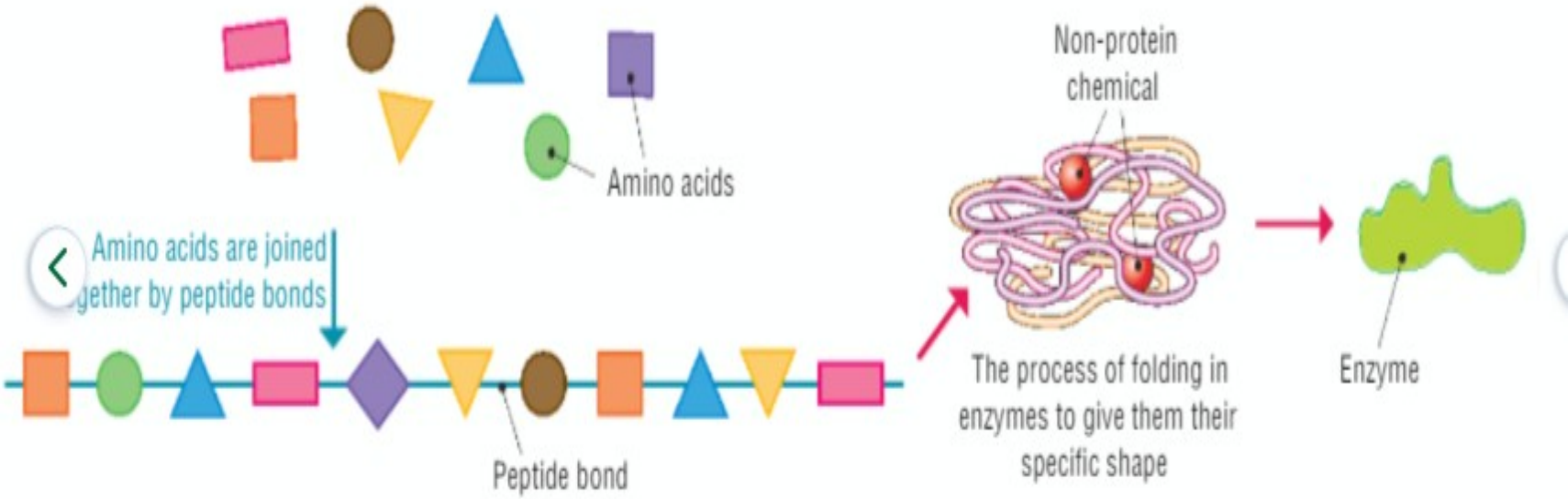
ENZYMES & METABOLISM

Metabolism

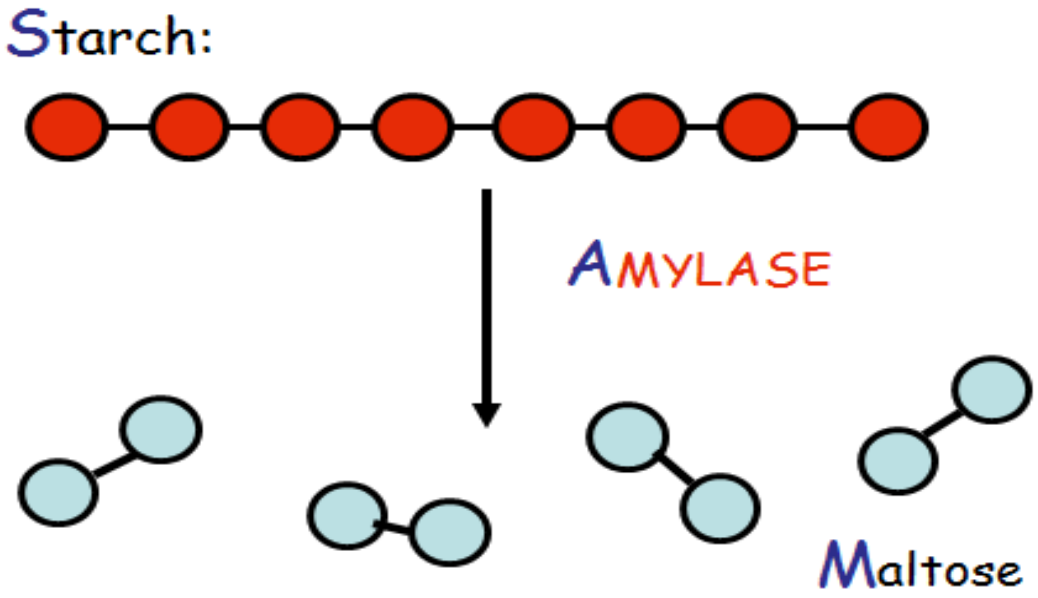
- **Metabolism** is all the chemical reactions that occur within a living organisms.
- All these reactions are controlled by enzymes.
- A metabolic pathway describes a series of reactions which result in a particular process e.g. respiration.
- Metabolic reactions can be divided into anabolic and catabolic reactions.



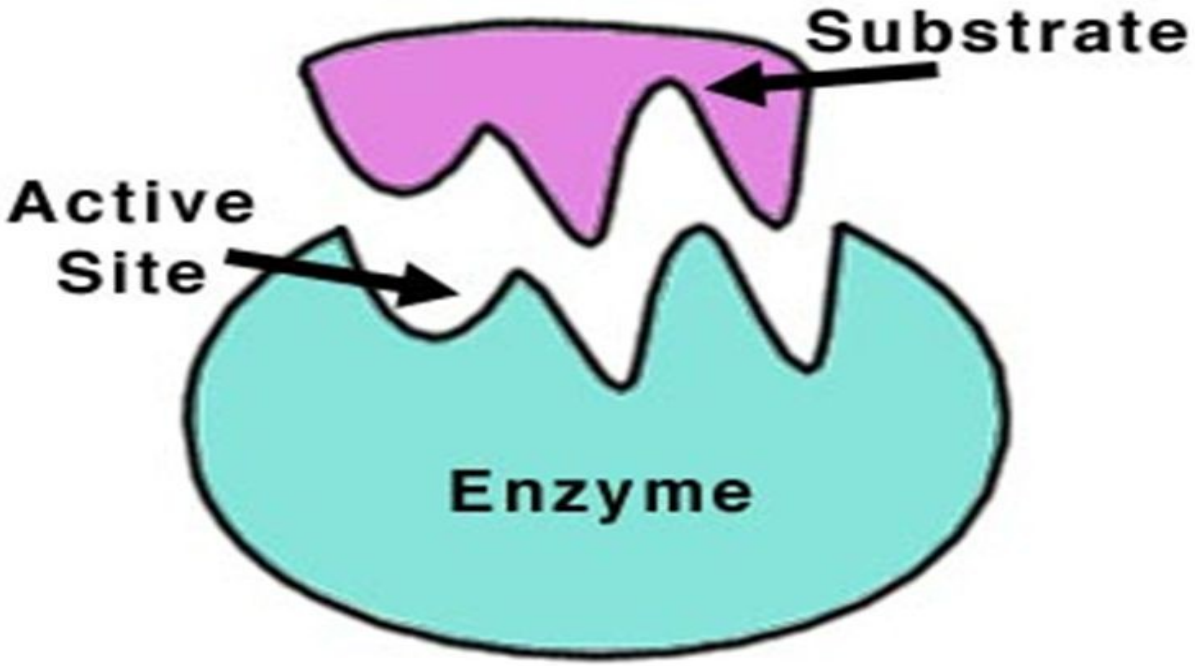
12.2 The process of folding in enzymes to give them their specific shape

ENZYMES

- An enzyme is a protein that speeds up a chemical reaction without being used up in the reaction



3.6.1: Define *enzyme and active site.*



Properties of enzymes

- Made of protein
- Speed up chemical reactions
- Specific to one reaction
- Can be reused many times
- They have a specific region on their surface which is called the active site
- They work on a substrate
- They produce a product
- Sometimes they need a co-enzyme to work.

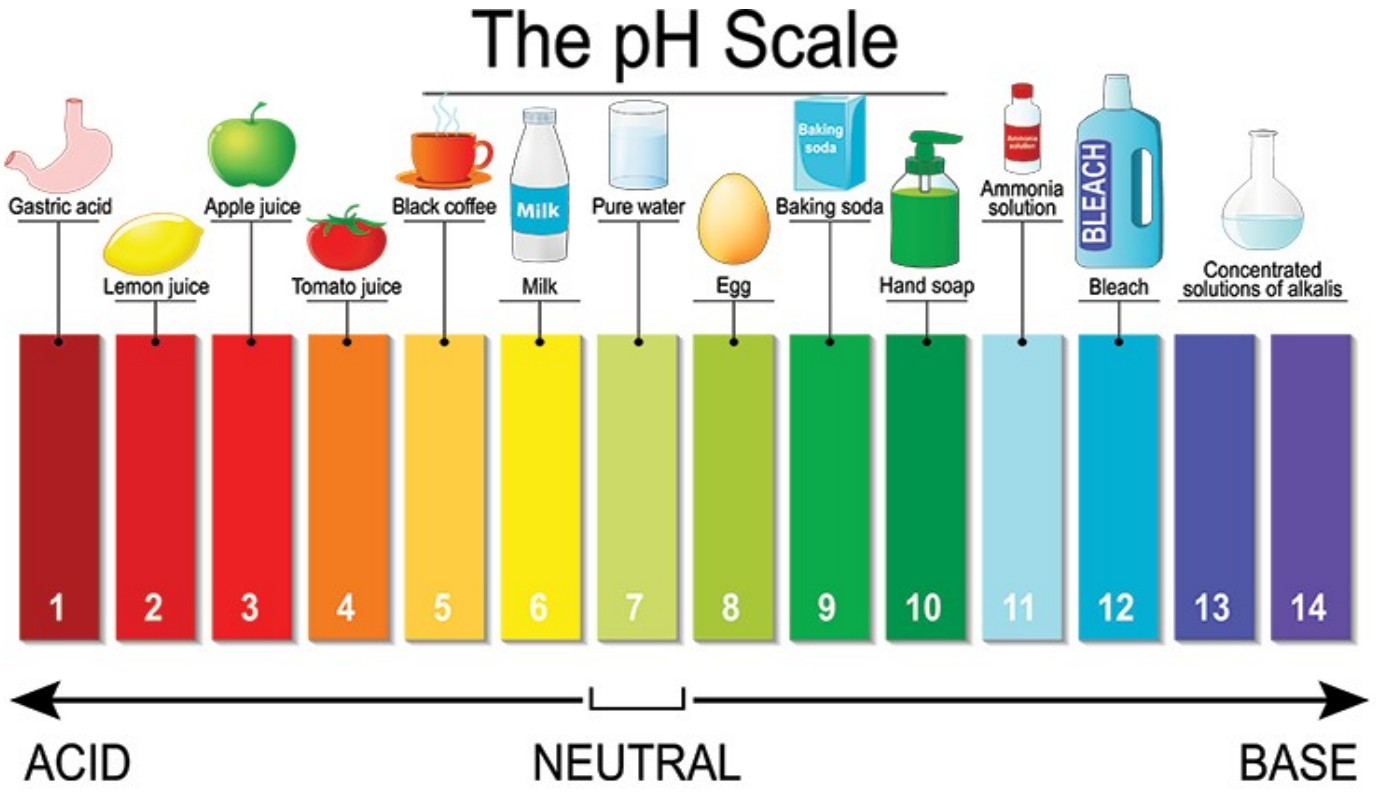
Examples of Enzymes

- **Pancreatic Amylase**-breaks down starch to glucose
- **Protease**-breaks down proteins and polypeptides into amino acids
- **Lipase**- breaks down fats into fatty acids and glycerol

Mechanism of enzyme action

- Induced Fit Theory

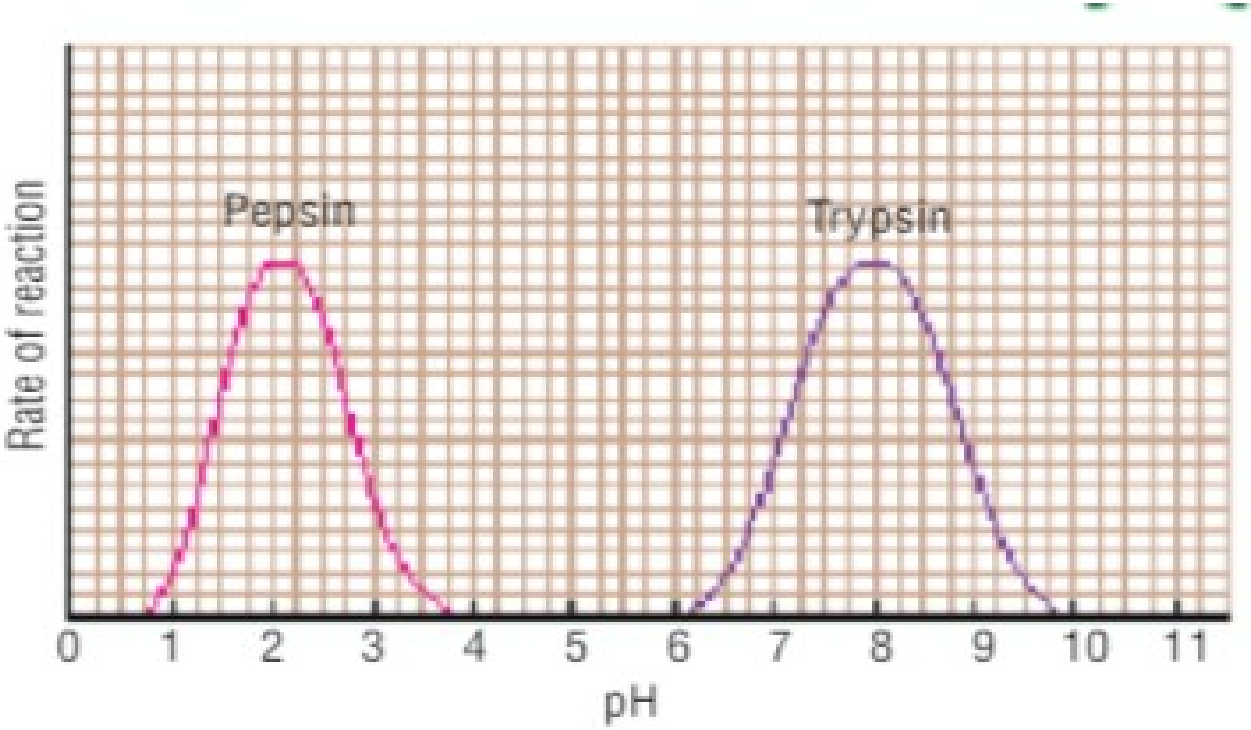
- The active site of an enzyme is a specific shape to fit the substrate.
- When the active site comes in close contact with the substrate it changes shape to closely fit the substrate.
- When the enzyme and substrate are joined together it is called the ‘enzyme-substrate complex’.
- The enzyme returns to its original shape and is then released leaving the product behind.
- The enzyme can now catalyse another reaction.


The pH Scale
Gastric acid
Lemon juice
Apple juice
Tomato juice
Black coffee
Milk
Pure water
Egg
Baking soda
Hand soap
Ammonia solution
Bleach
Concentrated solutions of alkalis
1
2
3
4
5
6
7
8
9
10
11
12
13
14
ACID
NEUTRAL
BASE

Factors influencing enzyme activity:

- 1) pH
  - pH is a measure of how acidic or alkaline(base that is soluble in water) a solution is.
  - Most enzymes work best in a narrow pH range close to neutral
  - Outside this pH range the shape of the enzyme changes and it can no longer catalyse the reaction. BECOMES DENATURED
  - Pepsin is an exception. Its optimum pH is 2 because it is active in the stomach.

Effects of pH on enzyme activity - graph



12.6 The effect of pH on the enzymes pepsin and trypsin

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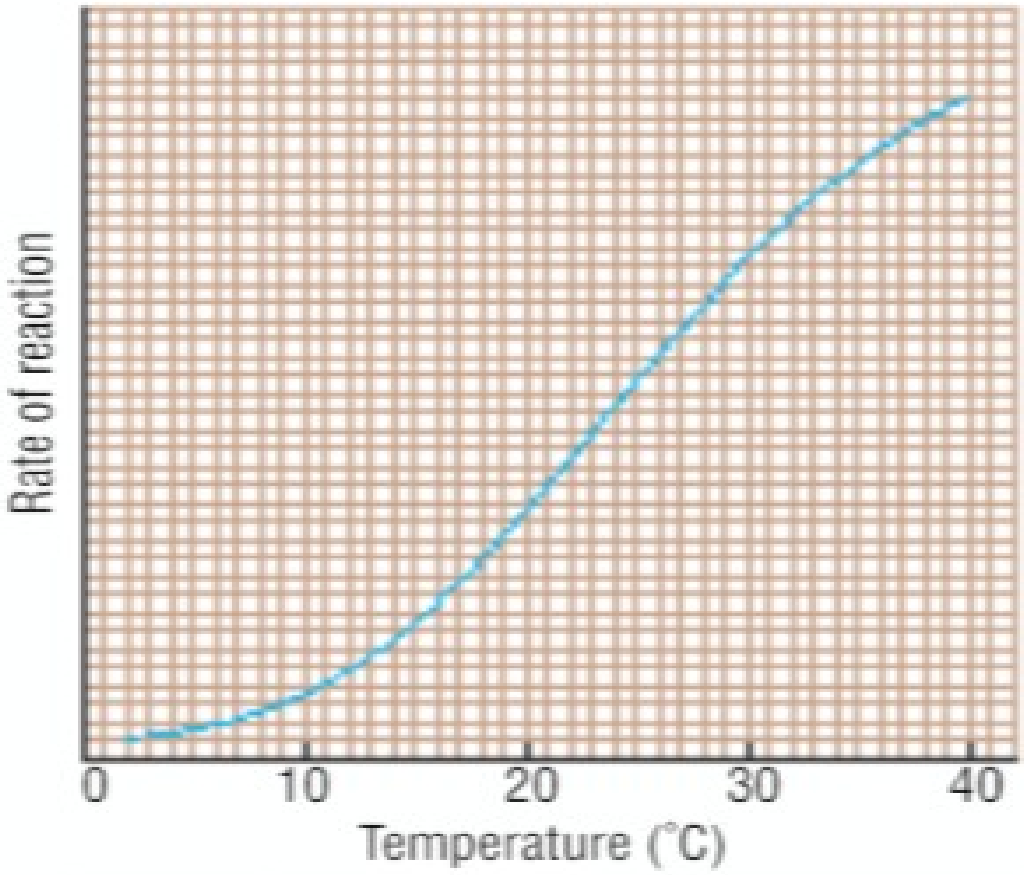
Factors continued…

- 2) Temperature
  - Temperature effects enzyme activity
  - Low temperatures mean less activity
  - As temperature increases, activity increases until it reaches an optimum temperature
  - Above the optimum temperature, activity starts to decrease
  - High temperatures change the shape of an enzyme and it becomes inactive – denaturation

- Optimum temperature for human enzymes is 37^{o}C – normal body temperature.
- Optimum temperature for plant enzymes is 20 – 25^{o}C or normal environmental temperature.

Effect of temperature on enzyme activity - Graph



12.12 The effect of temperature on the rate of enzyme action

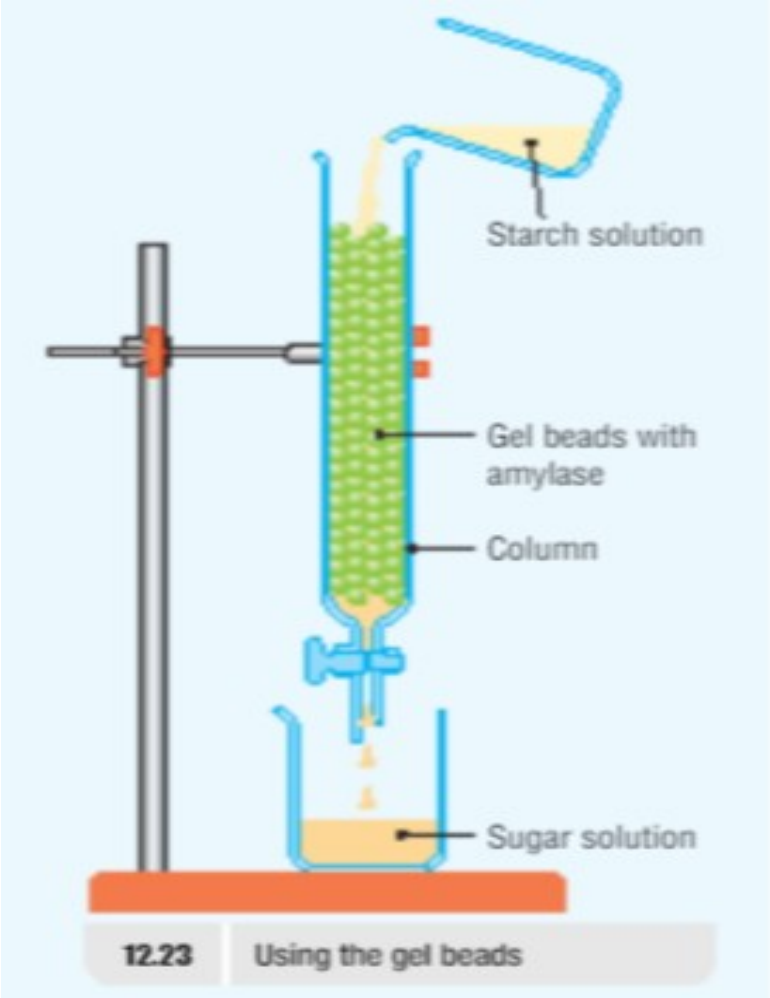
BIOTECHNOLOGY (Bioprocessing)

- Using living organisms or their enzymes to make useful products.
- Traditional
  - Brewing – using yeast
  - Baking – using yeast
  - Cheesemaking – using bacteria or fungi
- Modern
  - Antibiotics – using fungi or bacteria
  - Insulin – using genetically modified bacteria
  - Antibodies – to make diagnostic kits

Immobilised Enzymes

- A modern technique
- Useful enzymes (or a unicellular organism like yeast) are extracted.
- They are attached to an inanimate material (e.g. alginate) – immobilised.
- They are put into a column and the substrate poured on top.
- The product is collected at the end.

Diagram of column containing immobilised enzymes



12.23 Using the gel beads

Advantages of immobilisation

- They can be reused many times
- They are easily separated from the product
- They are more stable.

Examples:

Converting sucrose to glucose by the enzyme invertase.

Converting glucose to ethanol by yeast.