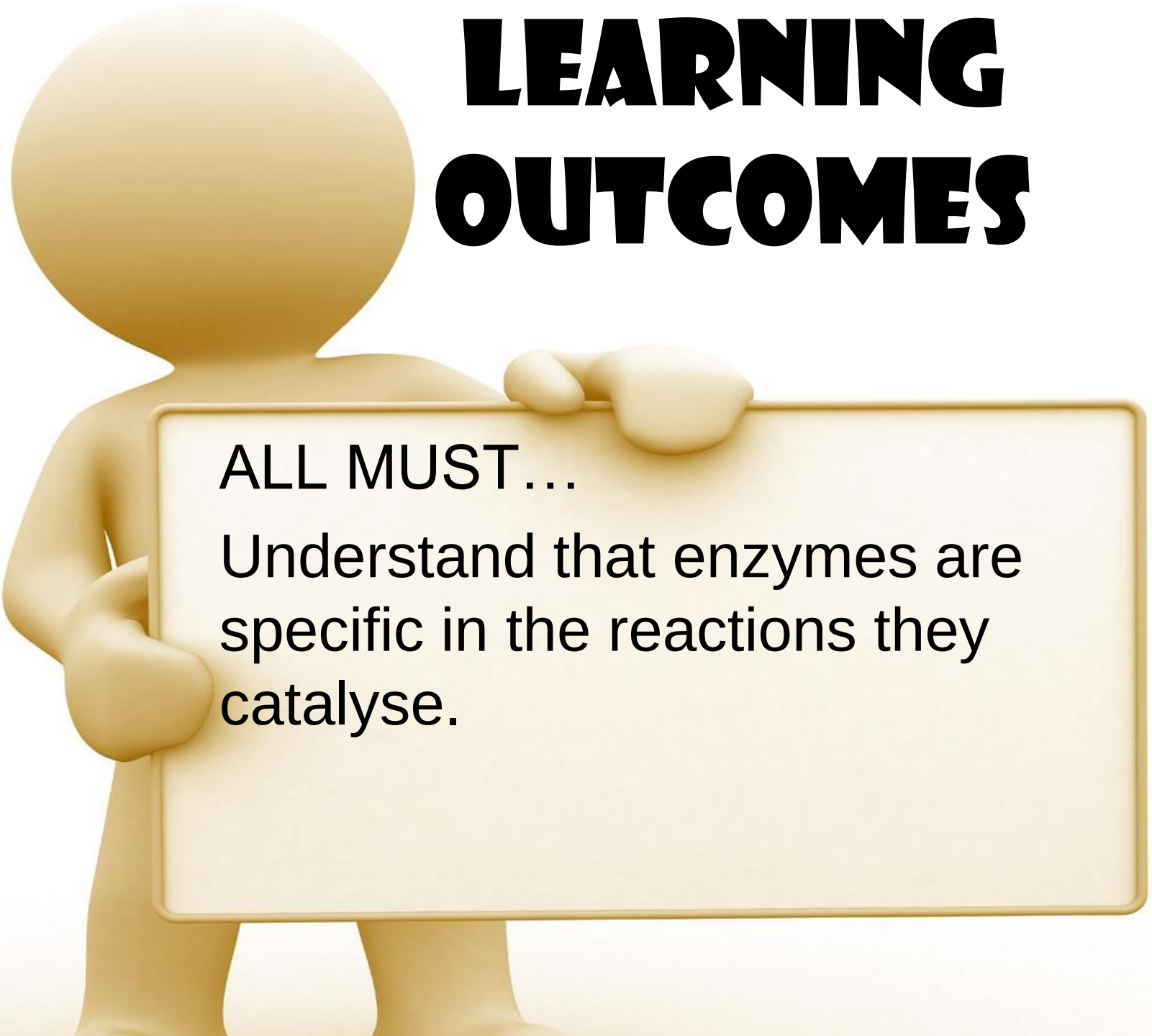
LEARNING OUTCOMES



ALL MUST…

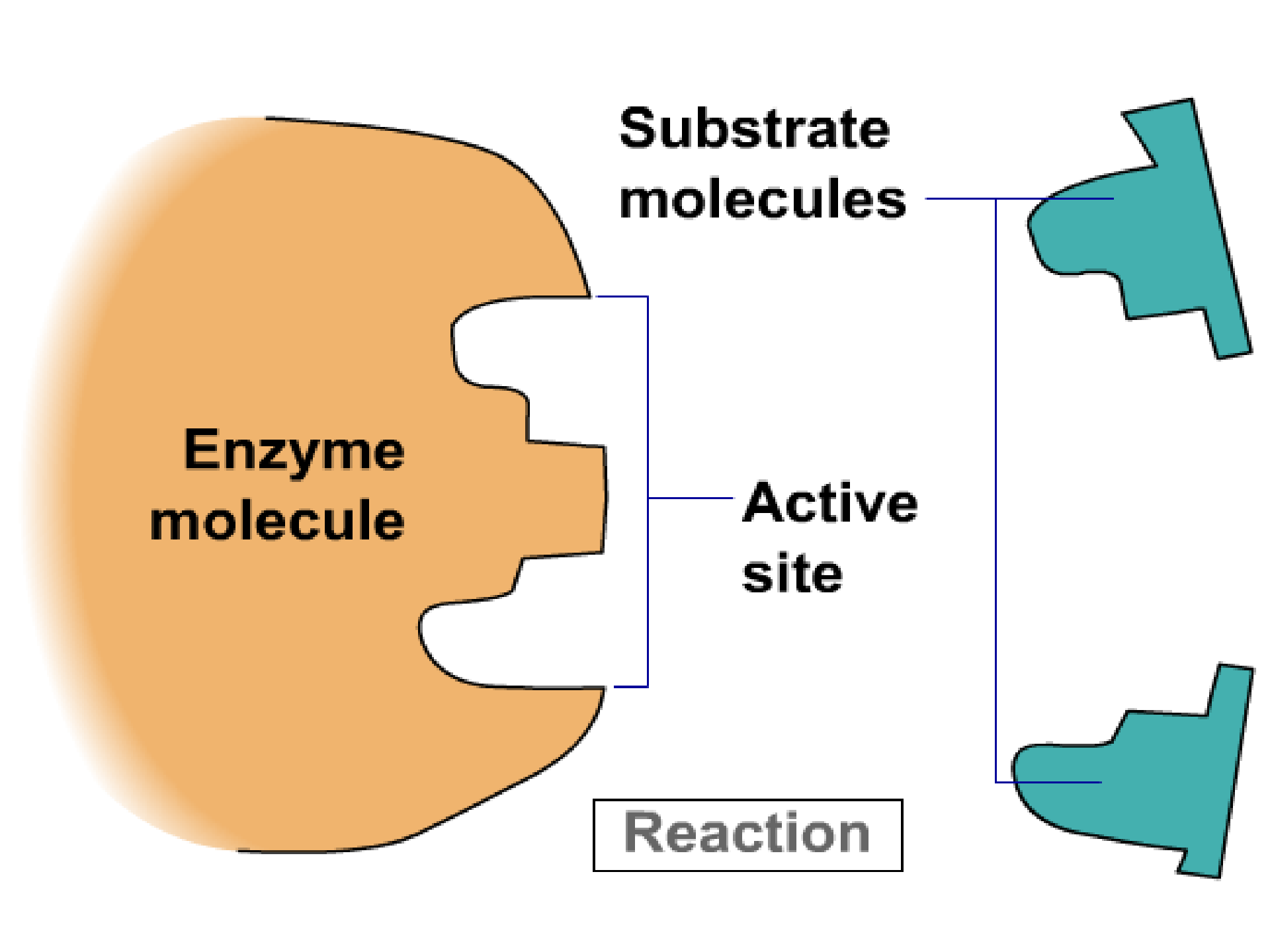
Use the terms active site, substrate and product to explain the lock and key theory of enzyme action.

LEARNING OUTCOMES



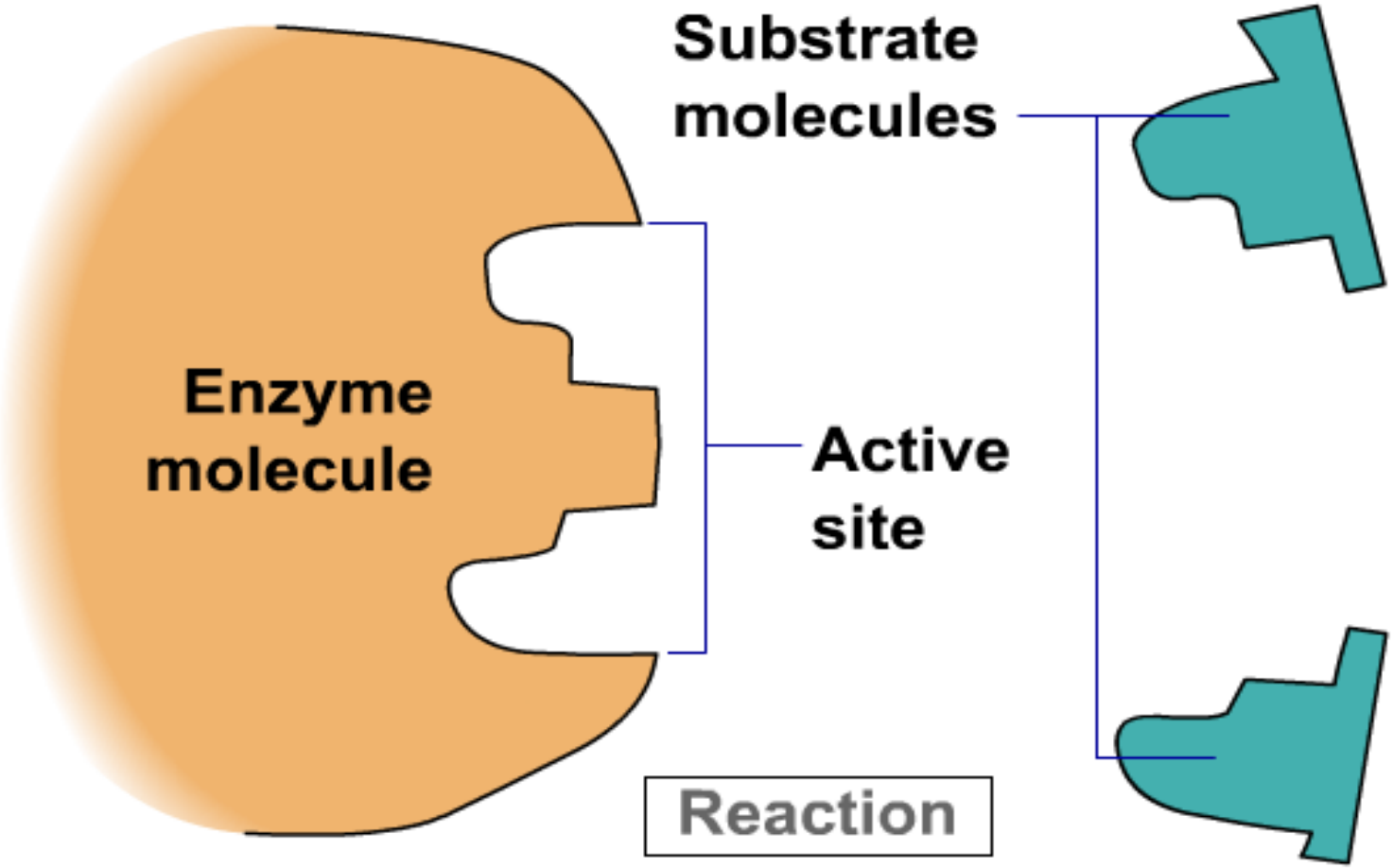
ALL MUST…

Understand that enzymes are specific in the reactions they catalyse.


Substrate molecules
Enzyme molecule
Active site
Reaction

HOW DO ENZYMES WORK?

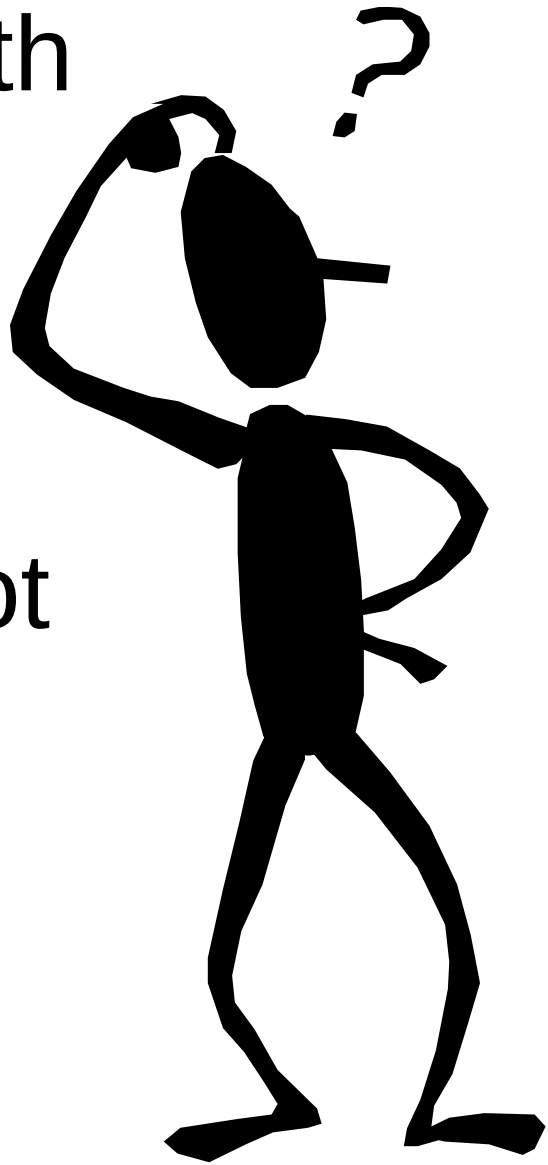
- An enzyme has a **3D shape**
- There is an indent in the enzyme called the **active site**
- The substrate **fits exactly** into the active site.



In this reaction the enzyme is joining 2 substrate molecules forming a single product. This is a synthesis or anabolic reaction

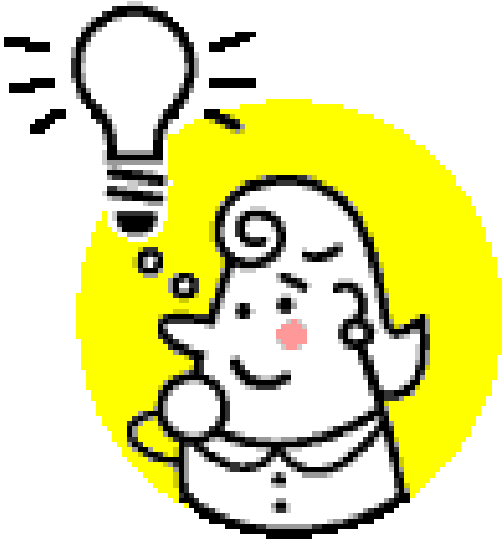
- An enzyme only works with one **specific** type of substrate

  e.g. protease enzymes break down protein but not starch

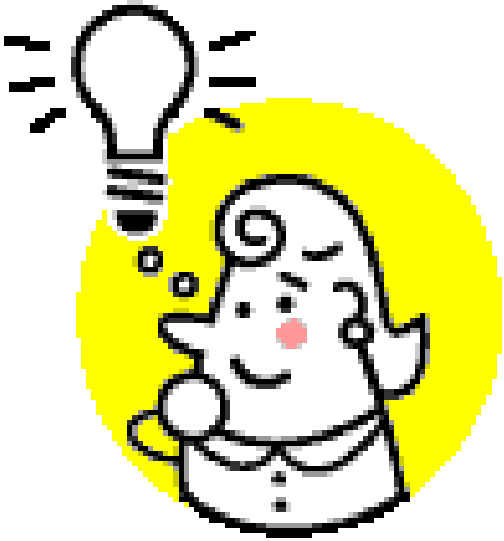


WHY ?

- The **shape** of the active site will only fit one type of substrate molecule.
- Other molecules **do not fit** so will not be broken down or joined together

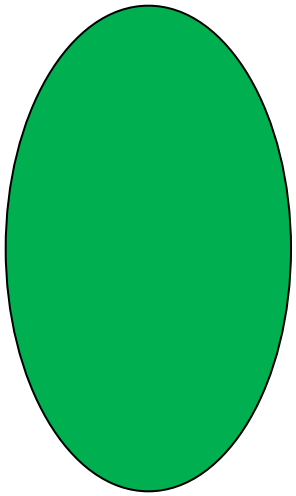


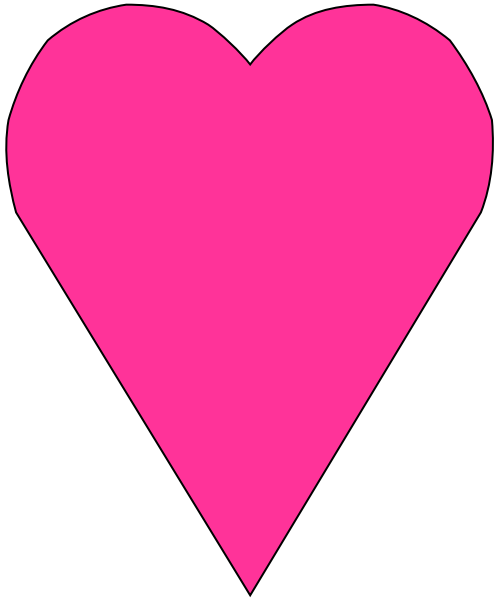
- This is called the **lock and key model** of enzyme action.
- The **enzyme** acts as the **key** to unlock or lock the **substrate** molecules

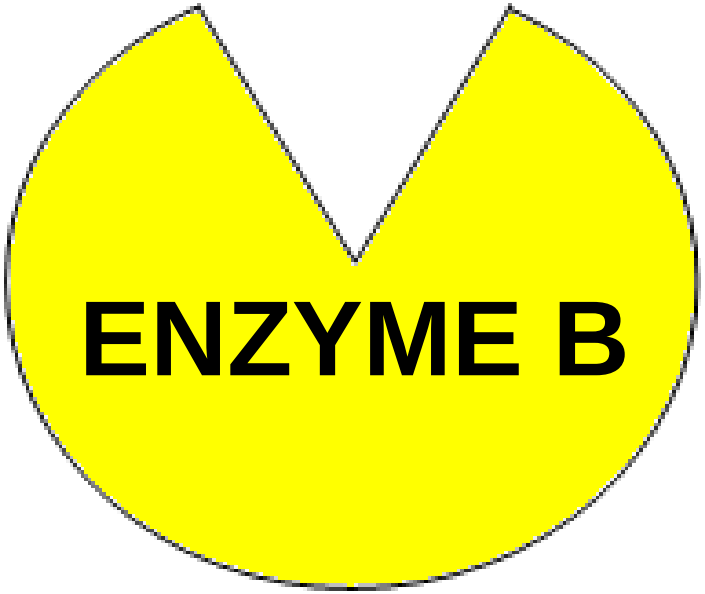


SUBSTRATE A

SUBSTRATE B







MAKE A MODEL TO SHOW HOW AN ENZYME WORKS

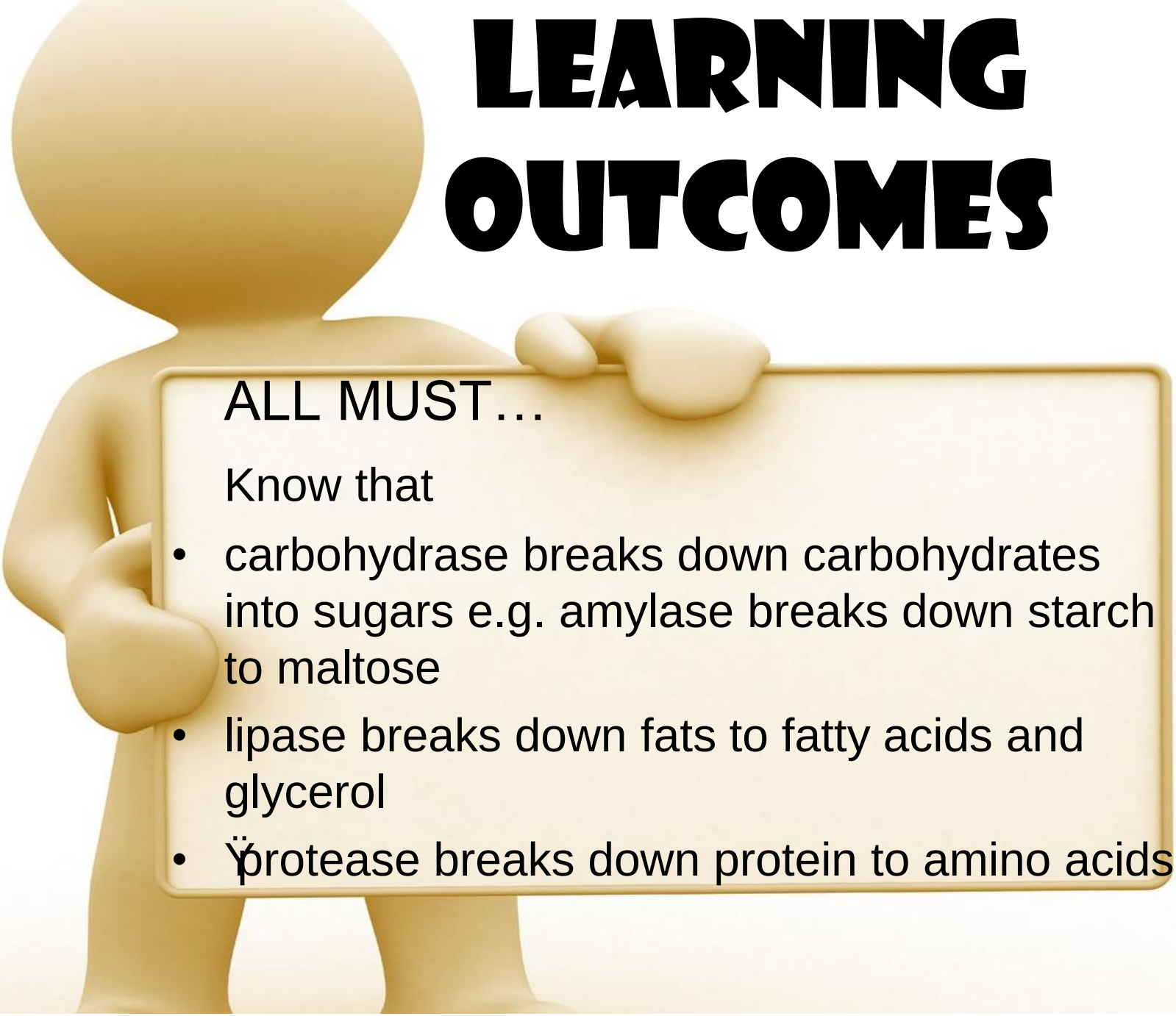
catabolic reaction

substrate

enzyme

product

LEARNING OUTCOMES

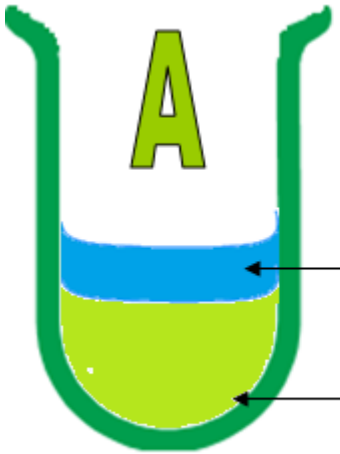


ALL MUST…

Know that

- carbohydrase breaks down carbohydrates into sugars e.g. amylase breaks down starch to maltose
- lipase breaks down fats to fatty acids and glycerol
- protease breaks down protein to amino acids

enzyme specificity investigation

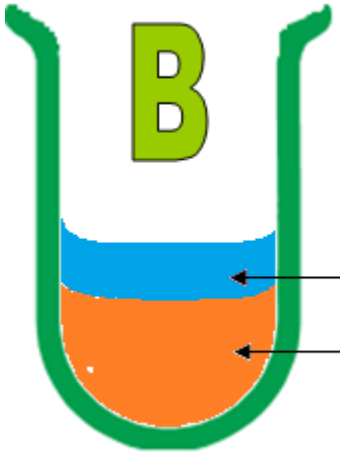


1cm^3 CARBOHYDRASE enzyme

0.5cm^3 STARCH solution

LEAVE 15 MINUTES

TEST A FOR STARCH



1cm^3 CARBOHYDRASE enzyme

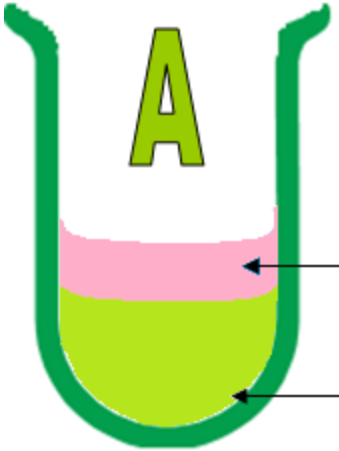
0.5cm^3 PROTEIN solution

TEST B FOR PROTEIN

RESULTS EXPT 1:

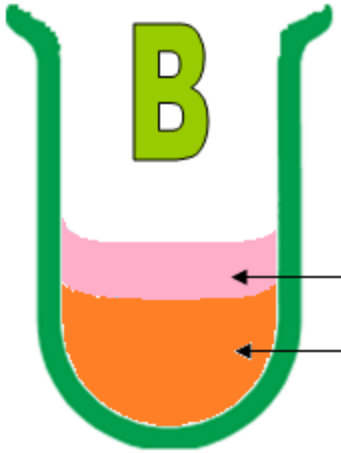
A: iodine solution remains **yellow/brown** showing no starch remains;
it has been broken down by the carbohydrase enzyme

B: biuret reagent changes from **blue** to **purple** showing protein remains; the carbohydrase has not been able to break down the protein.



1cm³ PROTEASE enzyme

0.5cm³ STARCH solution



1cm³ PROTEASE enzyme

0.5cm³ PROTEIN solution

LEAVE

15 MINUTES

TEST A FOR STARCH

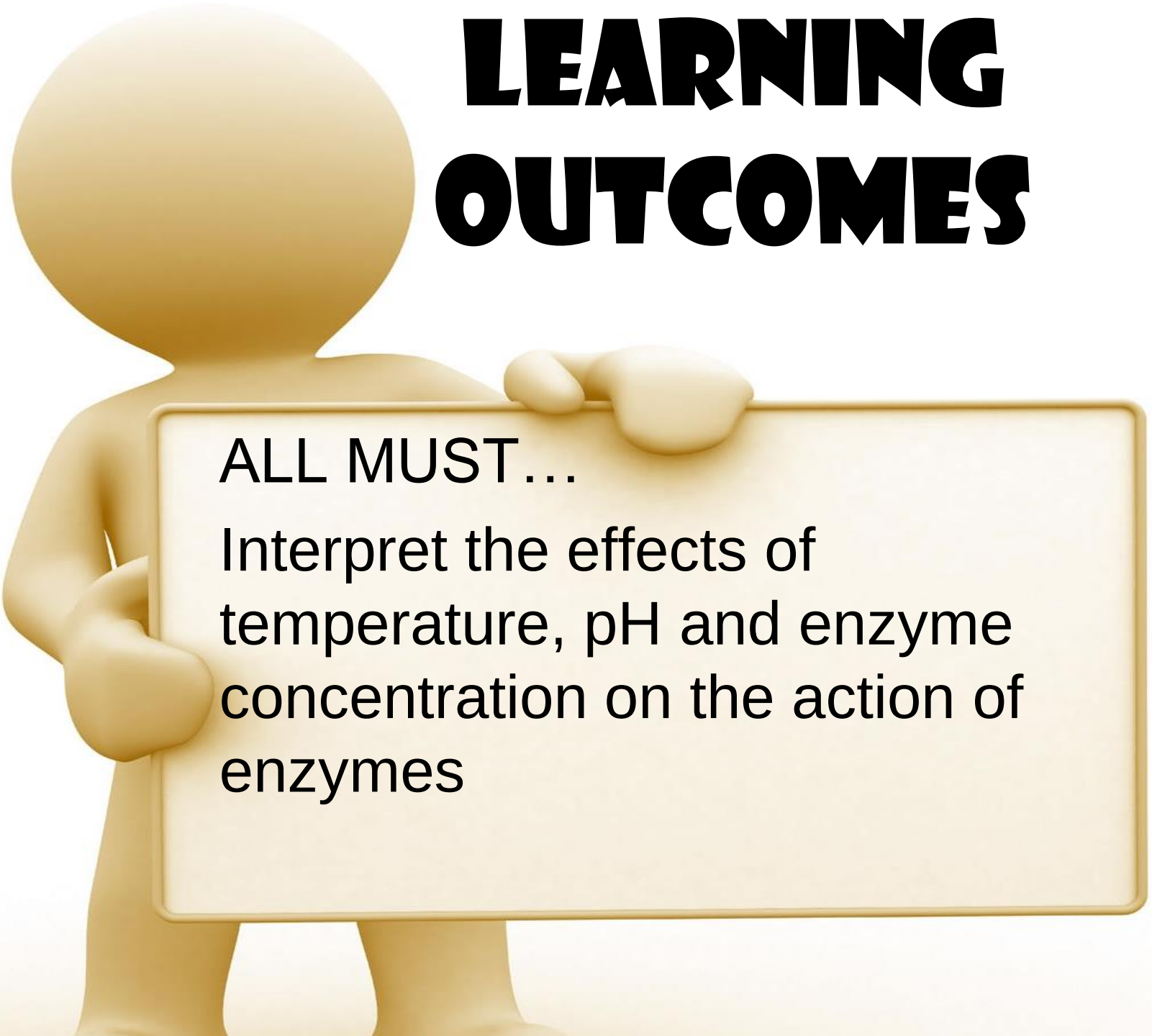
TEST B FOR PROTEIN

RESULTS EXPT 2:

A: iodine solution changes from **yellow/brown** to blue/black showing starch remains;
it has not been broken down by the protease enzyme

B: biuret reagent changes to purple showing no protein remains; the protease has broken down the protein.

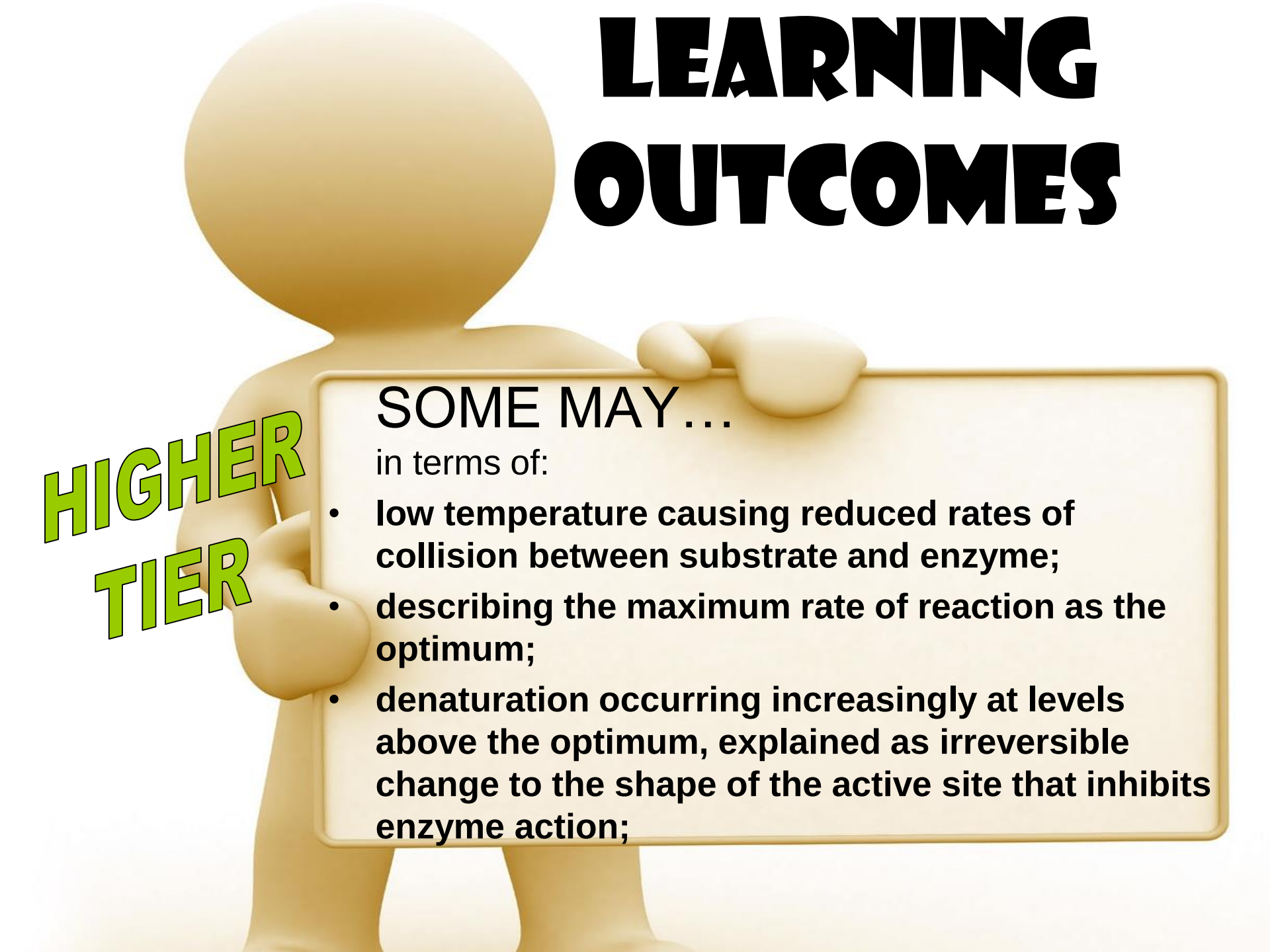
LEARNING OUTCOMES



ALL MUST…

Interpret the effects of temperature, pH and enzyme concentration on the action of enzymes

LEARNING OUTCOMES

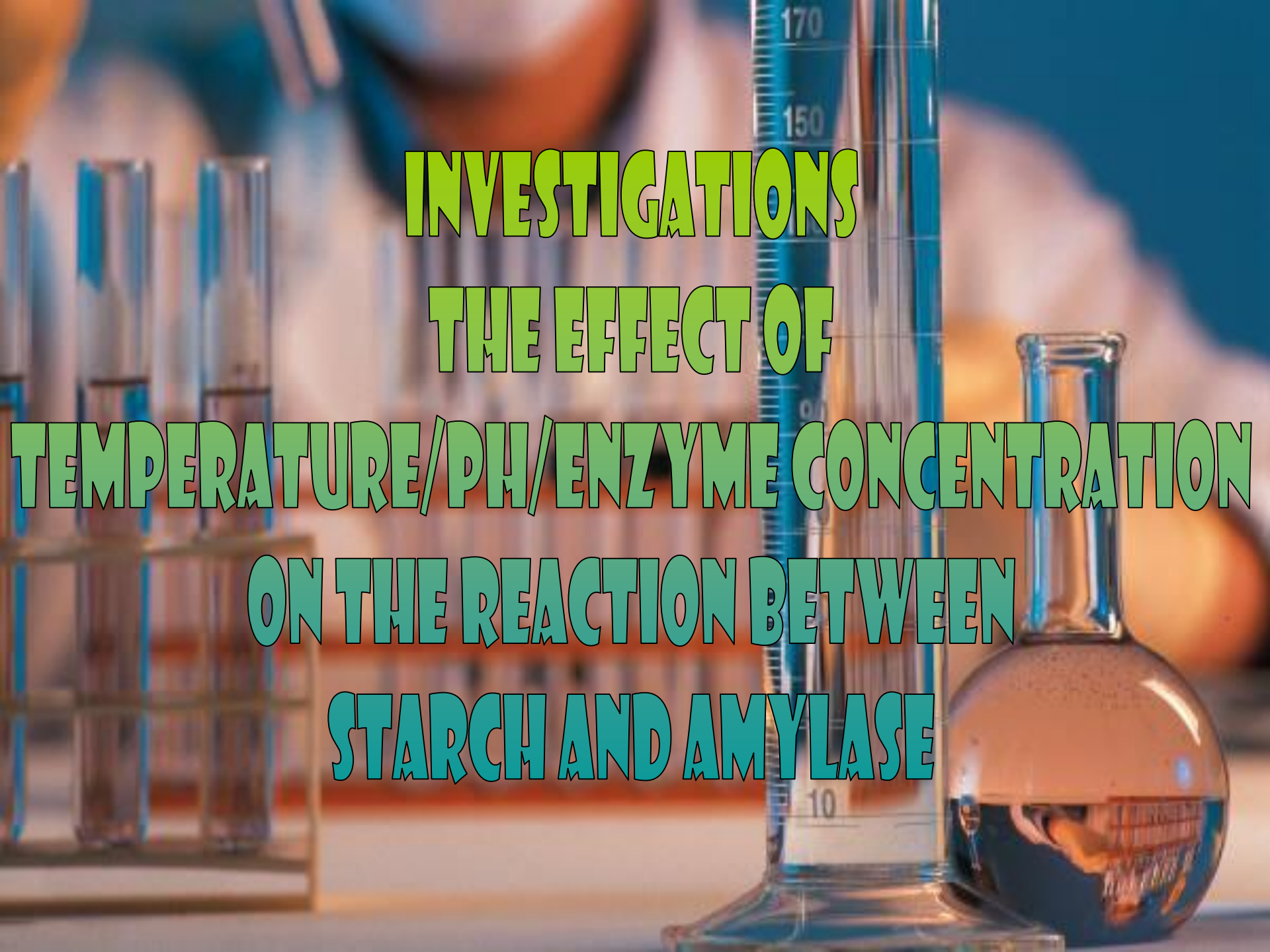


HIGHER TIER

SOME MAY…

in terms of:

- **low temperature causing reduced rates of collision between substrate and enzyme;**
- **describing the maximum rate of reaction as the optimum;**
- **denaturation occurring increasingly at levels above the optimum, explained as irreversible change to the shape of the active site that inhibits enzyme action;**



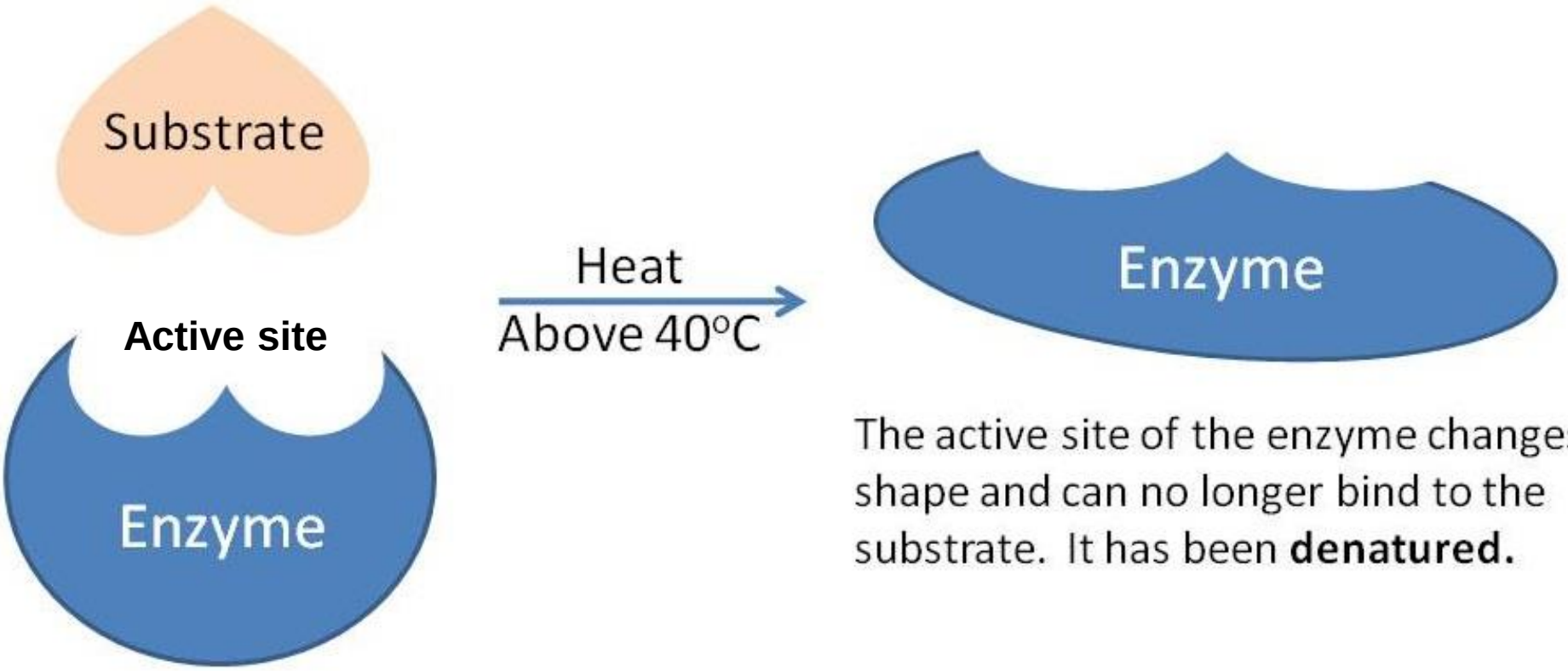
INVESTIGATIONS THE EFFECT OF TEMPERATURE/PH/ENZYME CONCENTRATION ON THE REACTION BETWEEN STARCH AND AMYLASE

TEMPERATURE

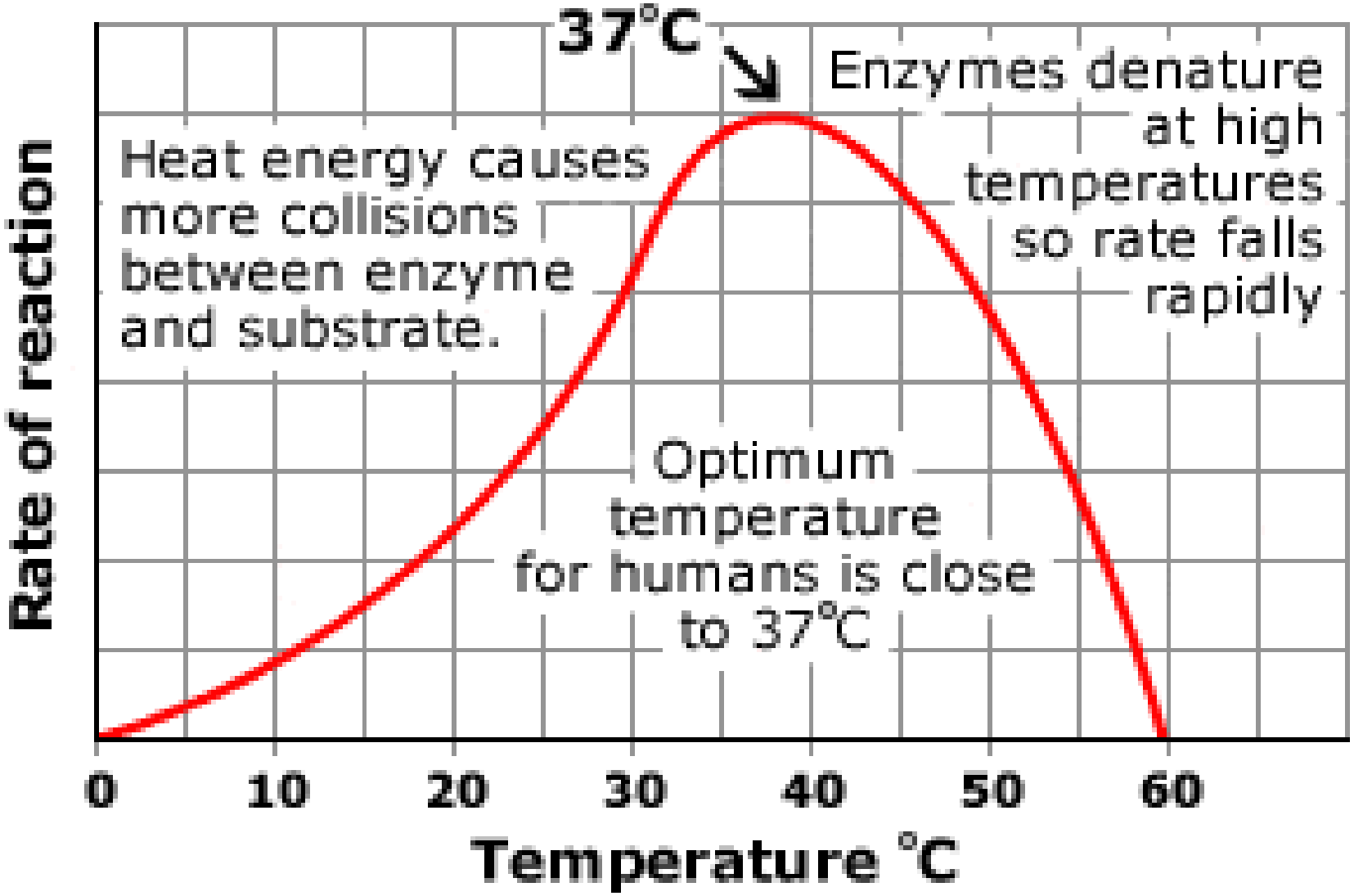
- **low temperatures** reduce the rates of collision between substrate and enzyme because there is **less kinetic energy**, so there are fewer reactions and the **rate of reaction is reduced**.
- As temperatures are **increased** there is **more kinetic energy** available, there are more substrate enzyme collisions and the **rate of reaction increases**

TEMPERATURE

- The temperature at which an enzyme works at its maximum rate of reaction is called the **optimum temperature**
- At temperatures above the optimum **the enzyme denatures**, the rate of reaction **slows** and eventually the reaction stops. This is due to a **permanent** change to the **shape of the active site** thereby **inhibiting** enzyme action
- The enzyme is said to have been **denatured**



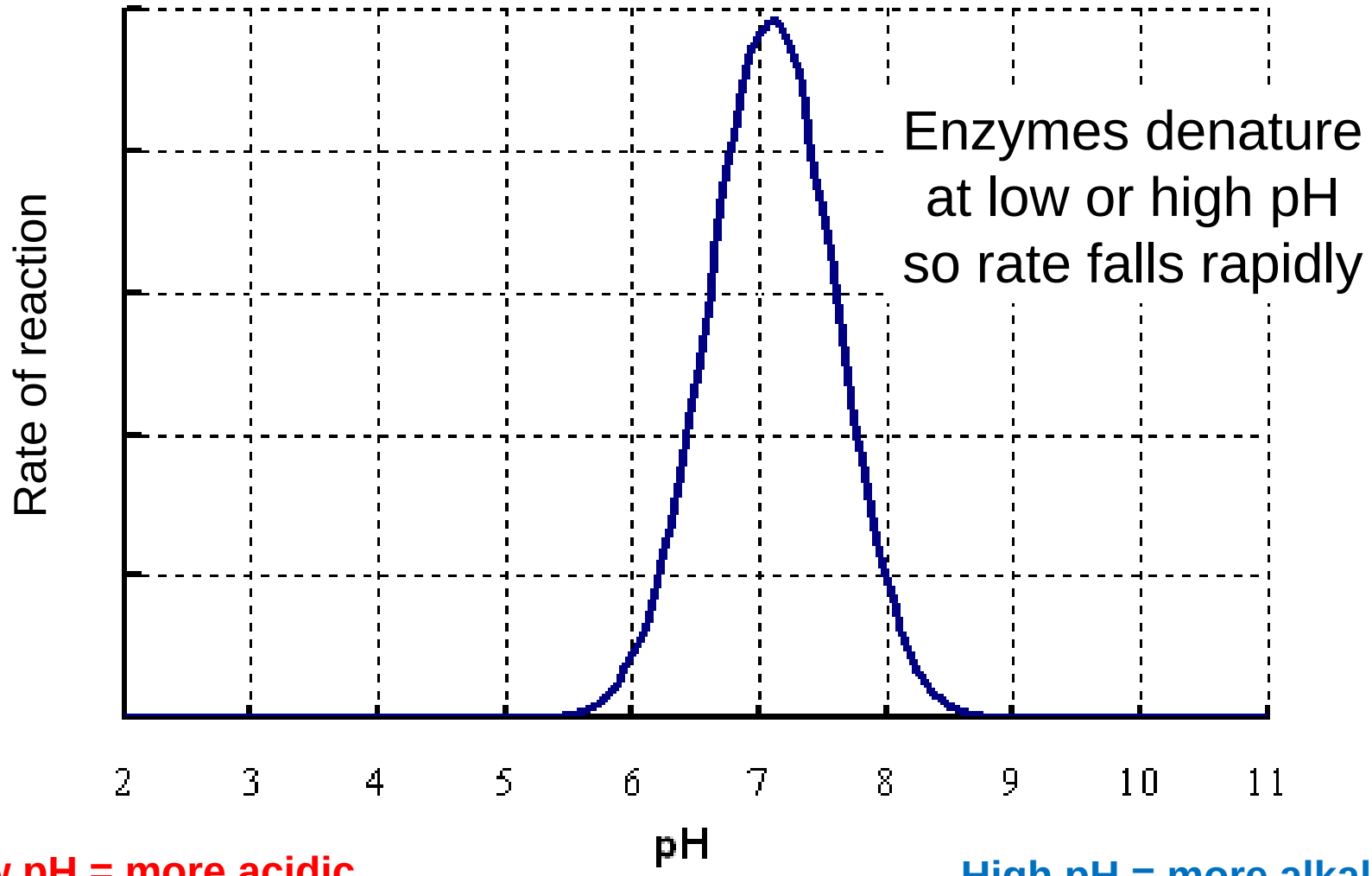
The active site of the enzyme changes shape and can no longer bind to the substrate. It has been **denatured.**


37°C
Enzymes denature at high temperatures so rate falls rapidly
Heat energy causes more collisions between enzyme and substrate.
Optimum temperature for humans is close to 37°C
Rate of reaction
0
10
20
30
40
50
60
Temperature °C

pH

- The pH at which an enzyme works at its maximum rate of reaction is called the **optimum pH**. This is usually pH 7.
- At pH values **above or below the optimum the enzyme is denatured**, the rate of reaction **slows** and eventually the reaction stops. This is due to a **permanent** change to the shape of the active site thereby inhibiting enzyme action
- The enzyme is said to have been **denatured**

Optimum pH for most human enzymes is pH 7



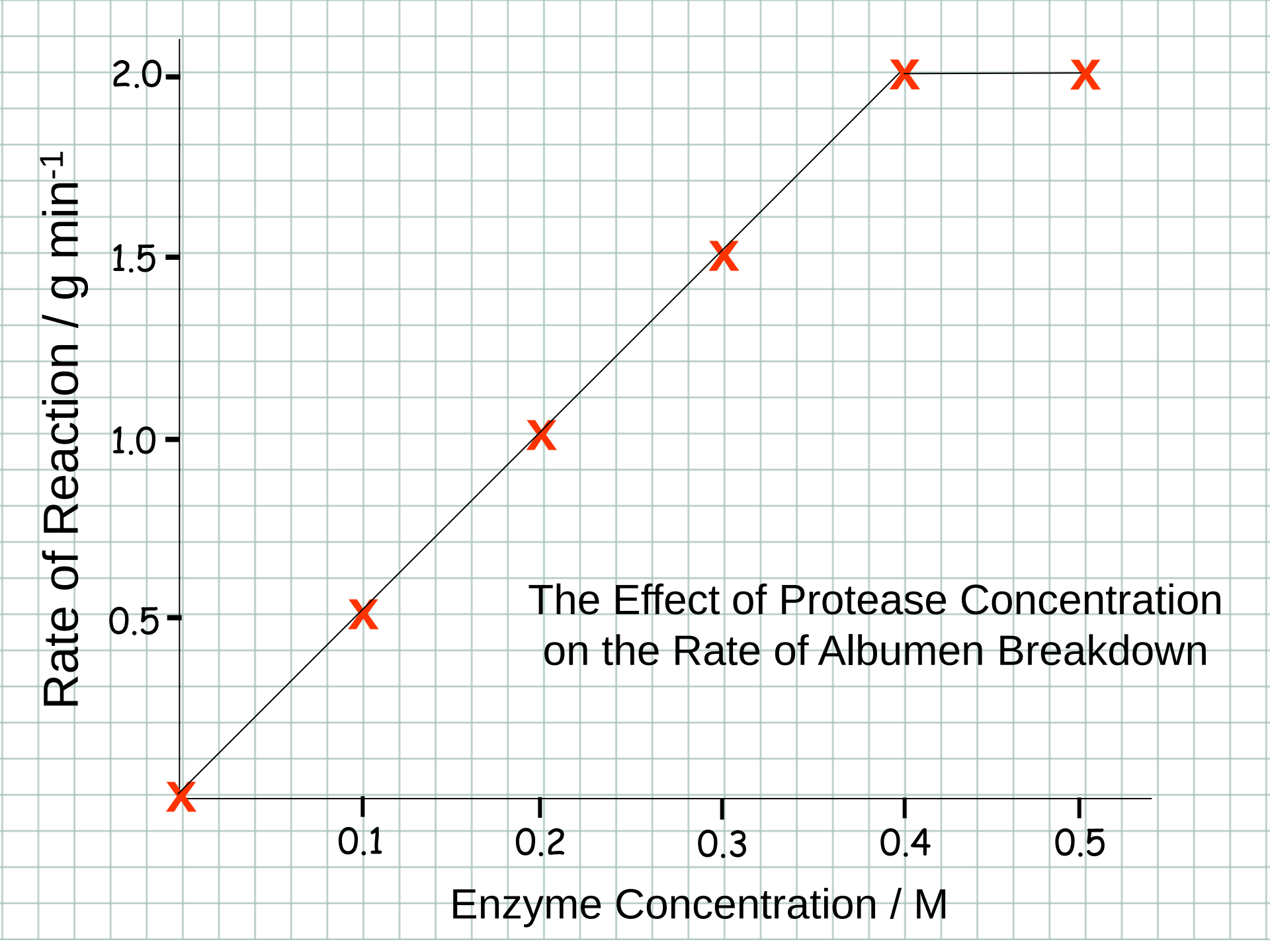
Enzymes denature at low or high pH so rate falls rapidly

Low pH = more acidic

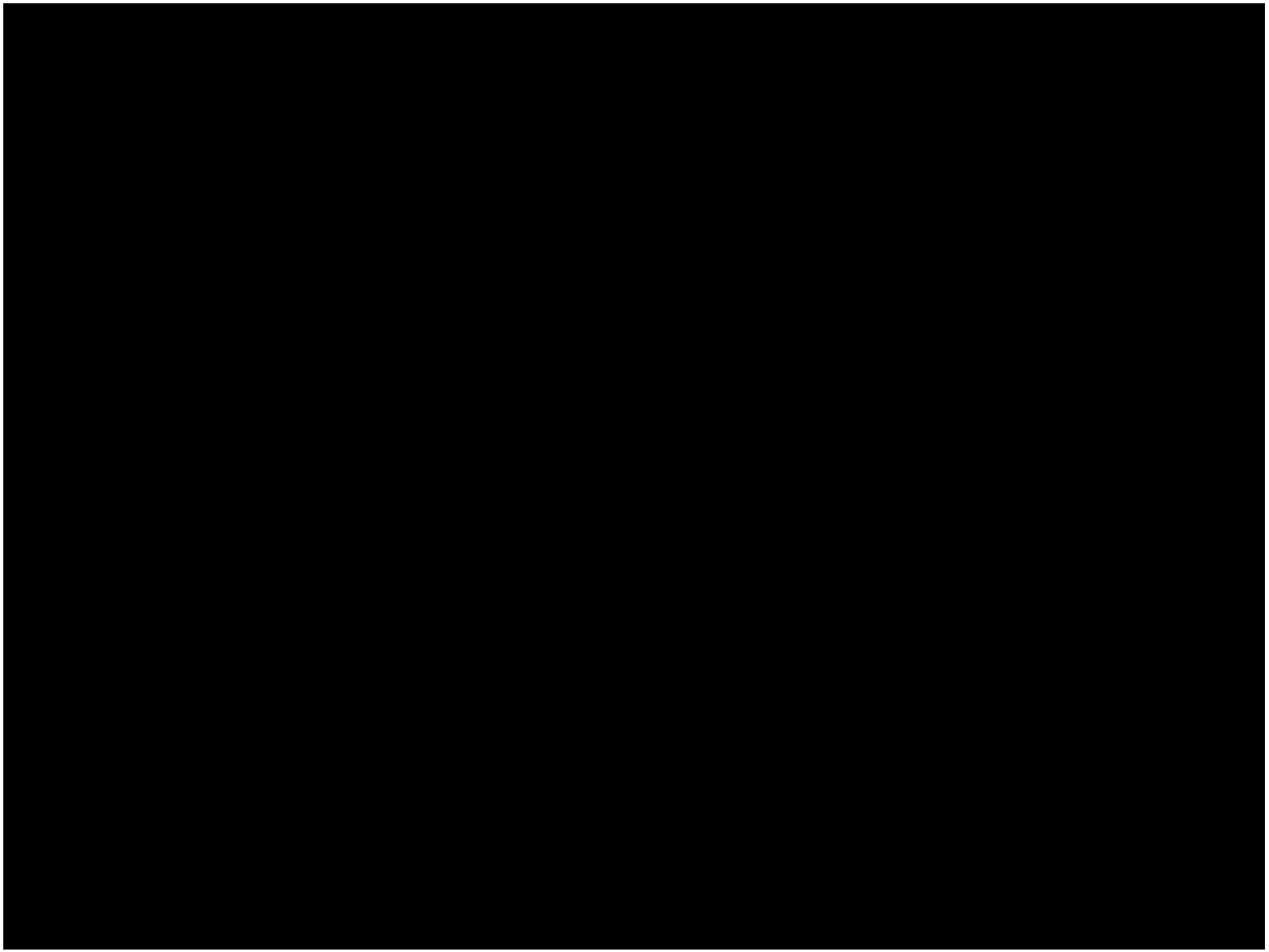
High pH = more alkaline

Enzyme Concentration

- The **more enzymes** there are the **faster the rate of enzyme reaction**.
- This is because there are **more enzyme active sites** for substrates to attach to.
- However eventually **the rate levels off** because there are **not enough substrate molecules to react with the extra enzymes**.


The Effect of Protease Concentration
on the Rate of Albumen Breakdown
Rate of Reaction / g min-1
2.0
1.5
1.0
0.5
0.1
0.2
0.3
0.4
0.5
Enzyme Concentration / M

BBC - GCSE Bitesize Enzymes activity.mp4



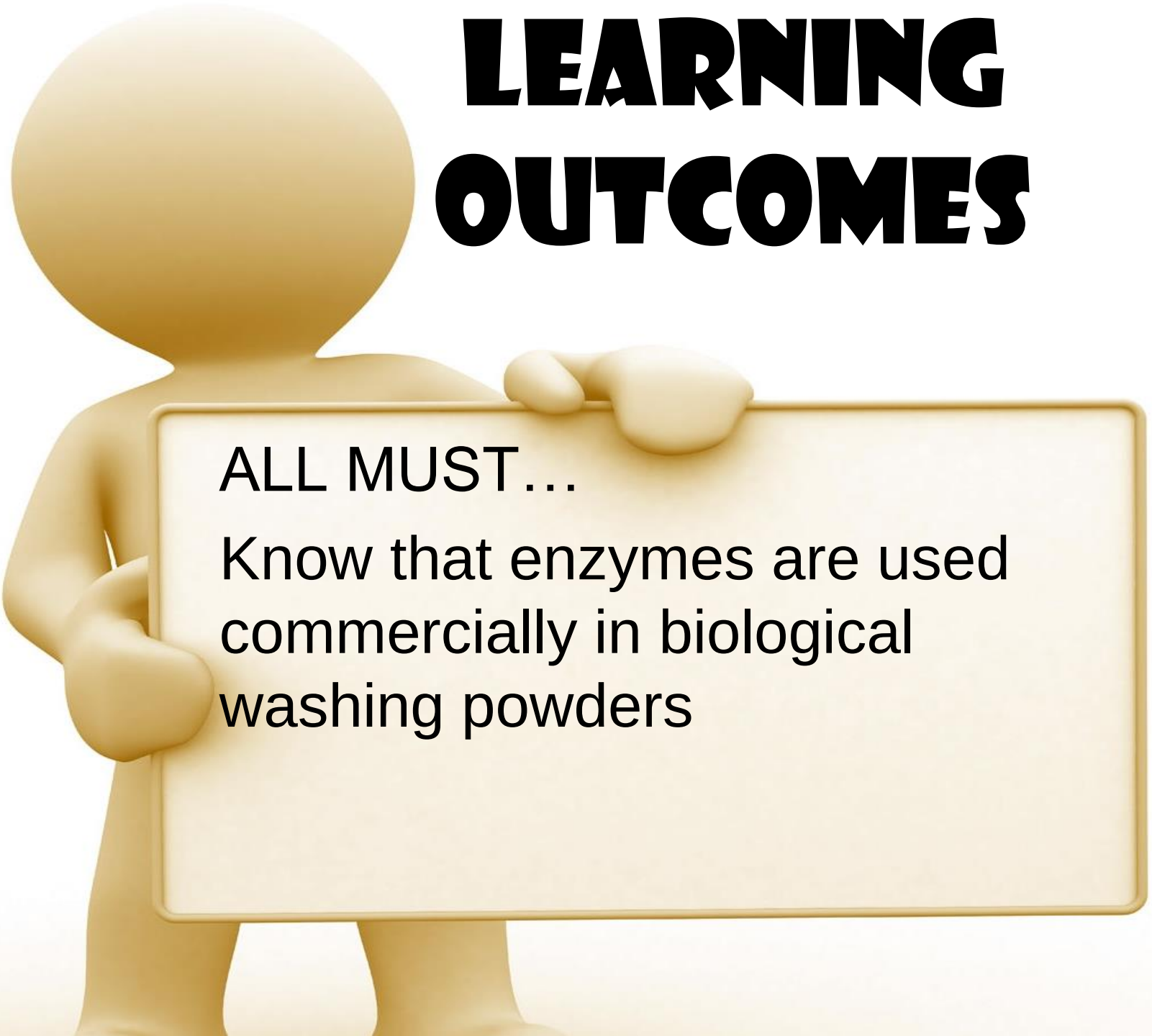
skoool enzymes

starter activity

video

B3

LEARNING OUTCOMES

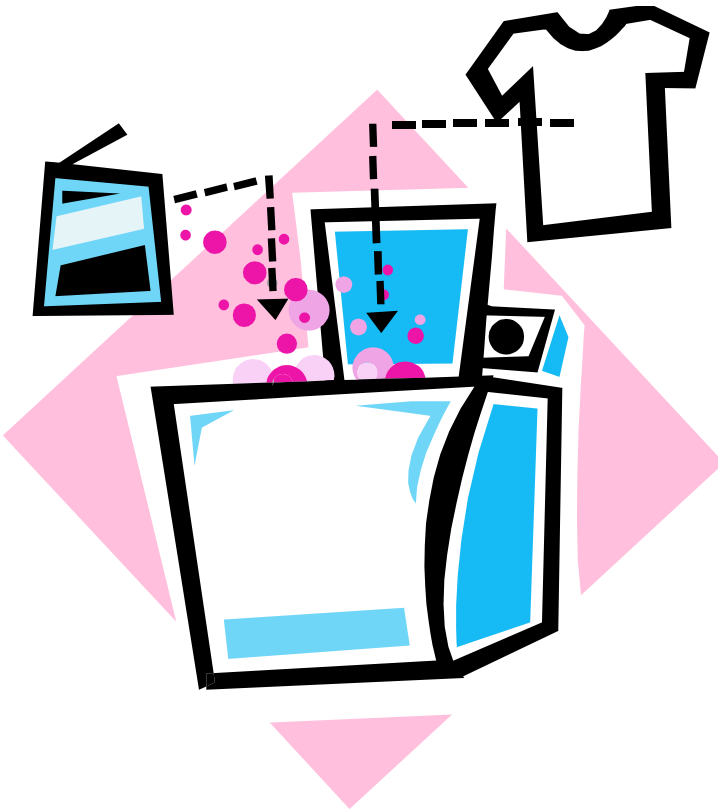


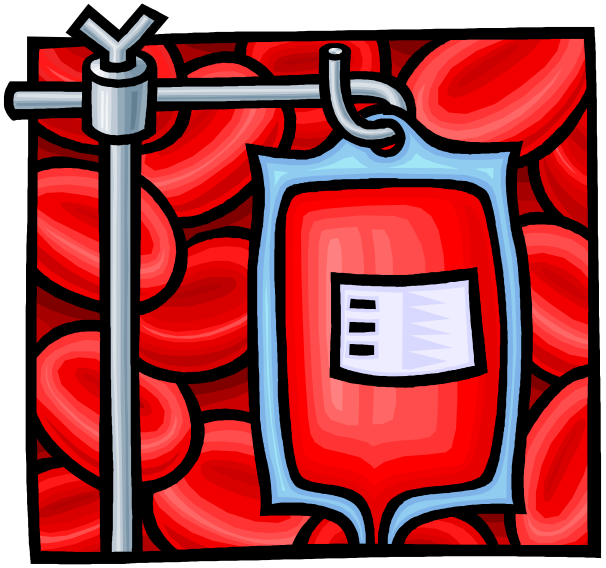
ALL MUST…

Know that enzymes are used commercially in biological washing powders

BIOLOGICAL DETERGENTS

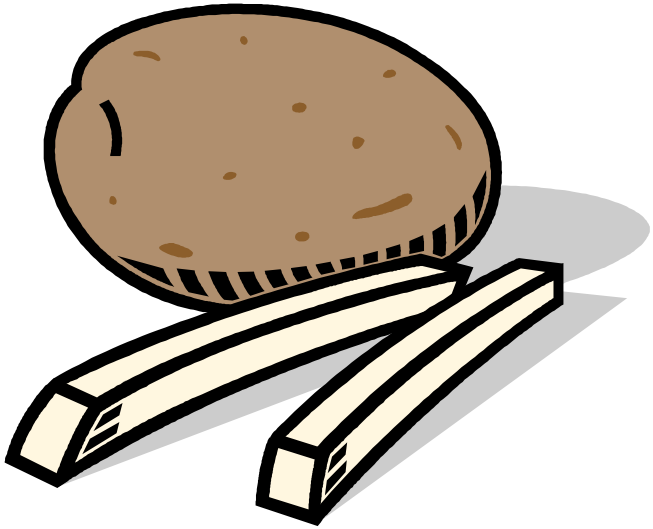
Enzymes are used to break down biological stains which can then be removed by a detergent.





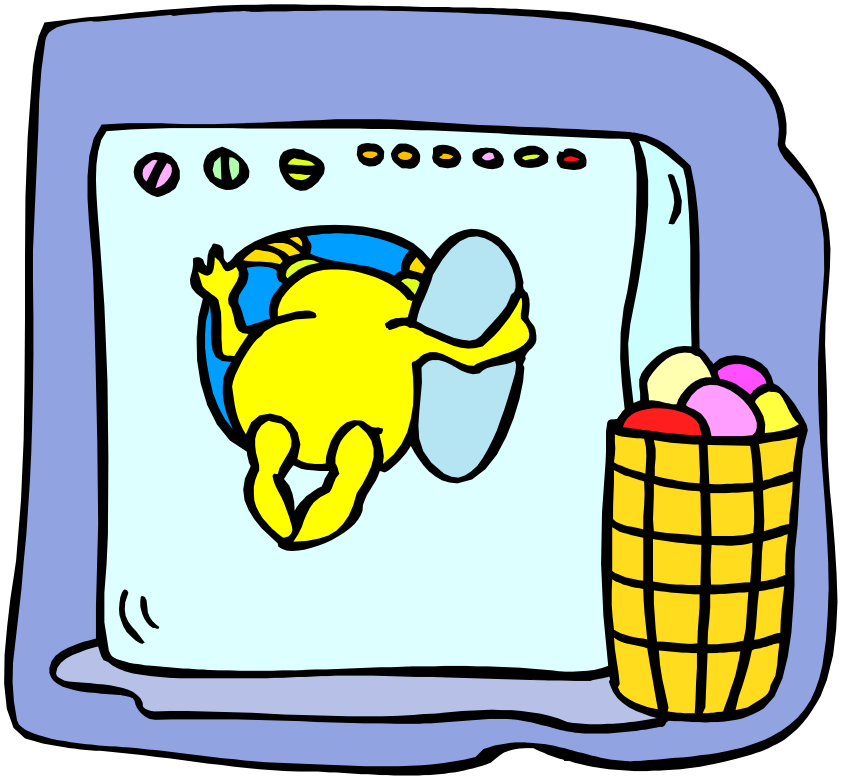
Protein stains (blood + sweat) are removed by proteases which break them down into amino acids.

Oil + grease are broken down by lipases into fatty acids and glycerol



Amylase allows the breakdown of starch compounds

Their effectiveness at low temperatures means that they are less demanding of energy and produce less wear of clothes.



Ask Jeeves

Literacy activity