

Chapter 3

Nutrition Types and Nutrient Compounds



By the end of this chapter, I should be able to;

- a) understand the term Nutrition
- b) identify the food nutrients, their sources and importance to humans
- c) perform food tests for various nutrients
- d) appreciate the importance of a diet containing the different nutrients
- e) appreciate the concept of balanced diet in relation to age, sex and an individual's activity
- f) appreciate the causes and effects of nutrient deficiency in humans, including diseases related to malnutrition
- g) calculate body mass index (BMI) and explain its implication
- h) identify the major plant mineral nutrients, their role and the symptoms of deficiencies

The meaning of Nutrition

ACTIVITY

1. In groups, brainstorm on the meaning of the term nutrition.
2. discuss the modes of nutrition of different organisms in your community.
3. present your findings to the rest of the class and make a conclusion on the meaning of the term Nutrition

(15 minutes)

Ctd

- Nutrition is the process by which an organism takes in and utilizes food substances.
- These food substances are called **NUTRIENTS** and they vary according to the nature of the organism. For green plants, the nutrients are inorganic

Nutrients in the food we eat

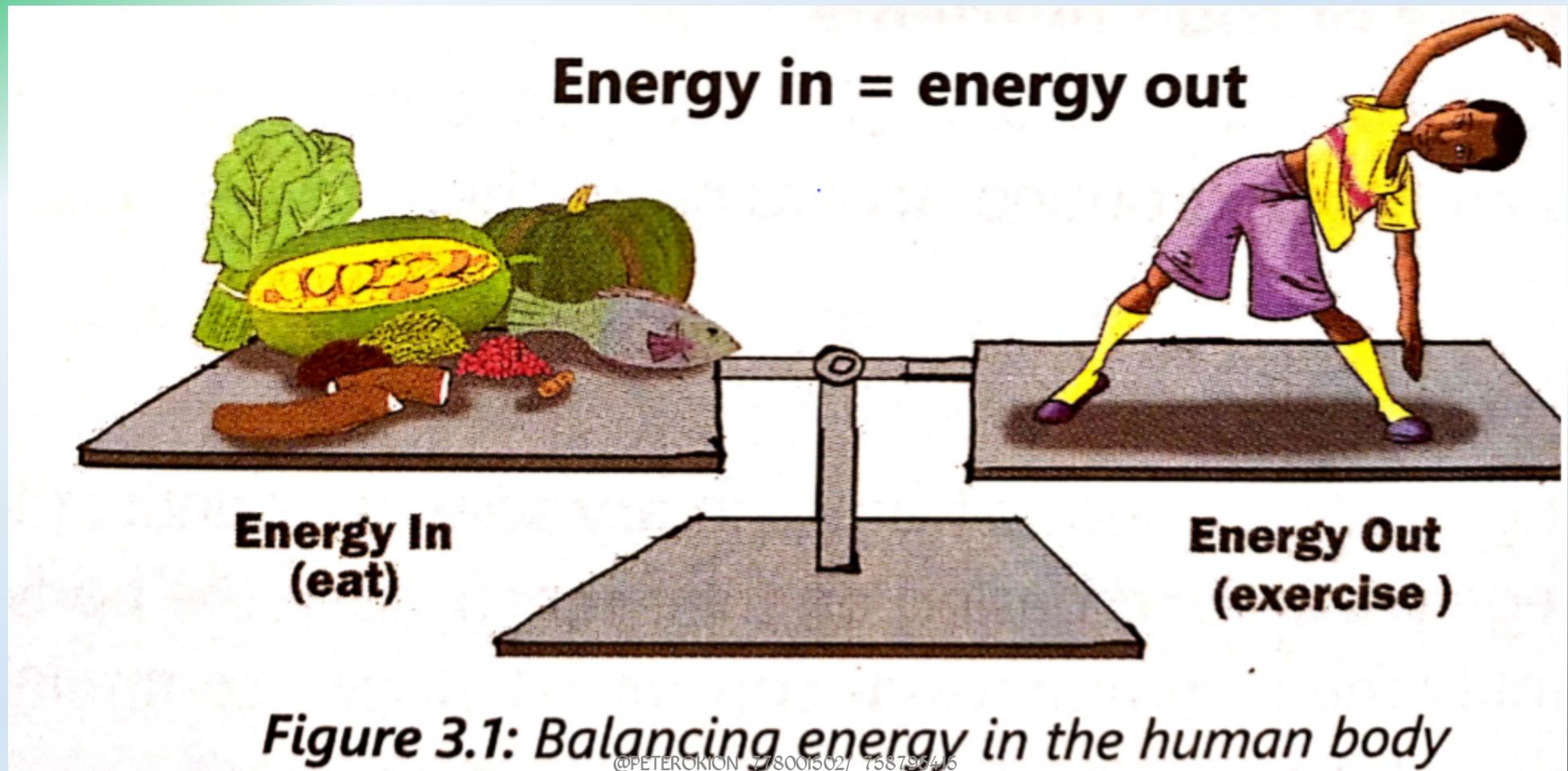
1. Can you live without eating food?
2. How do you feel when you spend some hours without food?
3. What is the food you eat used for?

ctd

- When you carryout physical activities e.g. playing football, netball or walking, energy is used. Even if you are doing passive activities like sitting, watching TV or sleeping, energy is still required to maintain a state of order in your body.

the energy for carrying out these activities comes from the food we eat

Energy balance in the human body



You have seen children who are stunted and those with pot bellies.

QN: What do you think could have caused such conditions among those children?

Like all other living organisms, our bodies need nutrients to carryout metabolism and synthesize proteins and other substances needed for your body to grow and develop. The source of these nutrients is the food we eat.

Ctd

- Nutrients are chemical substances that organisms need in order to live and grow.

QN: what are the different food nutrients required by our bodies?

- On a daily basis, you eat foods containing such nutrients in different amounts. Basing on the quantity that your body needs, nutrients are categorized into two groups;

1) the ones which our bodies need in fairly large amounts i.e. **MACRO-** nutrients. These are needed for, energy supply and growth

QN: what are the examples of these nutrients?

2) the ones which our bodies require in small amounts are the **MICRO-nutrients**

QN: what are examples of these nutrients?

Types and importance of food nutrients

- Most foods are mixtures of nutrients and many of them contain more of one nutrient than others. Foods are often grouped according to the nutrients that they contain in abundance

ACTIVITY

- 1) using your knowledge from primary science, identify 3 categories of food basing on their functions in the body
- 2) identify the common foods consumed in your community?
- 3) make a list of the nutrients present in those foods.

Carbohydrates

- Carbohydrates are the body's main source of energy; up to 65% of our energy comes from carbohydrates

ACTIVITY

- In groups, carefully study pictures in fig;3.2
- 1) Identify the food sources which are rich in carbohydrates
 - 2) Which other food sources in your community are rich in carbohydrates?
 - 3) What is the importance of carbohydrates in the body)

Share your findings with the rest of the class

• pictures in figure 3.2

What to do



yams



irish poatoes



cheese



bread



beef



milk



cassava



sweet potatoes



eggs



sorghum



ground nuts



bananas



maize



liver



sugar canes

soln

- 1) yams, Irish potatoes, cassava, sorghum, maize, sweet potatoes and sugar canes.
- 2) rice, simsim, wheat, bread

Classification of carbohydrates

- Carbohydrates are classified basing on the number of sugar units they contain. They are classified into 3 groups i.e.
 - 1) Monosaccharides (“mono” meaning single/one, “saccharide” meaning sugar)
 - 2) Disaccharides
 - 3) polysaccharides

Monosaccharides and disaccharides

- These are referred to as **simple sugars** or **simply carbohydrates** that our body can easily utilize. For this reason, people with **diabetes mellitus** should not eat too much of these carbohydrates.

QN: What are the examples of such foods? (give examples of mono and disaccharides)

Polysaccharides

- These are also called **complex carbohydrates**. They need to be broken down into simple sugars in order to be used by our body.
- They can be consumed by a diabetic patients without restriction.

QN: What are examples of such foods?

Exercise

- **Suggest why:**
 - a) monosaccharides and disaccharides are referred to as simple sugars
 - b) poly saccharides are referred to as complex sugars.

Proteins

- Do you enjoy drinking milk? Milk is one of the sources of proteins that you need to build body structures.
- Animal products contain more proteins than plant products and are therefore usually better sources of body building foods.

ACTIVITY

In groups, carefully study the pictures in fig 3.3;

- 1) Identify the food sources which are rich in proteins
- 2) Which other foods in your community are rich in proteins?
- 3) What are the importance of proteins in the body?

Share your findings with the rest of the class



yams



avocado



cheese



bread



beef



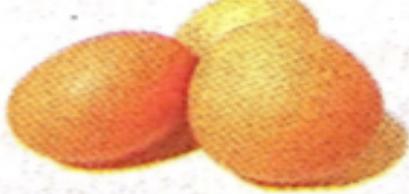
milk



cassava



sweet potatoes



eggs



chicken



bananas



maize



ground nuts



fish



liver



beans

soln

- 1) beef, avocado, eggs, fish, milk, butter, cheese, chicken and beans
- 2) soya beans, animal flesh

Lipids (fats and oils)

- When beef or offals (internal organs of animals) are prepared at home and the soup is allowed to cool, white or yellowish solids form on the surface. These are fats and when heated, they melt to form a liquid called oil. Fats and oils are the most common forms of lipids and they are a concentrated source of energy. They are important nutrients for young children who need a lot of energy. Fats can also make meals more tasty and satisfying. Lipids are common in animal food sources.

NB:

- Lipids contain more energy than an equivalent mass of carbohydrates. For example 1g of fat yields 39kj (kilojoules) of energy and set in 1g of carbohydrates yields 17kj of energy

Activity

- In groups, carefully study the pictures in fig. 3.4
 - 1) Identify the food sources which are rich in lipids
 - 2) Which other food sources in your community are rich in lipids?
 - 3) Why do you always include the foods you have identified in your diet?
 - 4) Outline 4 differences between fats and oils

Share your findings with the rest of the class



yams



beef



eggs



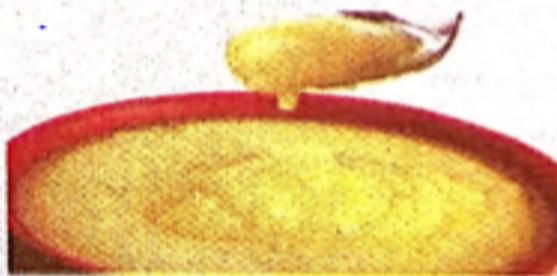
cooking oil



avocado



milk



Ghee



cheese



cassava



bread



sweet potatoes



liver



sugar canes

soln

- 1) beef, avocado, eggs, fish, milk, butter, cheese and groundnuts
- 2) yoghurt, margarine, sunflower and simsim

Vitamins

- Have you seen a child with bow shaped legs?

This symptom is caused by lack of vitamins in the child's diet. There are a range of vitamins that our bodies need to be healthy.

Assignment

In your groups, research the various vitamins known, source, functions and deficiencies and present in the table below

Present your findings to the class

Vitamin	Common Food source	Functions	Symptom of deficiency
A (Retinol)			
B1 (Thiamine)			
B2 (Riboflavin)			
B3 (Nicotinic acid/ Niacin)			
B12 (Cobamine)			
C (Ascorbic acid)			
D (calciferol)			
E (tocopherol)			
K (phylloquinone)			

Vitamin	Common Food source	Functions	Symptom of deficiency
A (Retinol)	Green vegetables, liver, butter, margarine, egg yolk and carrots	Growth in children Resistance to eye and respiratory tract diseases Good night (dim light) vision	Night blindness (poor dark adaptation) Frequent cold, sore eyes and unhealthy skin
B1 (Thiamine)	Yeast, beans, lean meat, egg yolk, bread and rice husks	Tissue respiration Keeps the heart, nerves and digestive organs healthy	Tiredness (fatigue) Retarded growth in children Poor appetite and pain in limbs
B2 (Riboflavin)	Yeast, milk, liver, cheese, leafy vegetables	Tissue respiration, growth and health of skin, keeps mucus membrane healthy	Retarded growth in children Cracks on lips, poor vision and skin disorders
B3 (Nicotinic acid/ Niacin)	Cereal grains, milk and its products, yeast and liver	Same as B2	Pellagra- disorders of Central Nervous System (CNS) like memory loss and depression
B12 (Cobamine)	Beef, kidney, liver, yeast	Forms Red Blood Cells	Anaemia – low blood count
C (Ascorbic acid)	Fresh fruits and raw vegetables	Development of teeth, bone and normal growth Repair of body tissues Proper function of the immune system	Scurvy- sore gums, poor healing of sores in the gum

D (calciferol)	Liver, fish, egg yolk, formed beneath skin of man in sunlight	Building hard and strong bones and teeth Promotes absorption of phosphorus and calcium in the gut	Rickets -weak bones and teeth, rickets in children and dental caries
E (tocopherol)	All foods	Anti-oxidant to prevent excess energy production Promotes fertility in animals like rats	Sterility (infertility) in animals like rats Muscle weakness
K (phylloquinone)	Cabbage, spinach	Normal clotting of blood	Prolonged bleeding

Minerals

- When you are preparing meals at home, you always add salt. The salt is a source of some minerals needed by your body to function well.
- Minerals are inorganic substances that we need to ensure proper functioning of our tissues, fluids and skeleton.
- Some minerals are required in larger amounts in the body (**macro minerals**). While others are required in smaller amounts (**micro minerals**)

Activity

- In groups, using the internet or Biology reference materials, research about the food sources and functions of the following minerals in the diet, Calcium, iron, iodine, phosphorous and sodium
present your results in the table below;

Minerals	Function	Food source
Calcium		
Iron		
Iodine	For normal functioning of the thyroid gland which controls the metabolic rate	
Phosphorus		Milk, cheese, liver, butter, egg yolk
Sodium		

Minerals	Function	Food source
Calcium	<p>Gives bones and teeth rigidity and strength</p> <p>For functioning of muscles and nerves</p> <p>Needed for normal blood clotting</p>	<p>Milk, cheese and dairy products</p> <p>Foods fortified with calcium for example flour, cereals, eggs, fish and cabbage</p>
Iron	<p>For making Haemoglobin, (the red pigment in blood) which carries oxygen</p>	<p>Beef and meat products, egg yolk, bread, green leafy vegetables, pulses and fruits</p>
Iodine	<p>For normal functioning of the thyroid gland which controls the metabolic rate</p>	<p>Iodized salt, sea vegetables, sea fish, yoghurt, cow's milk, eggs and cheese</p>
Phosphorus	<p>For growth of bones and teeth</p> <p>Formation of energy store (ATP)</p> <p>Maintains constancy of body fluids</p>	<p>Milk, cheese, liver, butter, egg yolk</p>
Sodium	<p>Keeps electrolyte balance in the body</p> <p>Control the blood pressure and value</p>	<p>Table salt, salted nuts</p>

ROUGHAGES / DIETARY FIBRE

They are indigestible materials in food and consist mostly of cellulose, pectin, and lignin. The major sources of roughages include: vegetables, such as cabbages, dodo, fruits, etc.

Functions of roughages

- ✓ They stimulate muscular movements called peristalsis which move food (propel) through the alimentary canal.
- ✓ Add bulk to food enable food nutrients pass through the intestines very fast.

NB: Deficiency or lack of roughages causes constipation.

Food tests

- In the laboratory, tests are carried out to find out which nutrients are present in certain foods.
- Chemicals known as reagents, are added to solutions which change color to indicate the presence or absence of particular substances in the food

Test for simple sugars

- Most of the simple sugars e.g. glucose are called Reducing sugars. These can be identified by adding **Benedict's solution** to the mixtures where simple sugars are suspected to be and then heating the mixture.

Observation

- The color of the food sample will change from **Blue** to **Green** to **Yellow** to **Orange** and finally to a **Brick-red ppt** to confirm the presence of reducing sugars



Blue
Solution

Green/Yellow
Precipitate

Orange
Precipitate

Brick-red
Precipitate

None

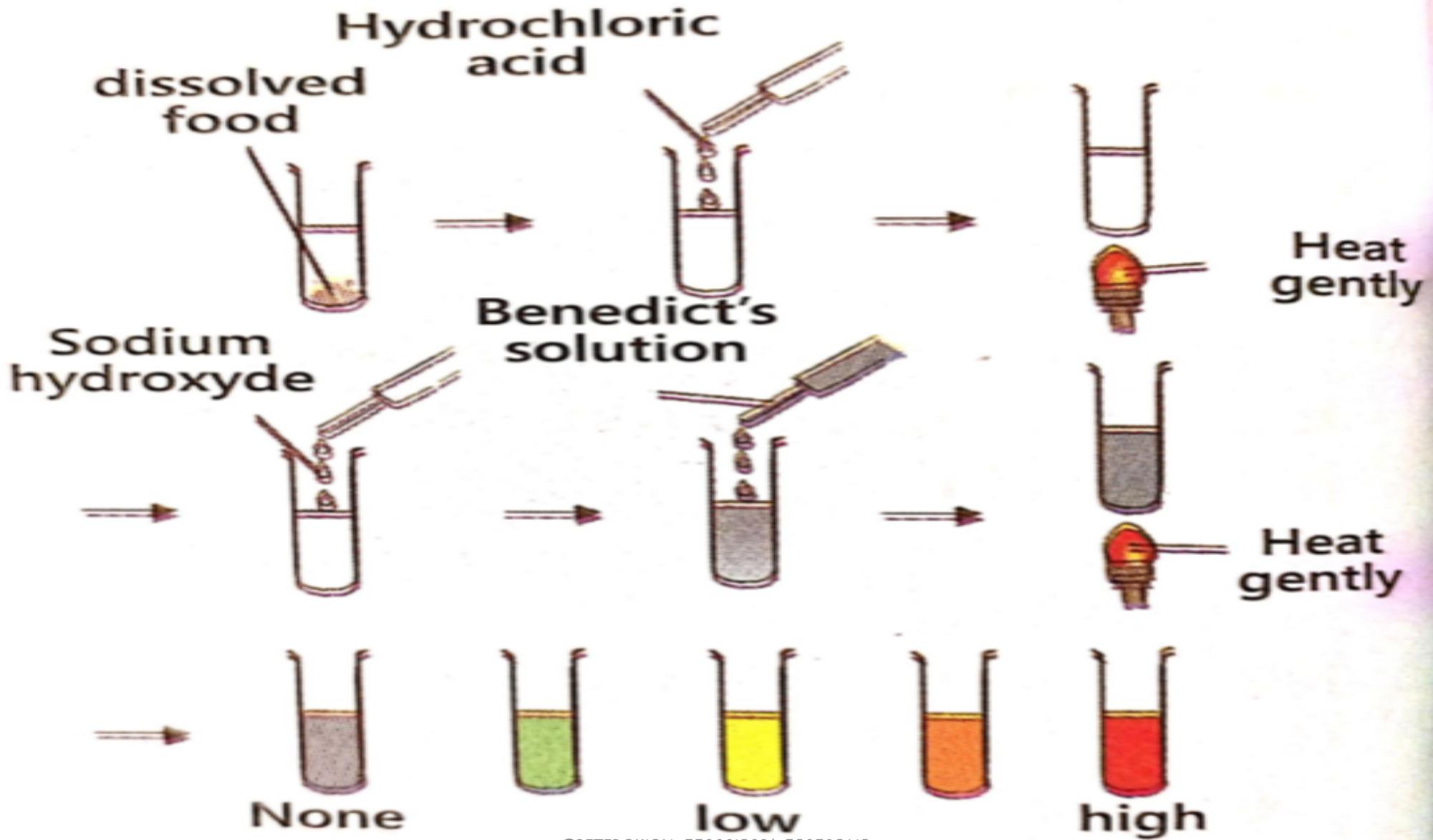
Traces of
reducing sugar

Large amount of
reducing sugar

Procedure	Observation	Conclusion
To 1 cm ³ of food solution, add 1 cm ³ of Benedict's solution and boil.	Solution turns to a blue solution, then to a green solution, to a yellow precipitate, to orange precipitate and to a brown precipitate on boiling.	Little or Moderate or Much reducing sugars present.
	Solution turns to a blue solution which persists on boiling.	Reducing sugars absent.

Test for non-reducing sugars (sucrose/ cane sugar)

- This is called so because it cannot change the color of Benedict's solution when heated. Therefore the sugars in the solution are first broken down to reducing sugars by boiling them in **dilute Hydrochloric acid**. **Sodium hydroxide solution** is added to neutralize the solution and then **Benedict's solution** is added to give observations as those seen for Reducing sugars



1. Test for non-reducing sugars

procedure	Observation	conclusion
To 1 cm ³ of food solution add 1 cm ³ of dilute hydrochloric acid and boil, cool under water then add 1 cm ³ of sodium hydroxide solution, followed by 1 cm ³ of Benedict's solution and boil.	Solution turned to a blue solution, then to a green solution, to a yellow precipitate and to a brown precipitate on boiling.	Little or Moderate or Much non-reducing sugars present.
	Colourless or turbid solution turned to a blue solution which persists on boiling.	Non-reducing sugars absent.

Test for complex carbohydrates (starch)

- Starch can be identified by adding a few drops of iodine solution to a mixture in which starch is suspected to be a component.

Observation

- The color of the solution turns black, blue-black or blue depending on the quantity of starch present



Positive result

Dark blue/black solution



Negative result

Brown solution

Procedure	Observation	Conclusion
To 1 cm ³ of food solution, add 3 drops of iodine solution.	Solution turned to a black or blue-black or blue solution or brown solution with black specks.	Much moderate little starch present.
	Solution turned to a yellow or brown solution.	Starch absent.

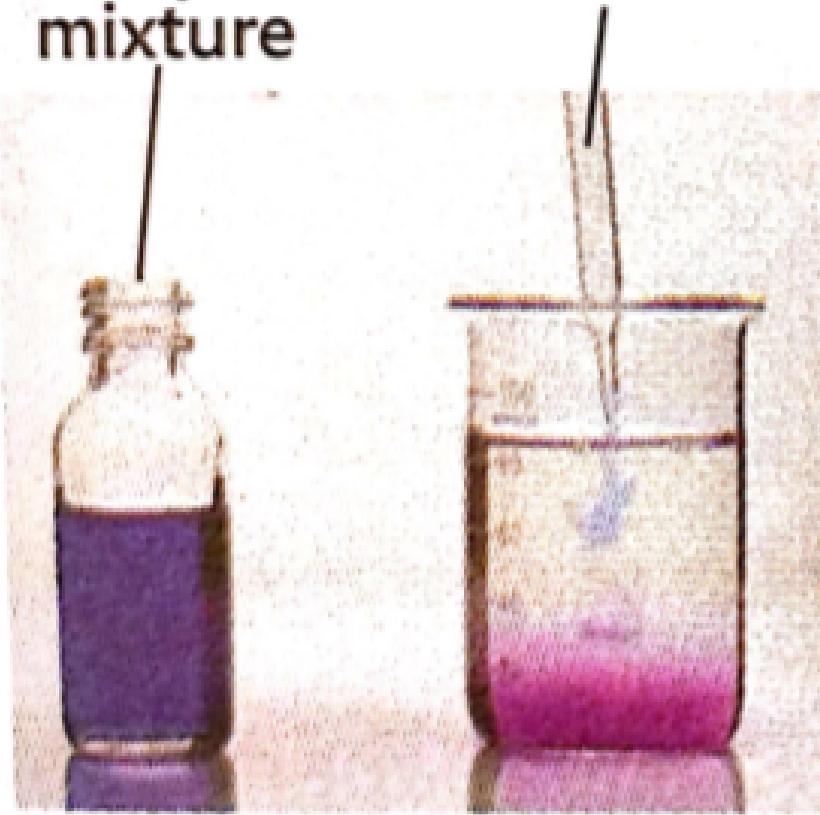
Test for proteins (e.g. egg albumen)

- Proteins in food sources can be identified by using **dilute Sodium hydroxide solution** and **1% copper (II) sulphate solution**. This is called a Biuret test.

Observation

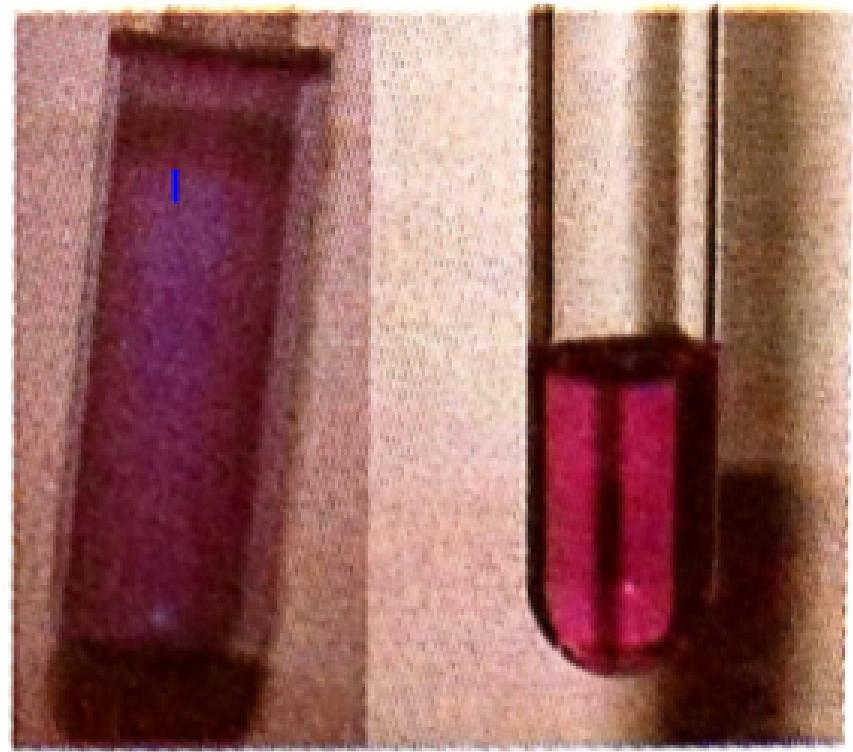
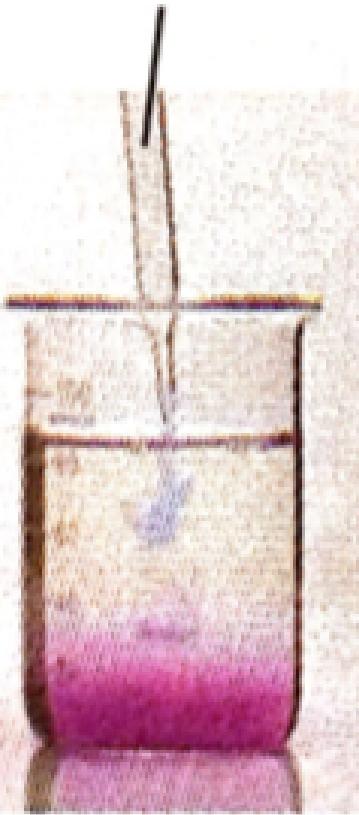
- This forms a **purple ring** around the top of the mixture and if the mixture is shaken, the contents turn **purple**

**Food
sample
mixture**



Test

**Biuret
reagent**



Test results

The Biuret test:

Procedure	Observation	Conclusion
To 1 cm ³ of test solution, add 1 cm ³ of sodium hydroxide solution, then add 3 drops of Copper (II) sulphate solution	Solution turns to a colourless solution then to a violet or purple solution.	Proteins present.
	Solution turned to a blue solution.	Proteins absent.

Millon's test:

Procedure	Observation	Conclusion
To 1 cm ³ of food solution, add 3 drops of Millon's reagent and boil.	A pink coagulated mass is formed.	Proteins present
	Solution remained turbid or colourless.	Proteins absent.

Test for Lipids

- Lipids in cooking oil can be identified by adding Ethanol, shaking well and then adding water to the mixture. This is called an **Emulsion Test**.

Observation

The mixture turns **milky (white emulsion)** if it contains lipids

NB: fats do not dissolve in water but dissolve in alcohol. If a solution of fat and alcohol is added to water, the fat forms tiny globules which float on water. This is called an **Emulsion**.

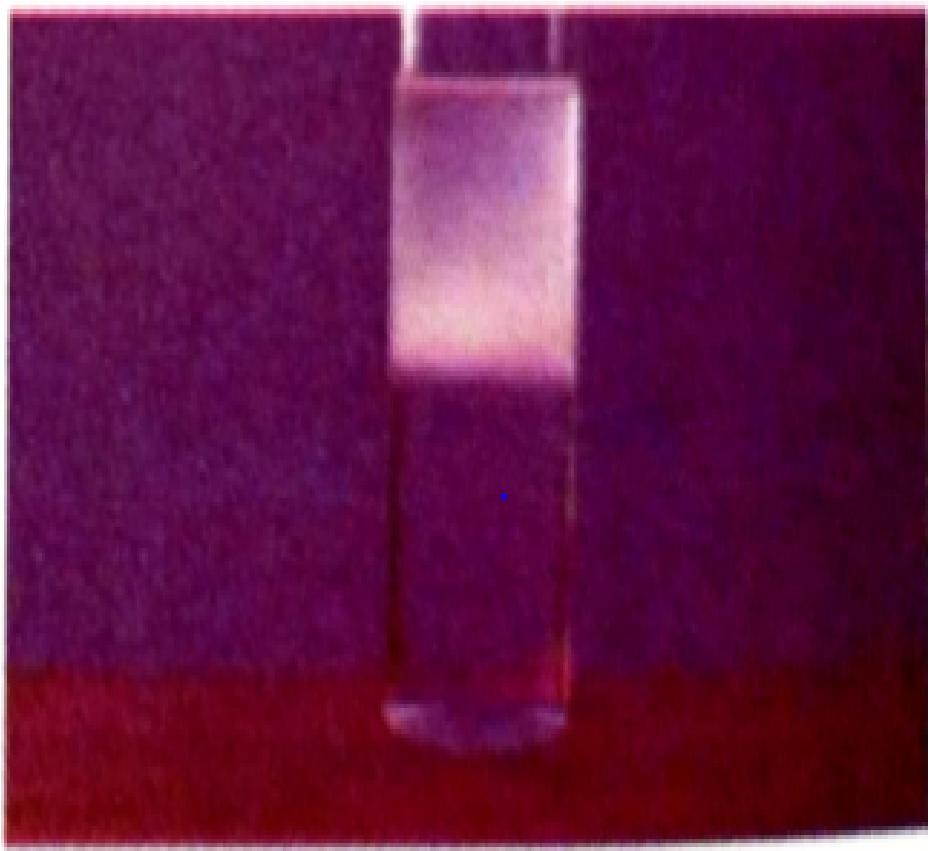


Figure 3.10: Results from emulsion test for Lipids

Alternatively;

- Fats can be tested using a **grease-spot test**. A solid piece of food containing lipids is rubbed onto a filter paper or any paper.

Observation

- A **translucent mark** is seen on the paper

a) The emulsion test:

The reagents used are ethanol and water.

Procedure	Observation	Deduction
To 1 cm ³ of food solution, add 1 cm ³ of ethanol and shake. Then add 5 drops of water and shake.	Solution turns to a cream emulsion	Lipids present.
	Solution remains turbid or colourless solution.	Lipids absent.

b) Translucent spot test:

Procedure	Observation	Conclusion
Add 2 drops of test solution on a piece of filter paper.	A translucent spot or patch is left on the paper.	Lipids present
Allow to dry and observe under light.	No translucent spot is formed on the paper.	Lipids absent.

Some plant seeds contain a large quantity of oil. This oil can be extracted for use by humans. Seeds e.g. groundnuts and sunflower, are pressed to provide cooking oil. Palm nuts from palm plants (like those in Kalangala islands) provide palm oil



(a) A palm tree



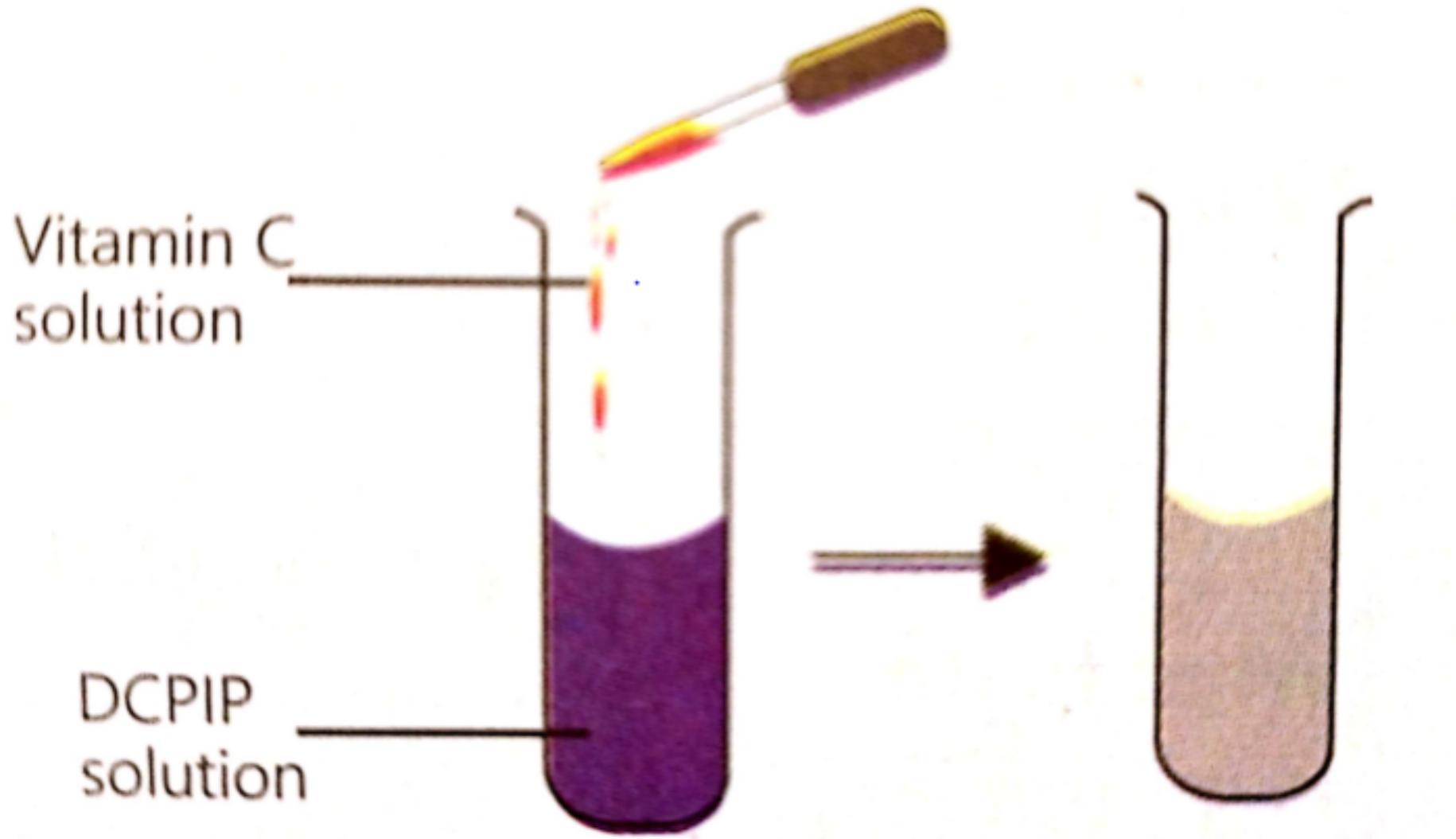
(b) Palm oil from palm seeds

Test for vitamin C

- Vitamin C is commonly found in fruit juices and vegetables. When 2cm³ of DCPIP solution is in a test tube and you add fruit juice containing Vitamin C drop by drop using a dropper, this is called the **DCPIP test**

Observation

- The DCPIP loses its color and may even become a turbid solution
- **NB:** The number of drops of juice required for DCPIP to lose it's color can be used to tell the quantity of vitamin C in the juice. The fewer the drops you add to DCPIP to lose it's color, the more vitamin C present in the juice.
- **DCPIP**- 2,6-Dichlorophenolindophenol



Procedure	Observation	Conclusion
To 1 cm ³ of DCPIP solution in the test tube, add the food solution drop wise.	The blue DCPIP solution is decolourised or turned to a colourless solution.	Vitamin C present +
	The blue DCPIP solution remained blue.	Vitamin C absent

BALANCED DIET

Activity

1. In groups, write down the food stuffs that made up the meals you ate the previous day in the table below.
2. Compare the food stuffs in the meals eaten by other members in the group and find out the common food nutrients.
3. Discuss whether the meals of the group members represent a balanced diet or not.
4. If the meal is not balanced, how can you advice each other so as to have a balanced diet.
5. Define a balanced diet

Present your findings to the rest of the class

Meal	Food stuff	Nutrient present
Breakfast		
Break		
Lunch		
Supper		

Meal	Food stuff	Nutrient present
Breakfast	Black tea/milk and bread	Proteins, vitamins, carbohydrates
Break	Porridge and bread, sweet bananas	Roughages, carbohydrates, vitamins, proteins
Lunch	Matooke/banana, green vegetables, ground nuts, fish, posho	Carbohydrates, water, vitamins, lipids, roughages and proteins
Supper	Rice, beans, posho, black tea	Vitamins, proteins, carbohydrates

Understanding the balanced diet of individuals basing on sex, age and level of activity

Activity

1. Carefully study the pictures below and fill the table below
2. What is happening in pictures (a) to (f)
3. Discuss the nutrients that should constitute a greater percentage in the diets of the individuals in the pictures below
4. Suggest what would happen if the individuals in the pictures above depend on an imbalanced diet.

Present your findings to the rest of the class

Picture	Balanced diet	Effect of imbalanced diet
a (baby crawling)	More proteins, vitamins and minerals, moderate carbohydrates and healthy fats and oils	
b		
c		
d		Underweight baby Difficulty in giving birth and breast feeding
e		
f		Obesity and diabetes

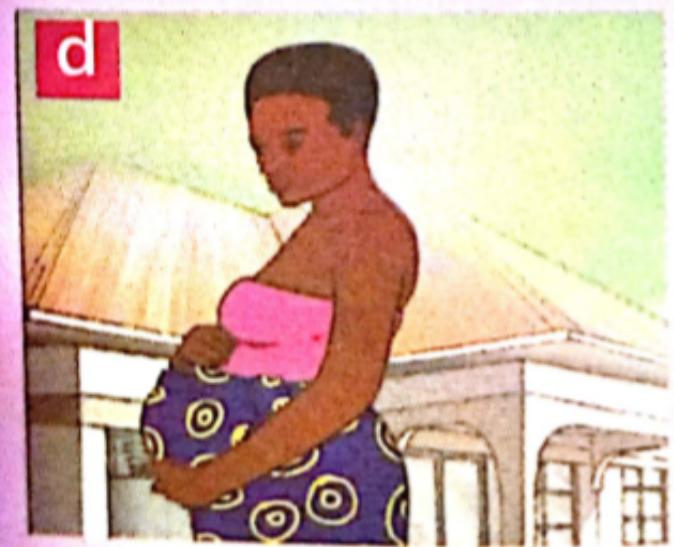


Figure 3.13: Individuals of different sex, age and level of activity

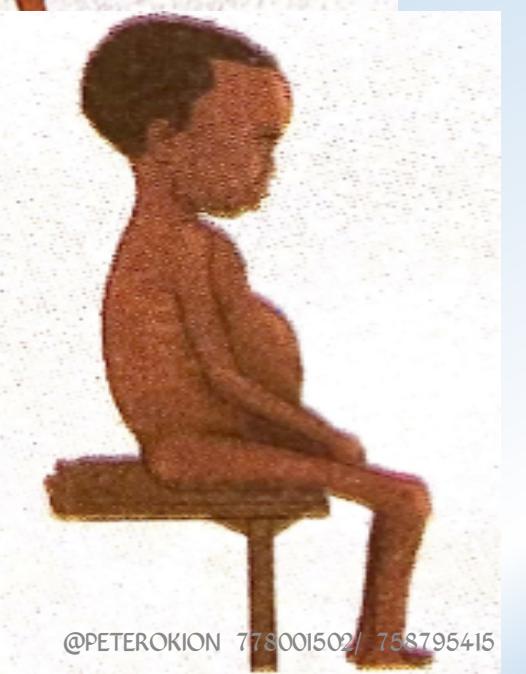
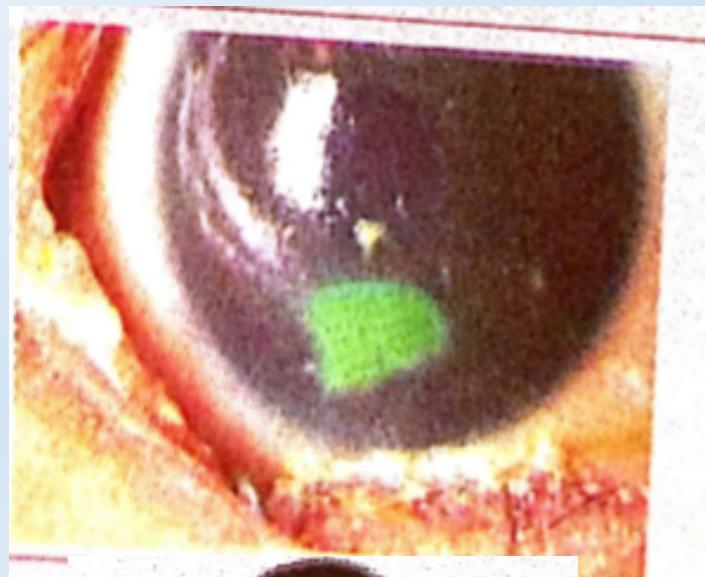
Picture	Balanced diet	Effect of imbalanced diet
a (baby crawling)	More proteins, vitamins and minerals, moderate carbohydrates and healthy fats and oils	Deficiency diseases depending on the nutrients lacking in the diet
b (old man walking)	Moderate proteins, more vitamins and minerals, little carbohydrates and no fats	Diseases due to lack of vitamins Diabetes and obesity incase more carbohydrates and fats are fed on
c (young girl playing)	More proteins, vitamins and minerals, moderate carbohydrates and healthy fats and oils	Deficiency diseases depending on the nutrients lacking in the diet
d (pregnant woman)	More proteins, minerals, vitamins and moderate carbohydrates and more healthy fats	Underweight baby Difficulty in giving birth and breast feeding
e (people exercising)	Carbohydrates, vitamins and minerals	Muscle wasting Weak bones leading to fractures Muscle cramps
f (inactive person)	Moderate proteins, minerals and vitamins Less carbohydrates	Obesity and diabetes

Nutrient Deficiency in Humans

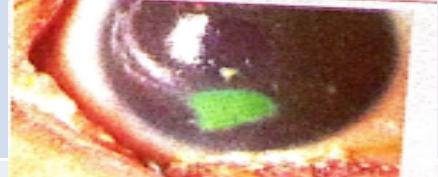
- Malnutrition has a number of causes e.g. poor choices of food, poor cooking method or poverty where the food which the people get does not contain all nutrients in the right proportions

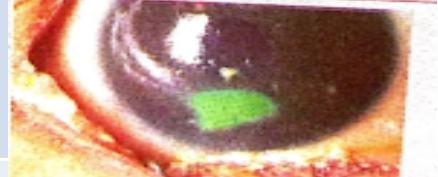
Activity

Study the pictures in the table below and complete the table



@PETEROKION 778001502/ 758795415

Picture	Deficient nutrient	Reason	Effect	Food source in community
	Vitamin B3			
		Deformed tissues		
				Green vegetables, liver, butter, margarine, carrots, egg yolk
			Goiter	
	Carbohydrates			
				Liver, fish, egg yolk, formed beneath skin in sunlight

Picture	Deficient nutrient	Reason	Effect	Food source in community
	Vitamin B3	Has pellagra	Pellagra Disorders of CNS e.g. memory loss	Cereal grains, milk, liver, yeast
	Proteins	Deformed tissues	Kwashiorkor	Milk, eggs, beans , beef , cheese, peas, soya beans
	Vitamin A	Night blindness due to pigmented eyes	Night blindness Frequent cold, sore eyes	Green vegetables, liver, butter, margarine, carrots, egg yolk
	Iodine	Swollen thyroid gland hence Goiter	Goiter	Iodized salt
	Carbohydrates	Wasted muscle due to marasmus	Marasmus	Cassava, rice, maize, potatoes
	Vitamin D	Bow shaped legs due to weak bone	Rickets	Liver, fish, egg yolk, formed beneath skin in sunlight

Exercise

- Suggest reason (s) why;
1. Children who live in geographical locations where there is less sunshine are at a risk of getting rickets.
 2. An individual whose diet is mainly animal products is most likely to develop scurvy.
 3. Pellagra is mainly found among individuals who depend on a vegetarian diet.
 4. Pregnant and menstruating women are at a high risk of being anaemic

Soln

1. sunlight is necessary in the formation of vitamin D in the body to absorb Calcium and phosphates required for the formation of strong bones, from intestines. Less exposure to sunlight reduces production of vit. D thus less calcium and phosphate minerals required for strong bone formation are absorbed by the body
2. vitamin C is found in plants material and not in animal materials
3. pellagra is caused by lack of vitamin B in the diet, which is found in animal materials but is lacking in plant materials
4. pregnant and menstruating women lose blood which contains haemoglobin a protein containing iron

Eating disorders

- 1) Anorexia

Today, many young people look at being slim as a fashion. They starve themselves to avoid gaining weight. This eating disorder that is characterized by self-starvation is called **anorexia nervosa** or simply **anorexia**



Figure 3.14: A boy rejecting food

2) Bulimia

- Just like anorexia, this disorder is associated with fear of gaining weight. It involves eating large amount of food in a short period of time(binge eating) followed by self-induced vomiting, fasting, or excessive exercise (purging)

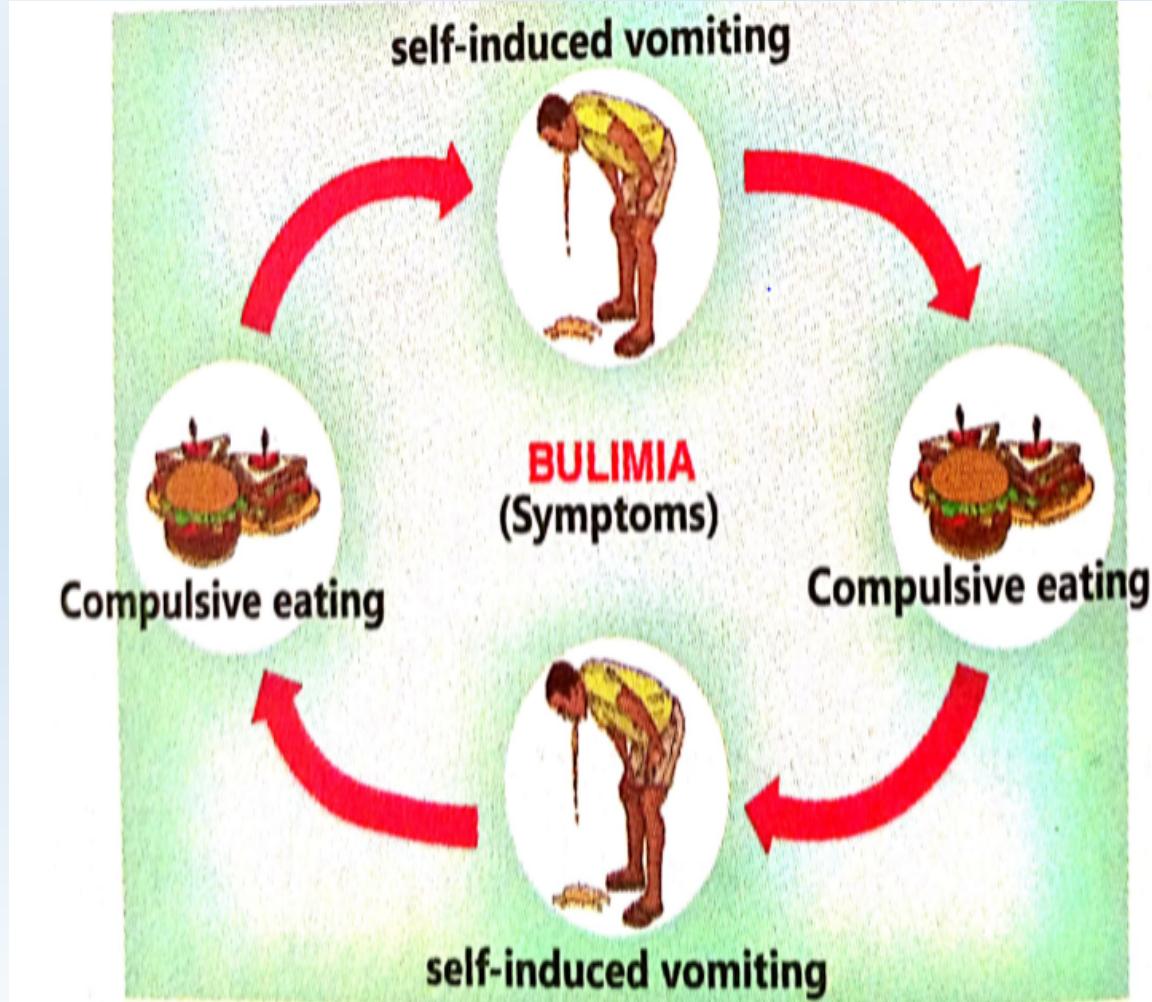
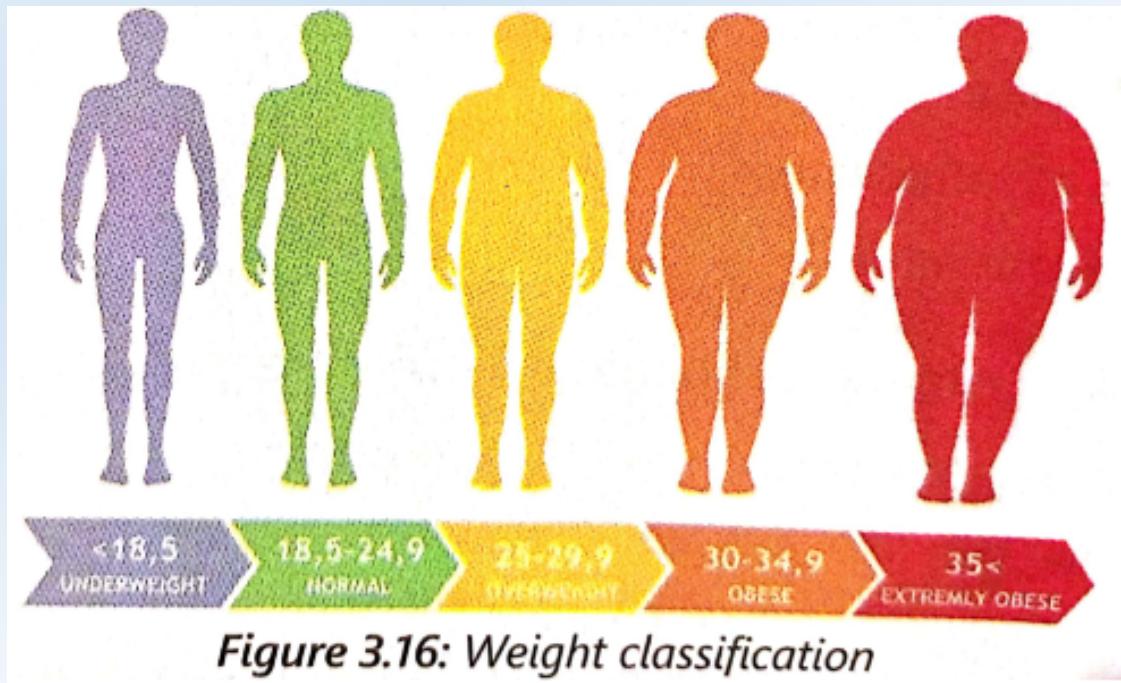


Figure 3.15: Bulimia symptoms

3) Obesity

- The height of a person can only support a given mass. Excess accumulation of body fat is called **Obesity**. This is caused by eating a diet that contains a lot of energy rich foods e.g. carbohydrates and fat. The body stores the excess energy as fat,
- Obesity is evaluated by calculating **Body Mass Index (BMI)**



Use of diet pills and steroids

- Diet pills

These are a class of drugs that facilitate weight loss. Diet pill drugs may work by curbing the appetite of the person who takes them or by his/her energy

- Steroids

These are synthetic hormones mainly used for muscle building, whose effects are more powerful than the usual hormones produced by our bodies. They can be taken in form of pills, powder or injections. They are highly **fat soluble**.

NB: use of diet pills and steroids to change body shape is highly addictive and has many health threats if not well monitored

Assignment

- Exploring the effects of eating disorders

In groups, research about dangers of eating disorders like;

- a) Obesity, bulimia and anorexia
- b) Use of drugs e.g. diet pills and steroids to change body shape

Write a report and include information on; the effect of eating disorders on health and social life of individuals

Eating disorder	Health effects	Social effects
Obesity	<ul style="list-style-type: none"> ✓ Increased risk of diseases and conditions e.g. high blood pressure ✓ Type 2 diabetes ✓ Complications during pregnancy ✓ Stroke ✓ Coronary heart diseases ✓ cancer 	<ul style="list-style-type: none"> ➤ Increased aggression and violent behavior ➤ Nervousness ➤ Impaired judgment ➤ Depression ➤ Mood swings
Anorexia	<ul style="list-style-type: none"> ✓ Cardiac complication ✓ Kidney and liver failure ✓ Anaemia ✓ Low blood sugar ✓ Constipation, bloating and gastro intestinal issues ✓ Loss of menses in women (amenorrhea) 	<ul style="list-style-type: none"> ➤ Withdraw from social situations especially those involving food ➤ Low self esteem ➤ Self destructive behavior e.g. self-mutilation (cut, burn or harm themselves to cope with painful emotions) ➤ Development of relationship difficulties
Steroids	<ul style="list-style-type: none"> ✓ Increased blood pressure ✓ Fast heart rate ✓ Restlessness ✓ Increased drug dependence ✓ Affects appetite 	<ul style="list-style-type: none"> ➤ Dependence and addiction ➤ Failed relationships ➤ Avoiding social encounters and interactions

Eating disorder	Health effects	Social effects
Diet pills	<ul style="list-style-type: none"> ✓ Increased risk of liver, kidney and prostate cancer ✓ High blood pressure ✓ Abnormal cholesterol levels ✓ Premature stopping of bone development ✓ Baldness, breast formation, shrunken testicles in males 	<ul style="list-style-type: none"> ➤ Prevents sexual intimacy ➤ Low levels of testosterone in males can lead to erectile dysfunction ➤ Reduced exercise due to fear of being bullied ➤ Negative self-image, demotivating the individual hence lacking self confidence
Bulimia	<ul style="list-style-type: none"> ✓ Feeling tired and weak ✓ Dental problems e.g. stomach acids from persistent vomiting can damage tooth enamel ✓ Bad breath ✓ Sore throat due to stomach acid ✓ Irregular or absent periods ✓ Dry skin and hair ✓ Brittle finger nails ✓ Bone problems e.g. osteoporosis ✓ Decreased breast size, irregular menstrual cycles 	<ul style="list-style-type: none"> ➤ Self-isolation to achieve shape and being secretive to hide their behavior leads to relationship breakdowns ➤ Individual feels down, lonely, isolated and worthless ➤ Low body weight, physical complications and hormonal imbalances can decrease the woman's sexual drive

Calculating BMI and its significance

- Body mass index is a persons' weight in kilograms divided by the square of his/her height in meters.

$$\text{BMI} = \frac{\text{weight (kg)}}{\text{height}^2}$$

- A BMI chart is used to show weight classification and risk illness associated with being over or underweight

BMI chart

BMI range	Weight classification	Risk illness
Less than 18.5	Under weight	Increased
18.5- 24.9	Ideal weight	Normal
25- 29.9	Over weight	Increased
30- 39.9	Obese	High
40- 50	Morbid obese	Very high
50 or Greater	Super obese	Extremely high

Activity

- In groups, measure your weight (kg) using a weighing scale and height (m) using a metre rule or measuring tape respectively. Use the results to calculate your BMI
- 2) With reference to the standard BMI chart, interpret your BMI status, and discuss the implications of being underweight or overweight. What can be done to remedy both cases?

Correcting underweight

- Eat more frequently e.g. have 5 to 6 smaller meals a day rather than 2 or 3 larger meals
- Choose nutrient rich food e.g. whole grains, bread, cereals, fruits, vegetables, diary products, lean protein sources, nutty and seeds
- Add extras e.g. scrambled eggs and fat free dried milk in soup and stews
- Sip a high calorie beverage along with a meal or snack
- Eat enough proteins
- Eat meals with fibrous carbohydrates e.g. brown rice and beans and healthy foods e.g. mono-saturated or poly saturated fats in foods e.g. nuts, avocados, oils and fish

Remedy for over weight

- ✓ Follow a healthy eating plan with fewer calories
- ✓ Start regular physical activity
- ✓ Enroll in weight management programmes
- ✓ Take weight loss medicines as prescribed by your doctor
- ✓ Undergo bariatric surgery for extreme obese individuals by making changes to individual's digestive systems
- ✓ Take calories restricted diets such as 1200 to 1500 calories per day for women and 1500 to 1800 calories for men
- ✓ Conduct intermittent fasting

Self-esteem and physical differences in body shape and size

- Do you ever wish you could change something about your body? Some people feel unhappy about some parts of their bodies, which easily lowers their self-esteem
- **Self-esteem** is how one perceives and values oneself. Self-esteem can be affected by people we always interact with e.g. classmates, parents, siblings and friends
- **NB:** You do not need a particular body size and shape to be happy, everyone's body is perfect as long as he/she is in good health. Therefore, we need to accept and appreciate ourselves and other people

Activity

- Write a short speech describing how you feel about your body in relation to size and shape. In your speech;
 - a) Explain the importance of good feeding in maintaining a healthy body shape and state.
 - b) Advise those who have low self-esteem because of their bodies.

Major plant mineral nutrients

- Plants require nutrients in form of minerals for proper growth and development. The major plant nutrients include;

Nitrogen

Potassium

Calcium

Phosphorus

Magnesium

Sulphur

Activity

- In groups, use the internet or biology reference material and make research on;
 - a) Uses of the following plant nutrients: N, P, K, Mg, Ca, and S
 - b) The effects of their deficiencies

Record your answers in the table below and present to the rest of the class

Element	Uses	Effects of deficiency
Nitrogen	Synthesis of amino acids, proteins and nucleotides Forms part of chlorophyll	Stunted growth Yellowing of leaves (chlorosis)
Phosphorous	Formation of ATP Synthesis of nucleic acids Formation of proteins	Red leaves Poor root growth Stunted growth Premature leaf fall off
Potassium	Formation of cell membrane and proteins Opening of stomata Enzyme activator	Yellow and brown edges of leaves Premature death
Magnesium	Formation of chlorophyll molecule Activates enzymes	Poor root and development of fruits Yellowing of leaves (chlorosis)
Calcium	Part of the cell wall Activates some enzymes Neutralizes certain acids in the soil	Poor root growth Stunted growth
Sulphur	Vitamins, amino acids and protein synthesis	Yellowing of leaves Stems become weak and slender

Activity of integration

- The people in your community have a challenge of deficiency diseases. You have been selected by your class teacher to represent your class on a sensitization campaign to help those people overcome the diseases.

TASK: Prepare a poster you will use to sensitize the people in your community on how to overcome the deficiency diseases

SUPPORT MATERIAL



Figure 3.17: Malnutrition in Children

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Test yourself

1. What is nutrition?
2. Complete the table below by filling in three major sources and two functions of the following food nutrients

Food nutrient	Example of food source	Functions
Proteins		
Carbohydrates		
Lipids		
Vitamin C		

3. A student conducted food tests on a given solution and presented information in the table below. Complete the table by filling in the gaps

ctd

Food test	Observation	Conclusion
Sample mixed with Benedict's solution and then boiled	Orange precipitate	
Sample mixed with sodium hydroxide and 1% copper (II) sulphate solution drop by drop		Proteins present
	Black suspension formed	
Sample mixed with ethanol and shaken water added to the mixture		Lipids present

4. With a reason, identify the food nutrients needed in large amounts by the following people

- a) elderly man
- b) actively growing adolescent
- c) pregnant woman
- d) brick layer

5. Sonia wants to lose weight by eating plain rice for all her meals. Explain why it is not advisable for her to do so for a prolonged period of time.

6. Eric a farmer found his plants A, B, and C with the following characteristics;

A: Yellow leaves with green veins

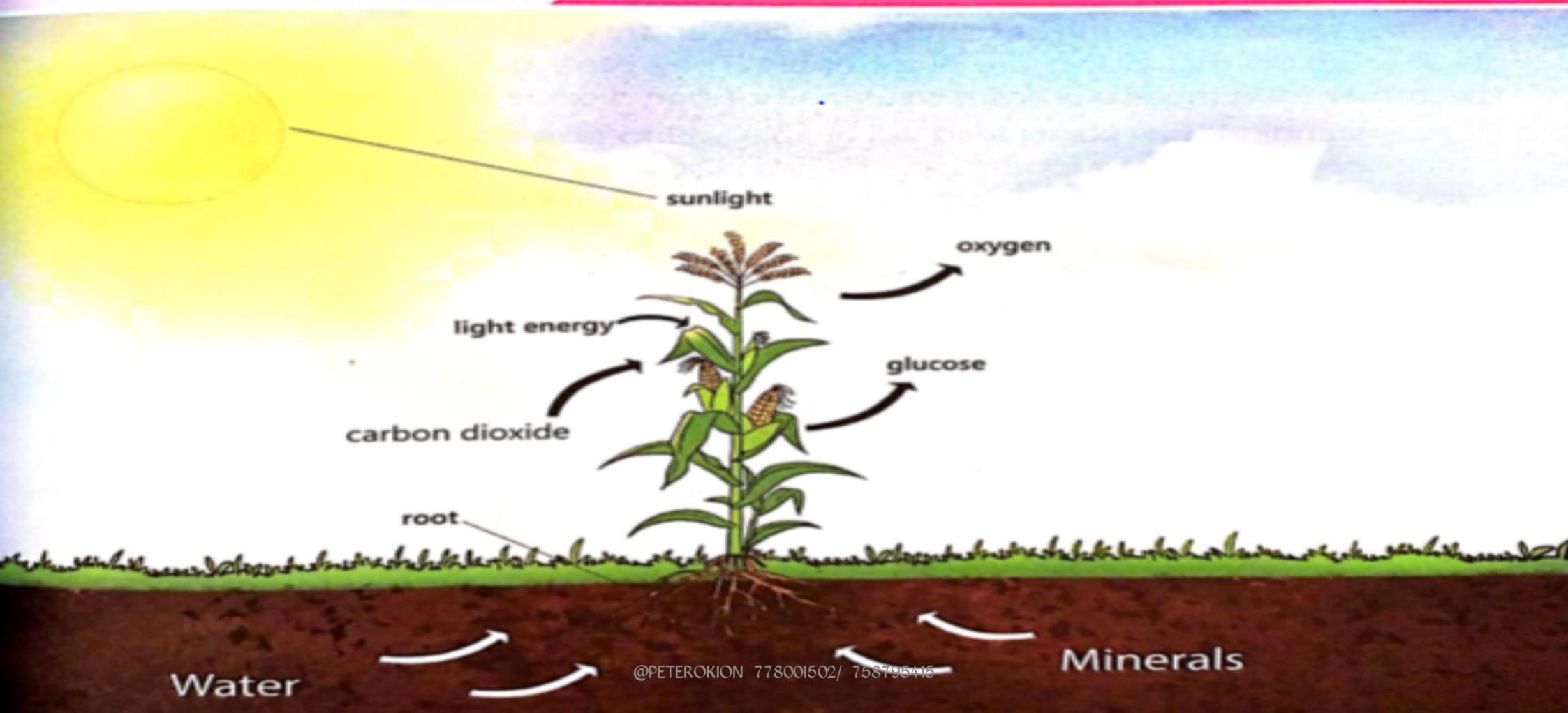
B: Small sized with yellow underdeveloped leaves

C: Very poor root growth

- a) identify the nutrient (s) each plant is lacking.
- b) how can Eric improve the health of his plants?

Chapter 4

Nutrition in Green Plants



Introduction

- Green plants like other living organisms, need food to carryout metabolic activities.
- Have you ever seen plants feeding?
- Do these plants feed in the same way that you do?
- If not, where do they get their food from?

Use the picture below to brainstorm on the above questions

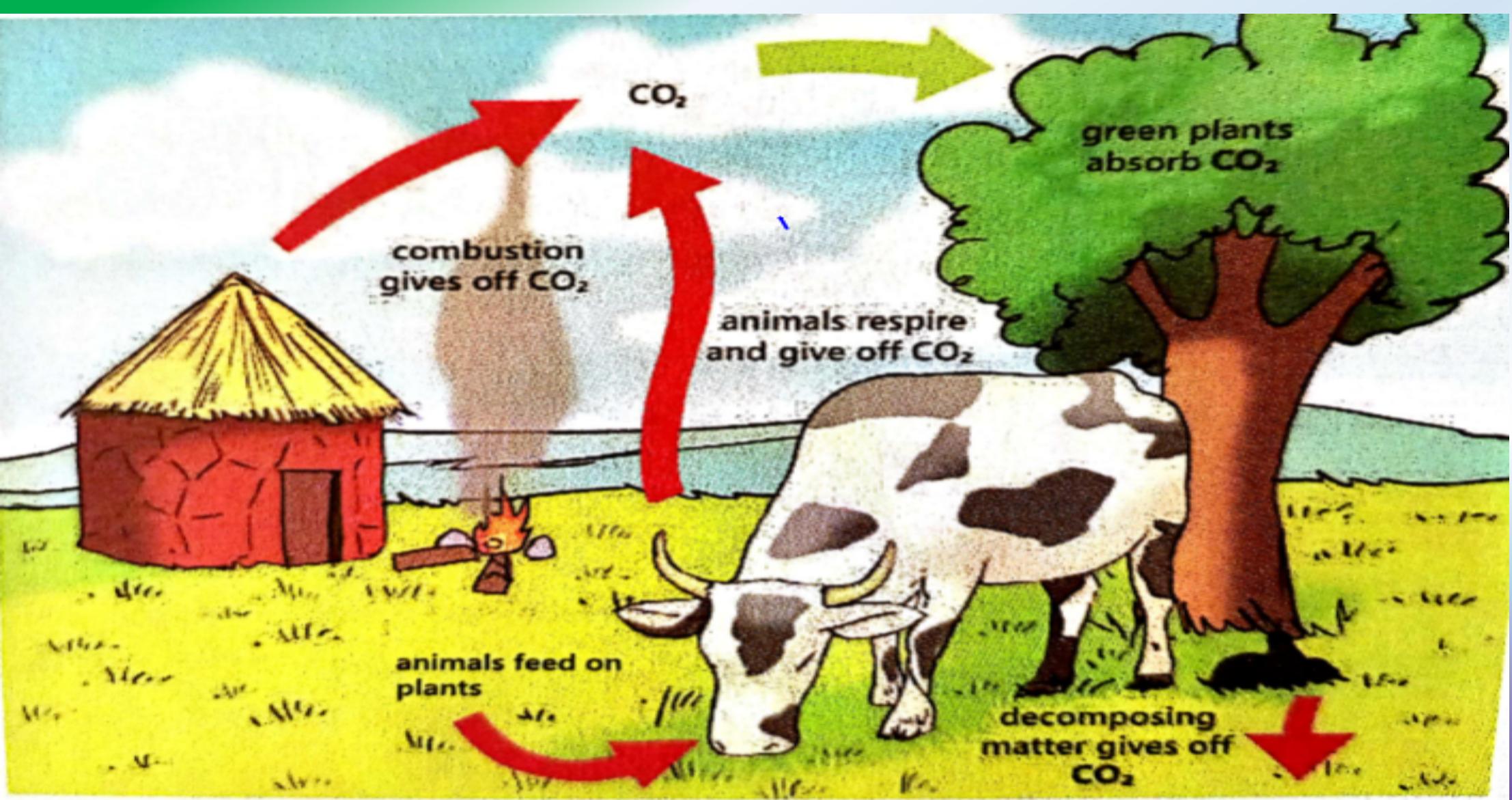


Figure 4.1: The role of plants in the environment

Nutrition in organisms

How do different organisms within your environment obtain and utilize food?

- Some utilize simple materials like carbon dioxide and water to make food. And others utilize already made complex food substances.
- Some are **autotrophic** while others are **heterotrophic**.



Figure 4.2: The rabbit feeds on plants, while plants make their own food.

Activity

- In groups:
 1. using the internet or any other Biology reference material, research and note down:
 - a) the meaning of autotrophic and heterotrophic nutrition.
 - b) why autotrophs are the providers of all food.
 - c) the meaning of photosynthesis
 - d) the equation for photosynthesis and it to explain what plants need for photosynthesis to take place.

Present your findings to the rest class

Soln

- a) **Heterotrophic nutrition** (hetero, other; tropho, nourishment)
- Means that organisms depend on organic nutrients obtained from others organisms due to their **inability** to manufacture their own food.
- Such organisms are called **Heterotrophs**, these are further categorized into saprophytism, mutualism, commensalism, parasitism and holozoic nutrition

- **Autotrophic nutrition** (auto- self)
- Is where organisms make their own organic nutrients from an external supply of simple inorganic raw materials and energy.
- Such organisms are called **Autotrophs**, autotrophic nutrition is further divided into **photosynthesis** and **chemosynthesis**

Ctd

- b) since the nutrition of all other organisms depends either directly or indirectly on these autotrophs, they are referred to as **producers**

- C) **photosynthesis**
- It's a form of nutrition which occurs in all green plants, algae, some protists and photosynthetic bacteria (**cyanobacteria**)
- It is the process by which organisms synthesize organic compounds (sugars, protein and lipids) from **carbon dioxide** and **water** using **sunlight** as a source of energy and **chlorophyll** or other related pigment for trapping the light energy.

d).

- Carbon dioxide
+ water

sunlight energy

chlorophyll

Glucose

+ Oxygen



What plants need for photosynthesis to take place

- **Chlorophyll**

This is a green pigment that absorbs light energy from the sun. the amount of chlorophyll present in a leaf is directly related to the rate of photosynthesis

- **Carbon dioxide**

Its absorbed from the atmosphere through stomata, aquatic plants absorb carbon dioxide as hydrogen carbonates which diffuse directly from water to plant tissues.

- **Light**

This is the source of energy necessary for photosynthesis. The rate of photosynthesis **increases with increase in light intensity**, up to a maximum and levels off. Light intensity is used for the following purposes;

- 1.) splitting water molecules into hydrogen atoms and oxygen in a process called **photolysis**. The oxygen is given off by plants and hydrogen atoms combine with CO to form carbohydrates

- 2.) providing energy for photo synthesis

Ctd

- **Temperature**

Photosynthesis proceeds by a series of chemical reactions controlled by enzymes. Temperature is necessary for activation of enzymes that catalyze photosynthetic reactions

- **Water**

Water is a raw material for photosynthesis. It is a source of hydrogen that reacts with carbon dioxide during photosynthesis. It is also an essential donor of electrons to chlorophyll

Exercise

1. explain how plants and animals depend on each other in nature.
2. why is photosynthesis an example of autotrophic nutrition?
3. why is it important for individuals to have potted plants in their houses during day time?
4. in your opinion, what do you think are the direct and indirect ways in which we benefit from plants?

Conditions necessary for photosynthesis

- These include light, carbon dioxide, water and chlorophyll

NB: to investigate the conditions required for photosynthesis to take place, a test for starch is necessary, to prove whether photosynthesis took place or not.

Test for starch in a leaf

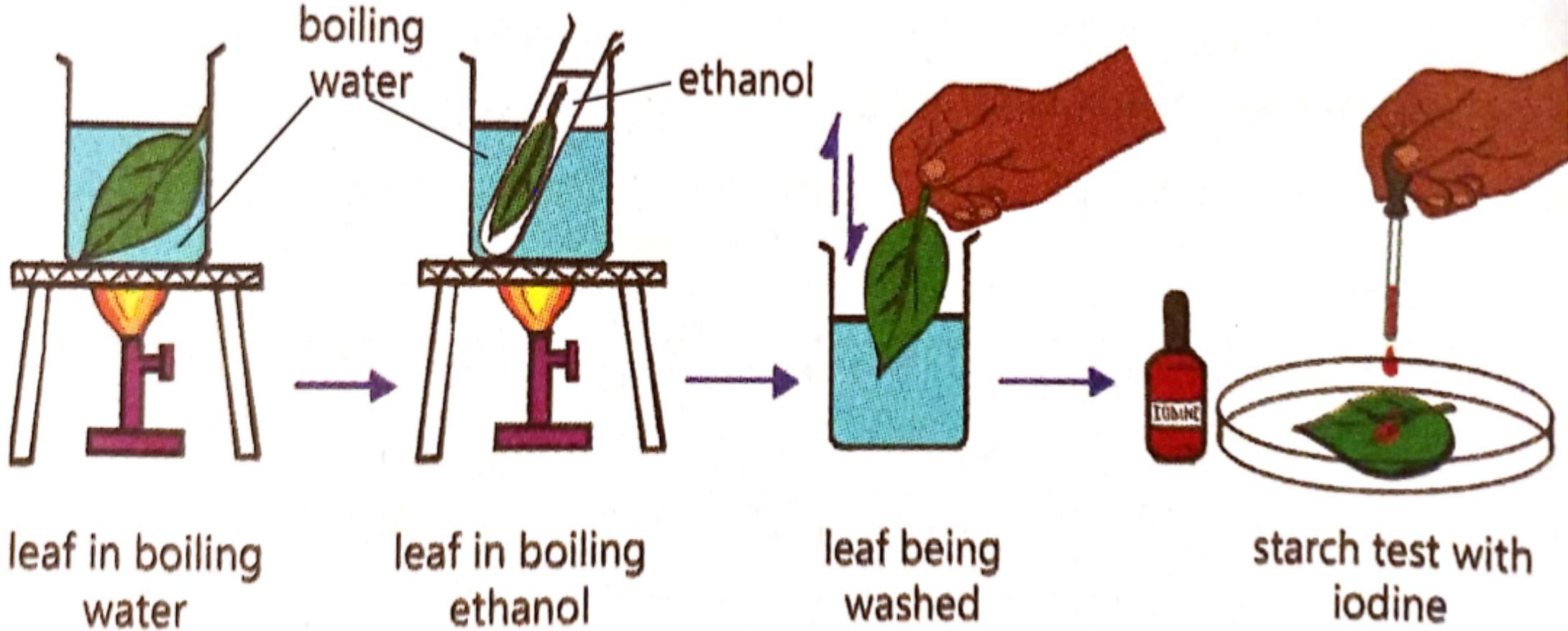


Figure 4.3: Steps involved in testing for starch in a leaf

ctd

- Procedure

1. DE touch the leaf
2. Dip a leaf in boiling water for a few minutes
3. After this, immerse it in a boiling tube containing alcohol
4. Carefully place the boiling tube in a water bath and heat until the alcohol begins to boil to decolorize the leaf.
5. Dip the leaf in warm water to soften it
6. Lay the leaf on a white surface and add drops of iodine solution or dip the leaf in a dilute solution of iodine for a few minutes

- Observation

The decolorized surface of the leaf turns **Black/ blue** including the **presence of starch** and turns **Brown** when starch is **absent**

Exercise

- Explain why the following was done during testing for starch in a leaf:
 - a leaf was dipped in hot water for sometime
 - a leaf was boiled in alcohol
 - a leaf was dipped in warm water after boiling it in alcohol.

soln

- a) to kill the protoplasm and stop any reactions in the leaf
- b) to decolorize the leaf by dissolving the chlorophyll
- c) to soften the leaf, preventing it from breaking

a) chlorophyll

- QN: do all plant leaves in your environment have the same color of the green pigment? If not why?
- The necessity of chlorophyll is investigated using variegated leaves. Variegated leaves are those leaves with differently colored patches

- Hibiscus plants



An experiment to show that chlorophyll is necessary for photosynthesis

- Materials used

Beaker, alcohol e.g. ethanol, white tile, sheet of paper, dropper, source of heat, iodine solution, boiling tube and potted plant with variegated leaves kept in darkness for 24 hours

- Procedure

- a) the plant with variegated leaves is exposed to sunlight for about 2 hours
- b) the parts of the leaf that are not green are used as the control experiment.
- c) at the end of the 2 hours, a leaf is removed and then tested for starch

Ctd

- **Observation**

The parts that were green are stained **blue-black** with iodine solution while the non-green patches are stained **brown** with iodine

- **Explanation**

the green parts of the leaf contained chlorophyll and thus turned blue-black while the non-green parts did not contain starch as they lacked chlorophyll.

CONCLUSION

Chlorophyll is thus necessary for photosynthesis

An experiment to show that carbon dioxide is necessary for photosynthesis

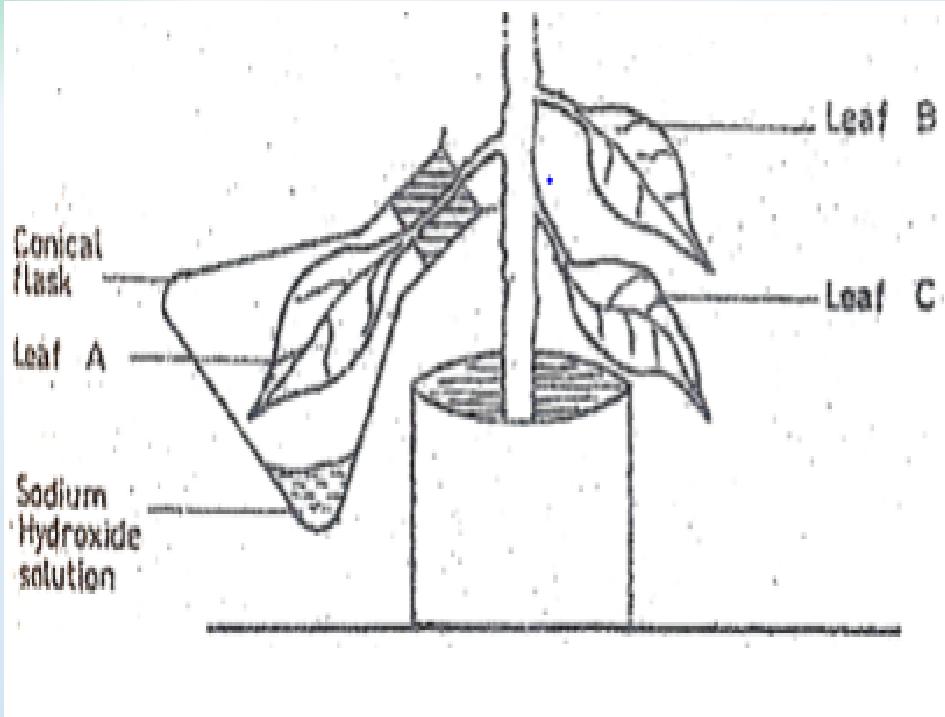
- Materials used

Potted plant kept in darkness for 24 hours, iodine solution, ethanol, water bath, source of heat, white tile, sodium hydroxide solution, soda lime or sodium hydrogen carbonate solution, sheet of paper, dropper, conical flasks, boiling tubes

- Procedure

- a) one leaf labeled A while still attached onto the plant is completely enclosed in a transparent conical flask containing sodium hydroxide solution
- b) a control experiment is set up, by enclosing another leaf B on a plant in a conical flask containing sodium hydrogen carbonate
- c) The potted plant is then left in sunlight for 6 hours
- d) The enclosed leaves are then detached from the plant and then tested for starch using iodine solution

- Experimental set-up



- Observation

The leaf (A) in a conical flask containing sodium hydroxide solution remains **Brown** when tested for starch while the leaf (B) in a conical flask containing sodium hydrogen carbonate (control experiment) turned **Blue-black**

- **Explanation**

Sodium hydroxide added to conical flask with leaf A absorbed all the carbon dioxide within the conical flask so the leaf did not photosynthesize due to lack of carbon dioxide.

For leaf B; sodium hydrogen carbonate in the conical flask was decomposed releasing carbon dioxide to the leaf hence photosynthesis took place

- **Conclusion**

Carbon dioxide is necessary for photosynthesis

An experiment to show that light is necessary for photosynthesis

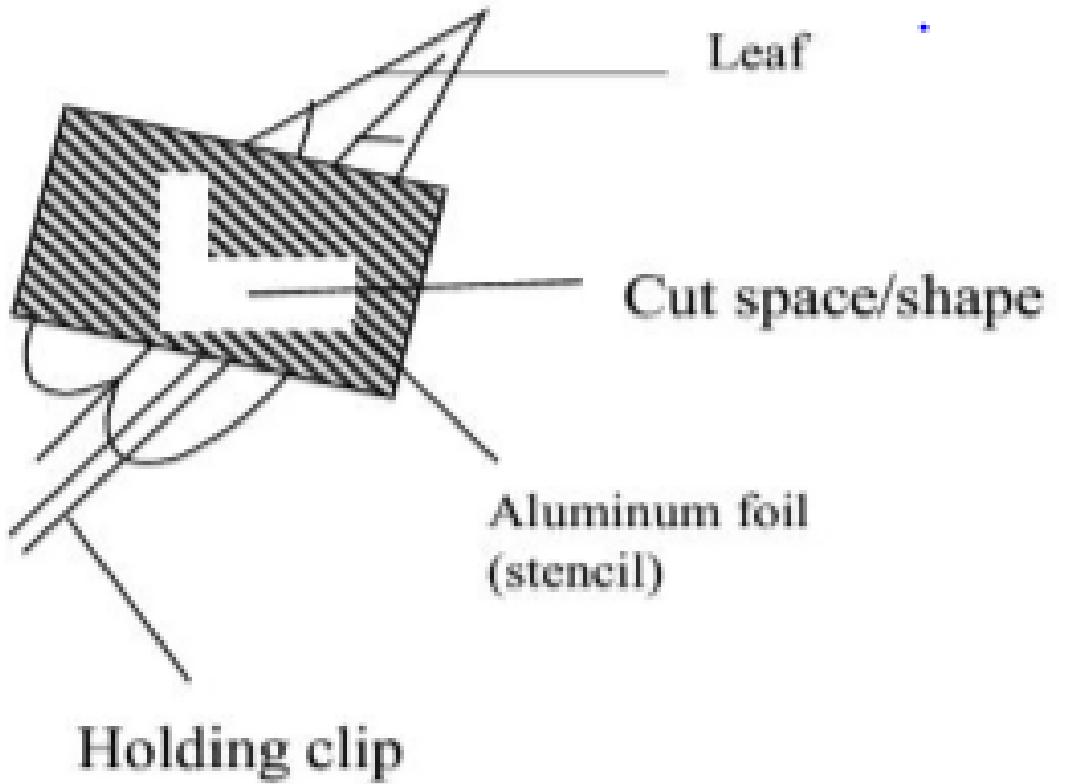
- Materials used

Potted plant with leaves kept in darkness for 24 hours, iodine solution, razor blade, Aluminum foil/ black polythene, ethanol, white tile, sheet of paper, dropper, source of heat, boiling tubes, water bath

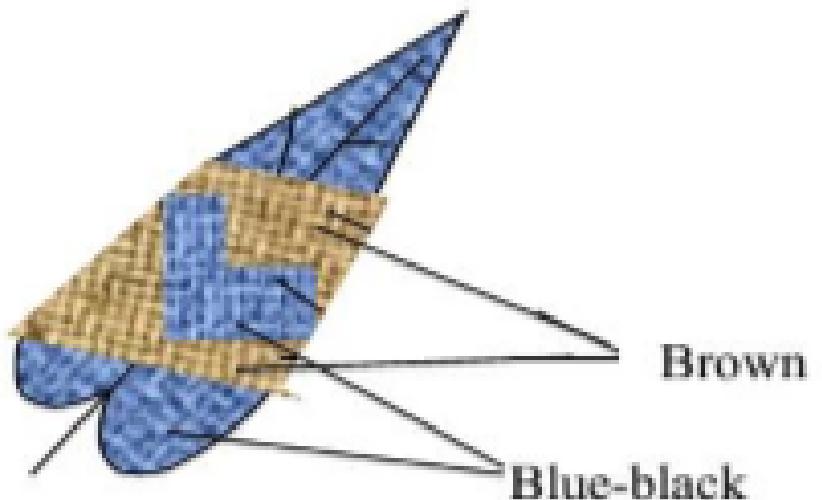
- Procedure

- a) simple L shape is cut from a strip of an aluminum foil to make a stencil.
- b) Place the stencil around the leaf still attached on the potted plant with the cut shape facing upwards where light strikes
- c) Expose the plant to sunlight for 3 hours
- d) Detach the leaf with a stencil from the plant using a razor blade
- e) Remove the stencil and test the leaf for starch

Before testing for starch



After testing for starch



Ctd

- **Observation**

The parts which were covered by the stencil, turned **Brown** while the parts exposed to light turned **Blue-black**

- **Explanation**

Putting the leaf in darkness removes starch from the leaf by converting the starch into simple sugars which are used by the plant. Putting the plant in light allows photosynthesis to take place. Covering the leaf with a stencil prevents light from reaching certain parts of the leaf. During exposure to light, the parts covered do not access sunlight and do not photosynthesize while uncovered parts access sunlight and photosynthesize. Testing for starch helps to find out whether photosynthesis took place or not.

- Conclusion

Light is necessary for photosynthesis to take place

- Exercise

1. Why was a potted plant kept in darkness for 24 hours used in the experiment?
2. Why were control experiments conducted in the investigations above?

Soln

1. to DE starch the plant before beginning the experiment
2. to prove that chlorophyll, carbon dioxide and light were indeed necessary for photosynthesis to take place

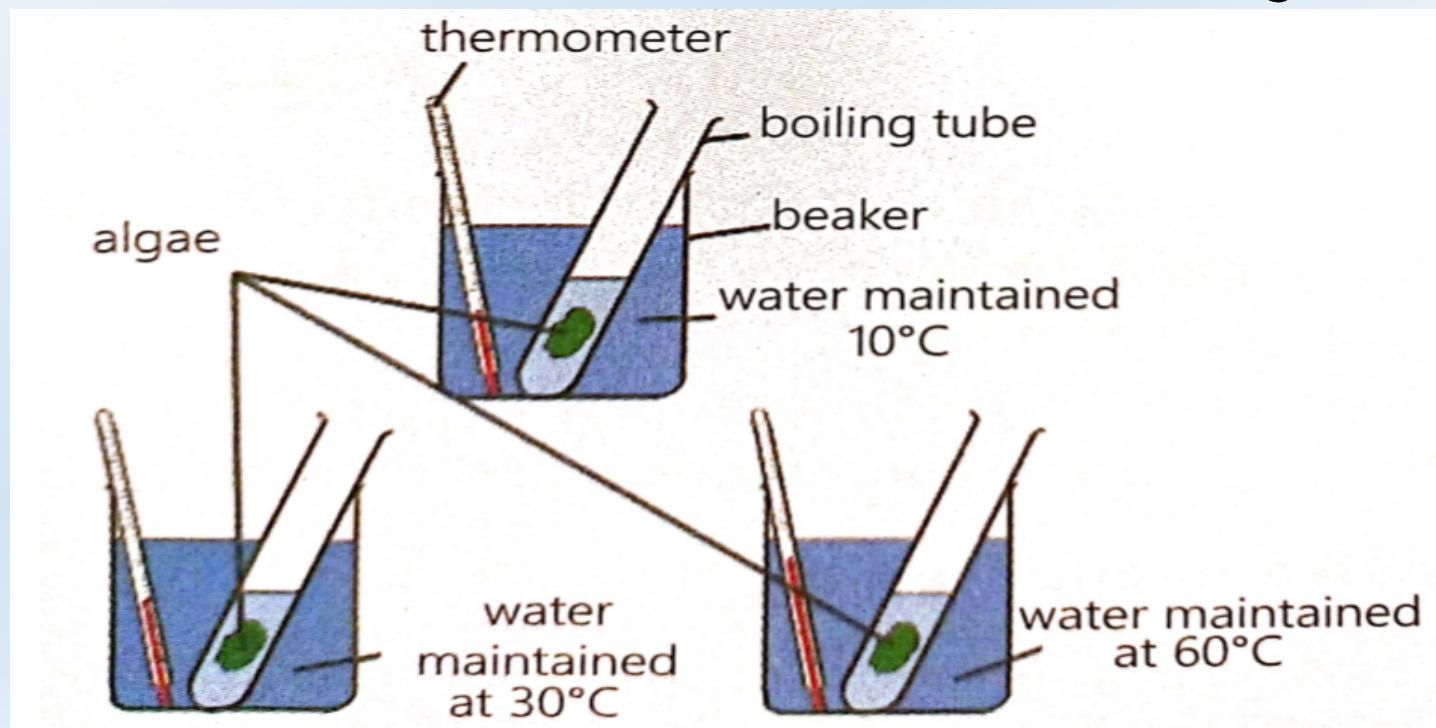
The rate of photosynthesis

- This can be determined by counting the number of oxygen bubbles produced in a given period of time.
- NB: The rate of photosynthesis is affected by a number of factors e.g. temperature, light intensity, carbon dioxide concentration, etc...

Effect of temperature on rate of photosynthesis

Activity

In groups, set up three sets of materials as shown in the fig 5 below



ctd

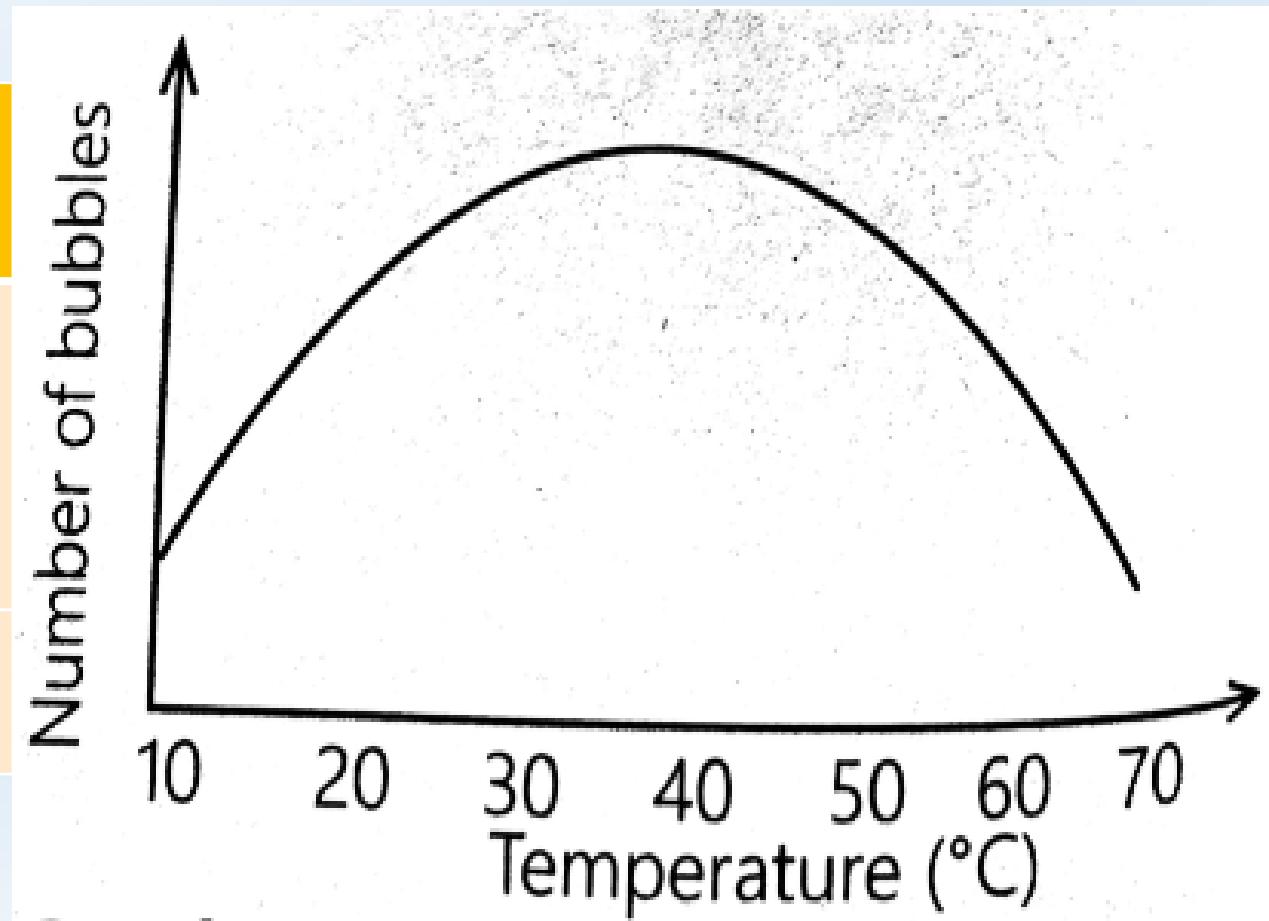
- Maintain each test tube in a water bath: the first maintained at 10 degrees Celsius, the second at 30 degrees and the third at 60 degrees Celsius
- Leave the test tubes in the water baths in sunlight for one minute and thereafter, observe and record the number of bubbles produced per minute over 5 minutes at each temperature in a suitable table
- Using the data you have obtained, plot a graph of estimated number of bubbles against temperature

QNS: a) Why were the test tubes left in the water bath for 5 minutes?

b) do variations in temperature affect the rate of photosynthesis? If so, how do they affect it and why?

Results

Temperature (degrees Celsius)	Number of bubbles
10	Increasing number of bubbles
30	
60	Decreasing number of bubbles



Explanation

- a) To allow the contents of the test tube to reach equilibrium with temperature of the water bath
- b) Yes, increase in temperature increases the rate of photosynthesis; higher temperatures below optimum activate more enzyme molecules that catalyse faster photosynthesis thus more bubbles of gas produced per unit time.
higher temperature like 60 degrees Celsius denature enzymes leading to decrease in the rate of photosynthesis.

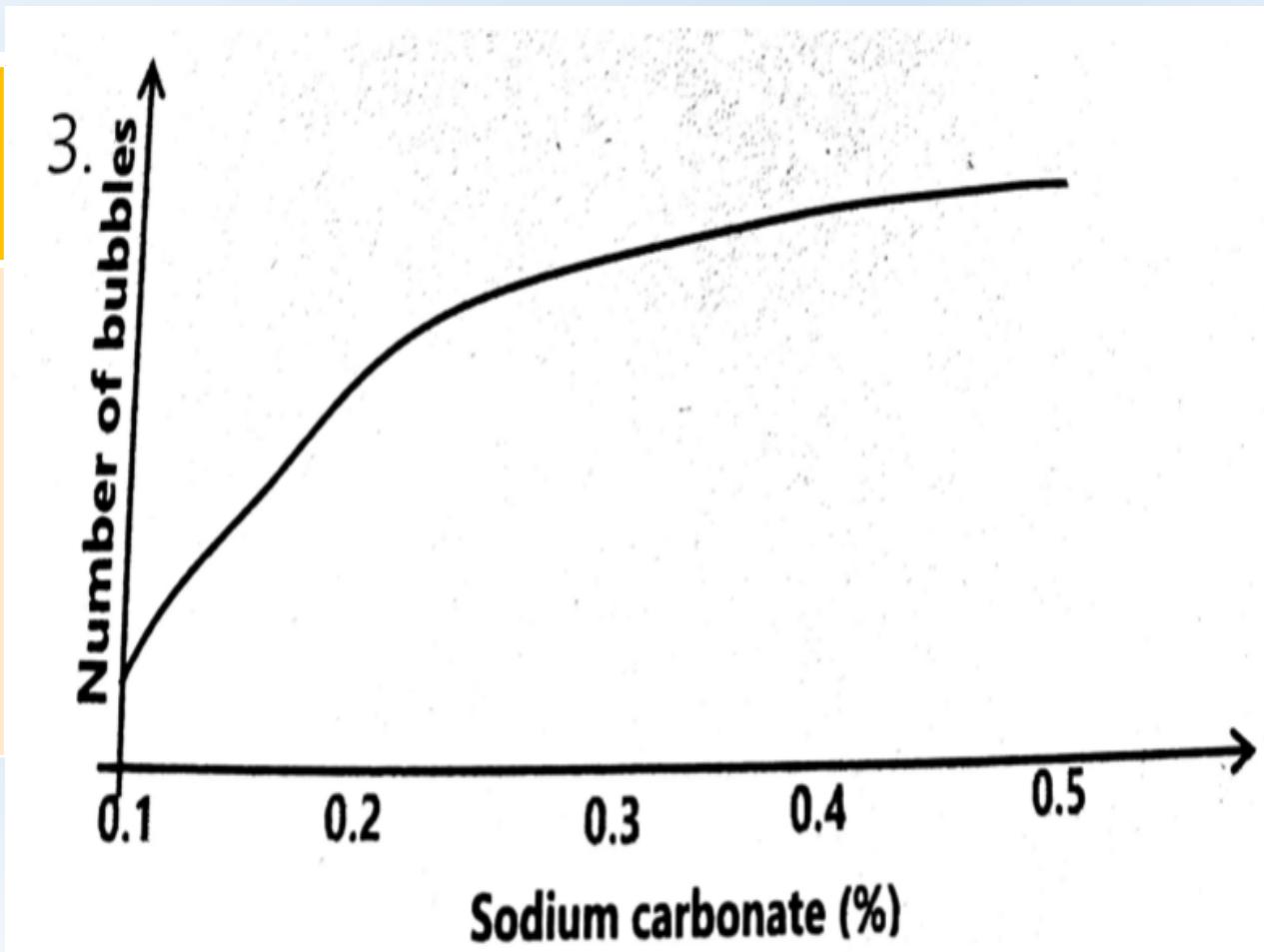
Effect of carbon dioxide concentration on the rate of photosynthesis

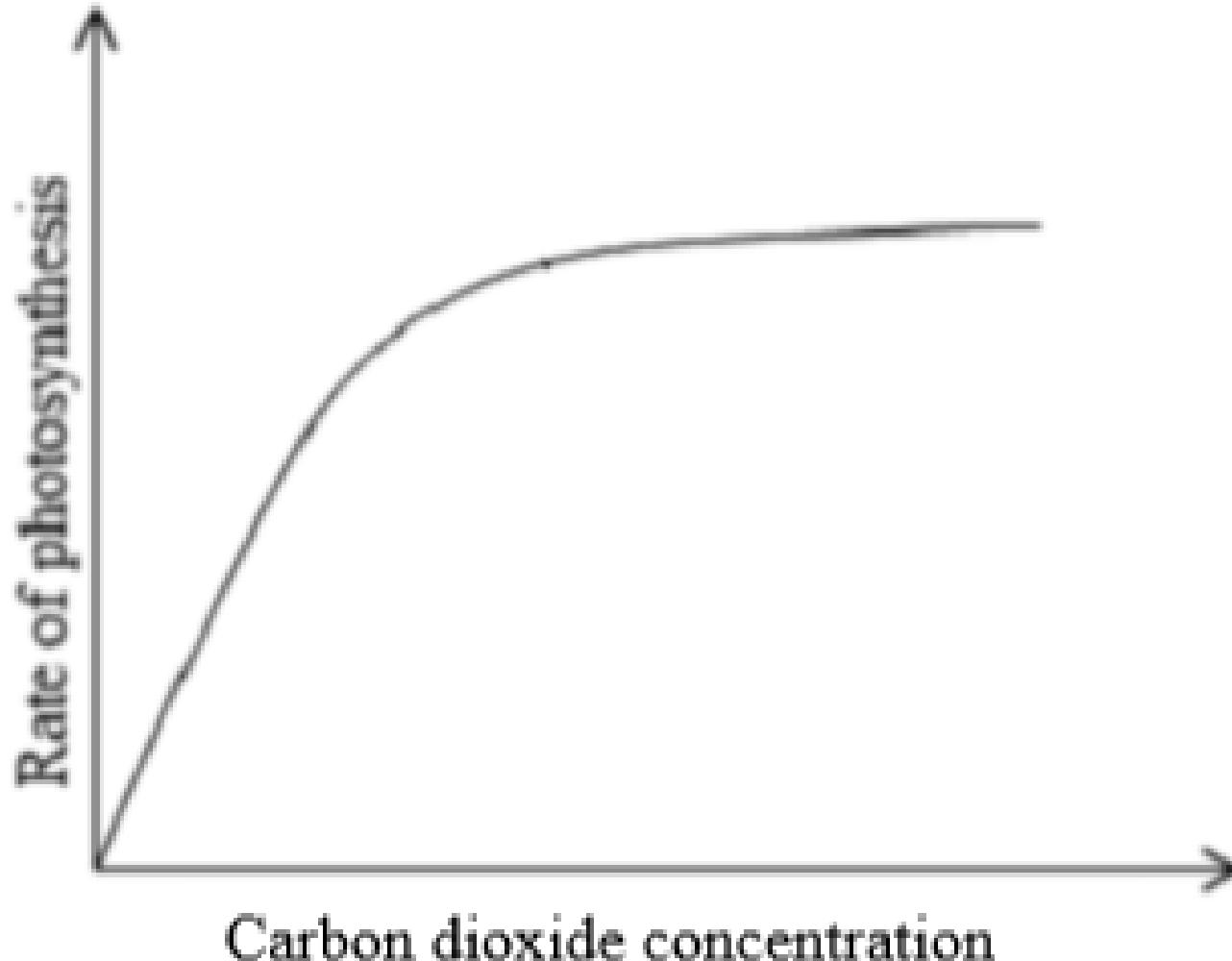
- Set up 3 sets of experiments as shown in the fig 5 above
- maintain each test tube in a water bath at 25 degrees Celsius, one test tube with 0.1% sodium carbonate solution, the second (0.3%) and third with 0.5% sodium carbonate solution
- Leave the test tubes in the water baths for 5minutes; observe and record the number of bubbles produced per minute at each concentration of sodium carbonate in a suitable table

QN: Do variations in carbon dioxide concentration affect the rate of photosynthesis? If so, how do they affect it and why?

Results

Sodium carbonate (%)	Number of bubbles
0.1	Increasing number of bubbles
0.3	
0.5	



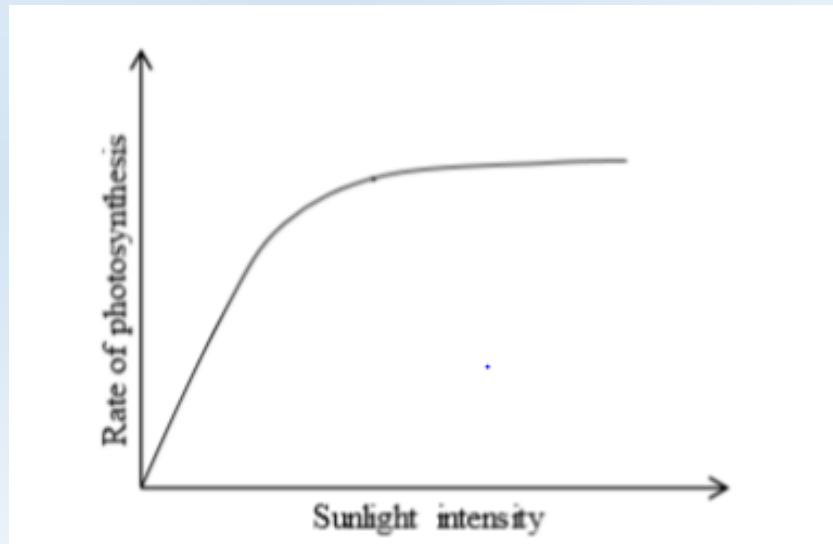


Explanation

- Yes, increase in carbon dioxide concentration increases the rate of photosynthesis; carbon dioxide is a raw material for photosynthesis; more carbon dioxide provides a larger source of carbon for synthesis of carbohydrates during photosynthesis

Effect of light intensity on the rate of photosynthesis

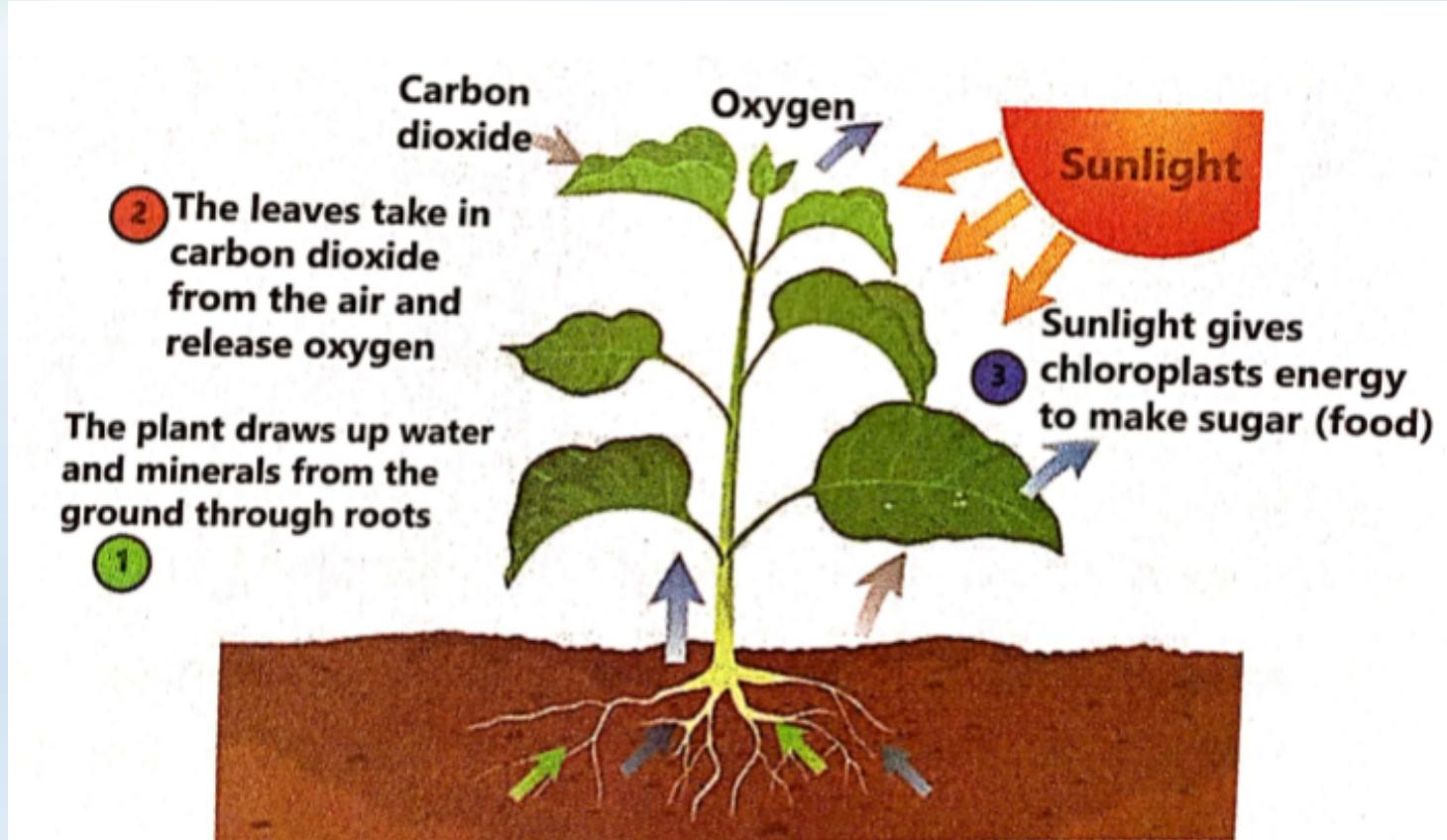
- Increase in light intensity increases the rate of photosynthesis; increase in light intensity provides more energy for driving the process of photosynthesis by exciting more electrons and releasing more hydrogen atoms which reduce carbon dioxide to form carbohydrates.



The leaf as an organ for photosynthesis

External features

Materials needed for photosynthesis are obtained by plant parts from the environment



Activity

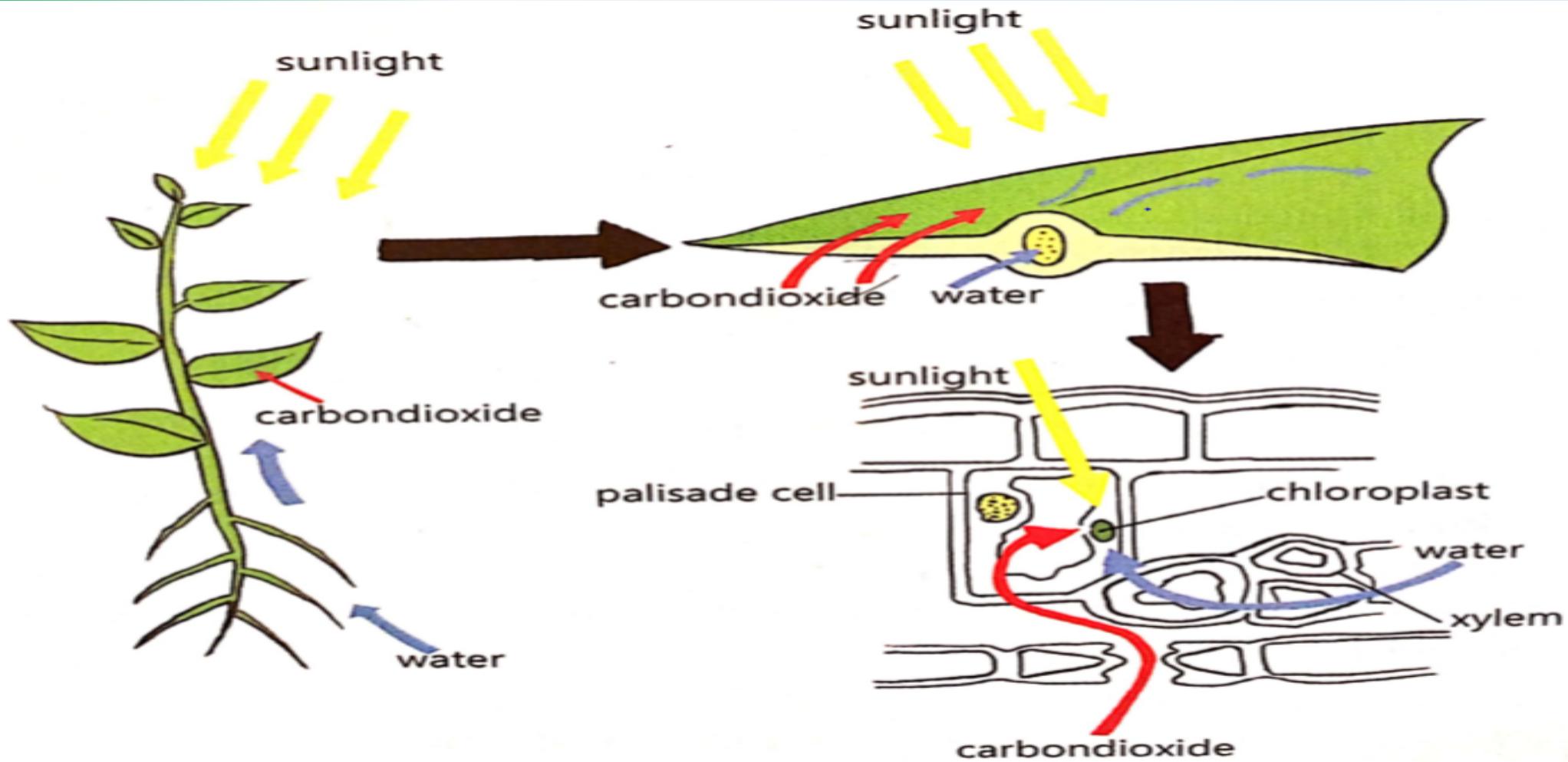
- Observe the plant image above or (observe the potted plant provided by the teacher) ; observe the leaf and note the arrangement of veins, size and thickness of the lamina.

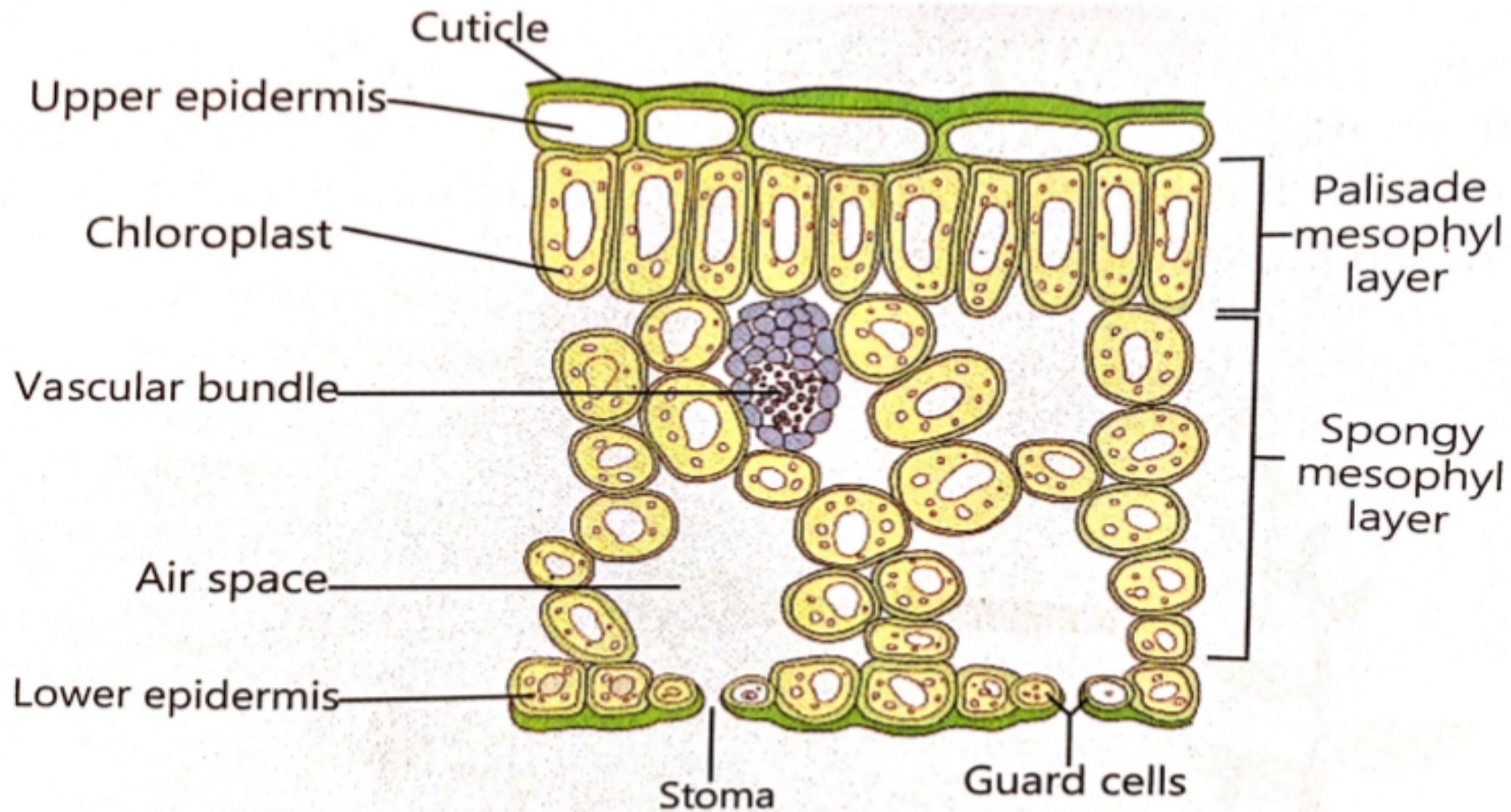
QN: How do these features enable the plant to photosynthesize more efficiently ?

soln

- Some leaves are broad provides a large surface area for trapping sunlight and taking in of Carbon dioxide.
- Numerous leaves which increase the total surface area exposed for sun light absorption thus increasing the rate of photosynthesis.
- Thinness and flatness of leaves providing a short distance for penetration of sunlight and diffusion of carbon dioxide.
- Leaf arrangement /mosaic; Leaves are arranged to ensure minimum shading of one leaf by another from light in such a way that each leaf obtains maximum sunlight for photosynthesis. This is minimum shading of one leaf by another to ensure maximum light absorption is called leaf mosaic.

Internal features





Activity

- From the illustrations above, observe and record the internal adaptations of the leaf to carry out the process of photosynthesis

- Presence of numerous chloroplasts in the palisade mesophyll layer, to absorb maximum light for photosynthesis
- Presence of a spongy mesophyll layer with air spaces to allow easy diffusion and exchange of gases during photosynthesis.
- Presence of xylem vessels which transport water a raw material for photosynthesis from stems to the leaves where it's required.
- Presence of phloem which conduct away manufactured food to storage organs thus maintaining a concentration gradient for manufacture of more organic materials.
- Presence of numerous stomata to allow carbon dioxide to diffuse into the leaf for photosynthesis.

ctd

- Presence of a cuticle, a water tight layer which prevent desiccation (water loss) by the photosynthesizing tissues.
- Transparent cuticle to allow light penetration
- Numerous chloroplasts providing a large surface area for photosynthesis to take place.
- Numerous chlorophyll molecules in chloroplasts to absorb maximum sunlight energy for photosynthesis.
- Has closely packed palisade cells with numerous chloroplasts to increase surface area for maximum light absorption

Activity

A shoot of hydrilla was placed in a boiling tube containing pond water. A bench lamp with a shinning bulb was placed 25cm away. The set up was connected to a syringe. The concentration of oxygen was recorded every after 5minutes for 10 minutes. The experiment was repeated using the same hydrilla in the same boiling tube but with the lamp placed 5cm away from the boiling tube

Results

Illustration

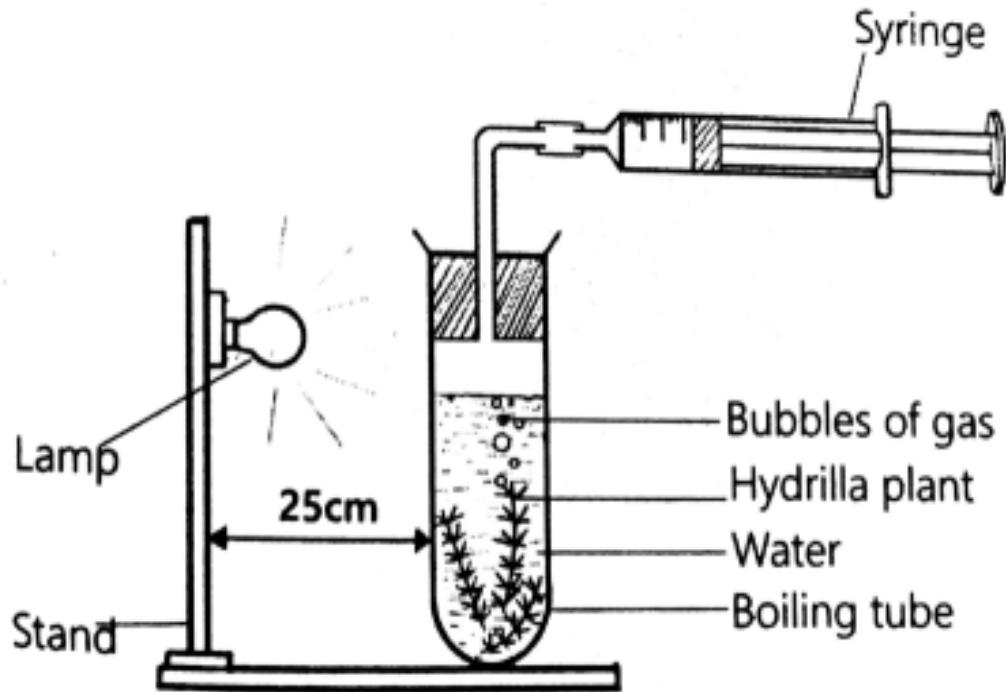


Table of results

Distance of the lamp/cm	Oxygen concentration after 5minutes	Oxygen concentration after 10minutes
25	60	65
5	64	84

Questions

- a) Based on the results of this experiment, explain the effect of light intensity on oxygen production
- b) What process is being investigated when oxygen concentration is measured in this experiment?
- c) Why is the measurement of oxygen concentration considered as inaccurate measurement of the rate of the process stated above?
- d) State one environmental condition that would need to be kept constant during this experiment. Describe how this condition can be kept constant'
- e) How are plant leaves adapted for photosynthesis?

Activity of integration

- A man who lives alone at his home in a certain district had 3 plants at home that he treasured so much.
 - ✓ An arrow head plant that he grew in a nutrient rich bottle
 - ✓ A pond weed. Hydrilla, grown in a sealed transparent container that he regularly opened and added sodium hydrogen carbonate to.
 - ✓ A hibiscus plant in a porous pot containing soil that he watered every day

The hibiscus and the pond weed were stationed on a well-lit, water proof veranda, while the arrow head was stationed in his bedroom. One day the man left his home and went to visit a friend where he spent 2 month. On coming back, he found when his three plants had dried

Support material



Figure 4.9(a): An arrow head plant in a bedroom



Figure 4.9(b): Hibiscus plant and pond weed on a veranda

TASK: write a report you will use to explain to this man what could have caused the drying of his plants

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Chapter 5

Nutrition in Mammals



By the end of this chapter, I should be able to;

- ✓ Understand the role of enzymes in influencing life processes
- ✓ Conduct experiments on and explain the effects of pH and temperature on enzyme activity
- ✓ Know and identify the different types of mammalian teeth and relate their structure and position in the jaw to diet.
- ✓ Understand the importance of oral hygiene and describe good practice in caring for teeth and gums in humans
- ✓ Appreciate the structure of the different parts of the mammalian alimentary canal, and its role in the digestion of food
- ✓ Understand how end products of digestion are absorbed and assimilated.

Introduction

QN: Can animals live without plants?

Obviously not! Animals get their food from plants, by directly or indirectly eating plants.

All animals, including humans, require already made food for growth, repair and normal body functioning. That is why they are said to be **HETEROTROPHIC**

ENZYMES

The human body has catalysts called enzymes which quicken the process of breaking down food. Enzymes increase the speed of the reactions in our bodies.

NB: an enzyme is a biological catalyst, protein in nature and produced by living cells, which speeds up the rate of a biochemical reactions but its not changed in the process.

Activity

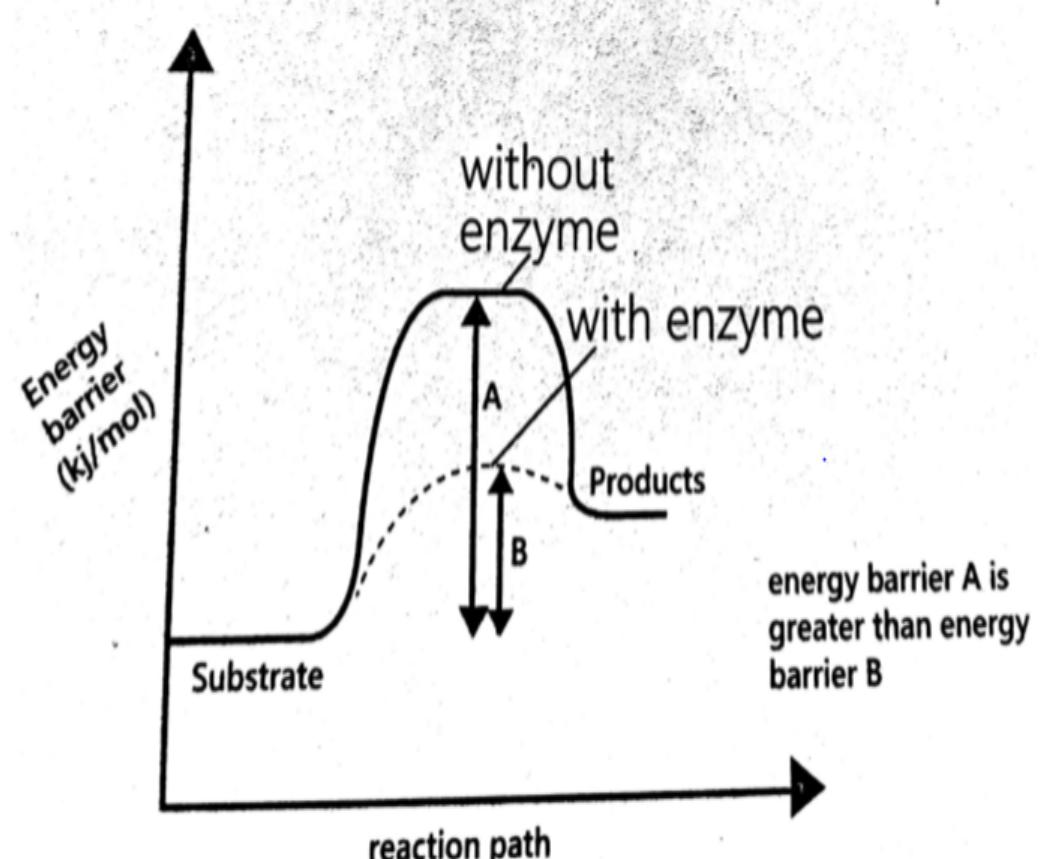
In groups, use the internet or any other Biology reference materials to research, discuss and write about:

- a) Effects of enzymes on biochemical reactions
- b) Properties of enzymes
- c) The names and functions of some enzymes that work in the digestive system.

Present your findings to the rest of the class for further discussion.

Soln

a) Enzymes are biological catalysts that alter the rate of biochemical reactions. They make biochemical reactions to occur faster than if they are absent. They do this by providing an alternative route that requires less energy to convert substrates into products as seen in the graph below.



b

- ✓ They are protein in nature.
- ✓ They are specific in their action i.e. they catalyze specific food i.e. Maltase on Maltose.
- ✓ They speed up the rate of chemical reactions (they are catalysts).
- ✓ They are required in small amounts to catalyze reactions.
- ✓ They remain unchanged at the end of the reaction.
- ✓ They are denatured by high temperatures since they are protein in nature and are inactivated by low temperatures.
- ✓ They are inactivated by inhibitor chemicals (poisons e.g. cyanide).
- ✓ They work at a specific PH. (either acidic or alkaline)

C)

ENZYME	LOCATION	FUNCTION
ptyalin/salivary amylase	Saliva secreted by salivary glands in the mouth	Catalyses the conversion of starch to maltose
Renin	Gastric juice secreted by gastric glands in the walls of the stomach	Coagulates soluble milk protein caseinogen to insoluble casein
Pepsin		Catalyses conversion of proteins to peptides
Trypsin	Pancreatic juice secreted by the pancreas into the duodenum	Catalyses conversion of peptides to amino acids
Pancreatic amylase		Catalyses conversion of starch to maltose
Pancreatic lipase		Catalyses conversion of lipids to fatty acids and glycerol
Maltase	Intestinal juice secreted by the walls of the ileum	Catalyses conversion of maltose to glucose
Sucrase		Catalyses conversion of sucrose to glucose and fructose
Lactase		Catalyses conversion of lactose to glucose and galactose

Exercise one

- i) Why does your body need enzyme ?
- ii) Why can't proteases digest starch ?
- iii) Why doesn't the body need as many enzymes as the number of substrates for effective digestion?

Soln

- i) To increase the rate at which biochemical reactions occur in the body thus enabling efficient body functioning
- ii) Proteases are specific in their action and can only catalyse the breakdown of protein and not starch.
- iii) Enzymes can be used over and over again since they are not used up in the reaction therefore one enzyme can catalyse the breakdown of a number of substrate molecules.

Exercise two

During food processing, manufacturers now days use enzymes to produce products for a lactose-free diet, to reduce the allergic effects of food to man.

- a) Name the enzyme that manufacturers use to produce these lactose free-diet products
- b) What do you think is the role of the enzyme in (a) above in the production process?
- c) What would be the effect of manufacturers continuing to produce their products without using the enzyme ?

Soln

- a) The enzyme is lactase.
- b) The enzyme catalyse the breakdown of lactose to glucose and galactose.
- c) Increased allergy in man since the food will be containing lactose.

How enzymes work

Study Tip:

- ✓ The molecules which are acted upon by the enzymes are called **SUBSTRATES**
- ✓ The working of an enzyme is similar to that of a key and a lock. If the right key fits in the right lock, the lock can be opened but if it does not fit, the lock will not be opened.
- ✓ Similarly, if the right substrate fits in the enzyme active site, the product is formed but if it does not, the product is not formed. Only substrates with the proper shape can fit into the active site of the enzyme.

The work of an enzyme depends on the factors e.g. **temperature** and **pH** in the environment where it is operating and the rate at which the enzyme works is also affected.

QN: which other factors affect enzyme activity?

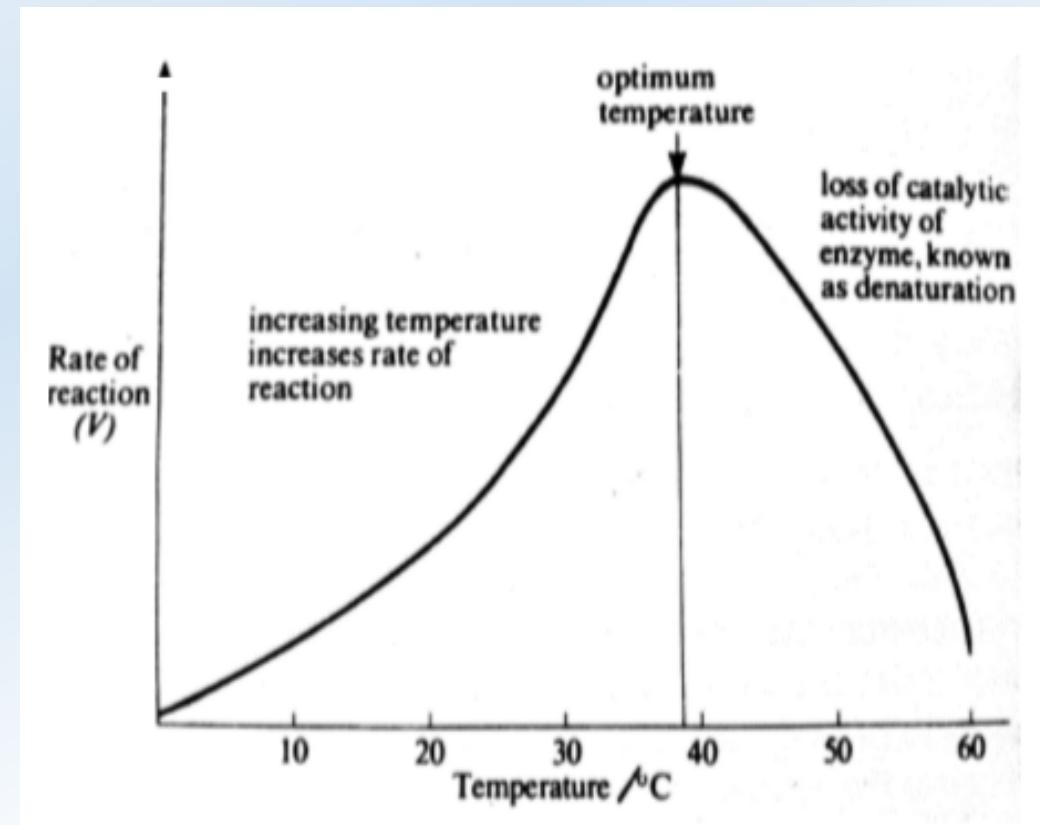
Effect of temperature on enzyme activity

Enzymes work best at optimum temperatures.

At very low temperatures, the rate of enzyme reaction is **very slow** because of **low kinetic energy** leading to few collisions.

As the temperatures increases, the rate of reaction also **increases** due increasing kinetic energy resulting into an increase in effective collisions between enzymes and substrate molecules.

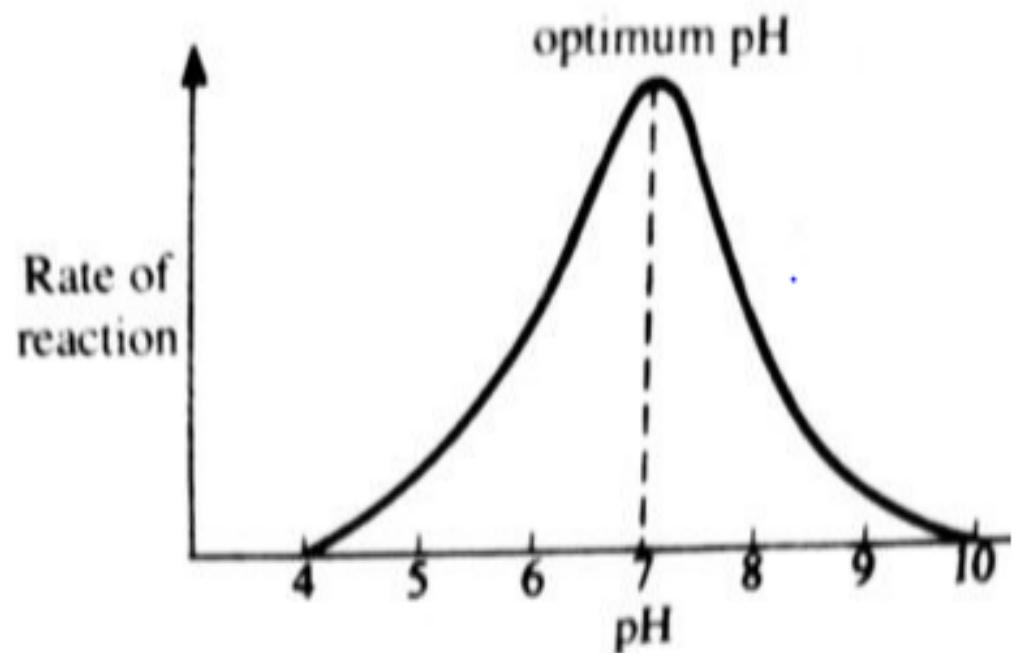
However, further increase in temperature reduces the rate of reaction since enzymes are **denatured** i.e. the shape of active site of the enzyme is changed.



Effect of pH on enzyme activity

Enzymes work best in optimum pH

pH below or above the optimum pH results into reduction in enzyme activity, as shown for the enzyme amylase below

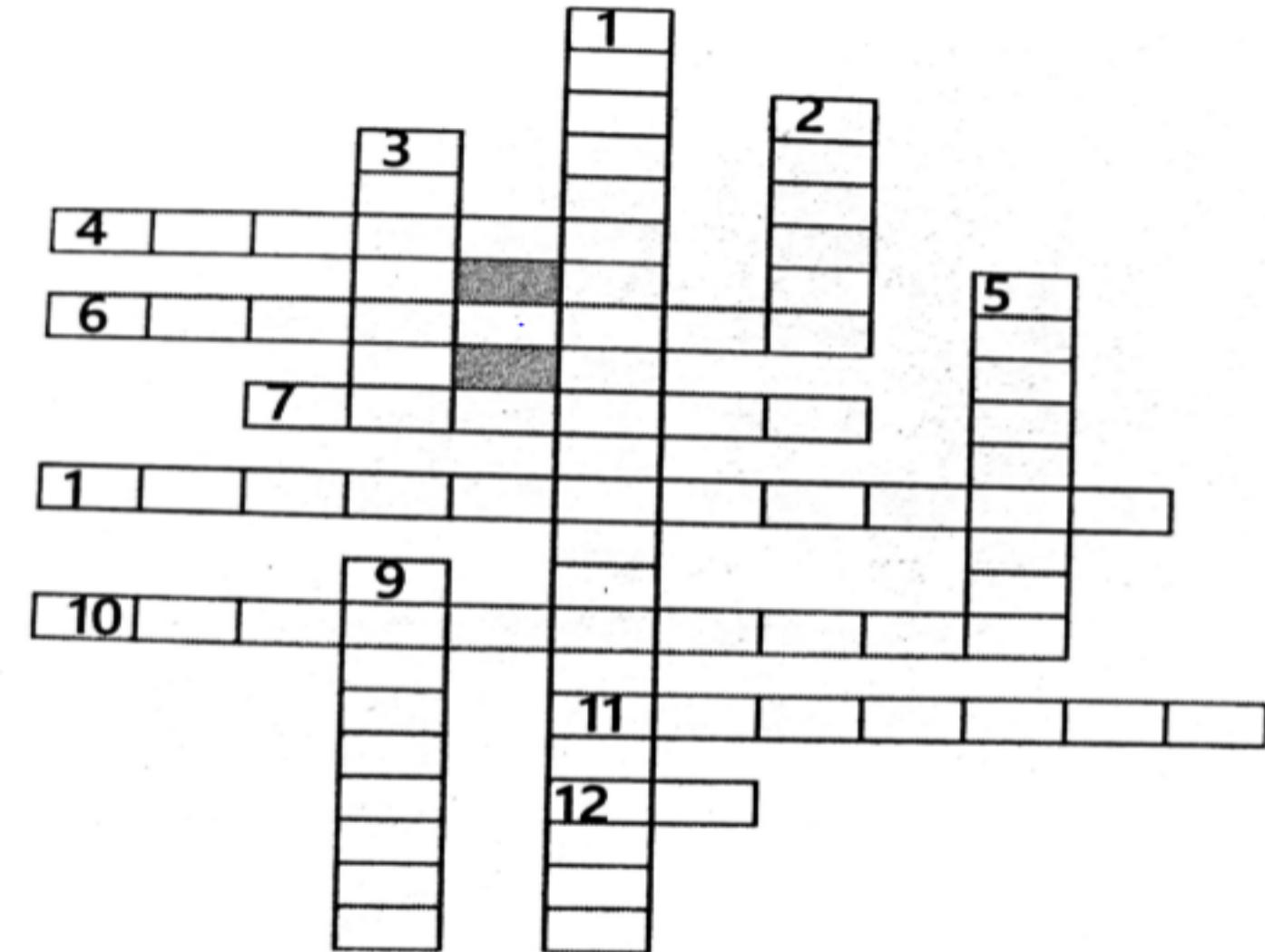


Ctd

Enzyme	pH	Substrate	Products
Pepsin	2	Proteins	Short chain polypeptides
Salivary amylase	7.4 to 7.7	Starch	Maltose
Pancreatic trypsin	8	Short chain polypeptides	Peptides
Catalase	8	Hydrogen peroxide	Water and oxygen
Lipase	8 to 9	Fats	Fatty acids and glycerol

- Other factors affecting enzyme activity include;
 - i) Concentration of the substrate
 - ii) Presence of activators
 - iii) Presence of inhibitors
 - iv) Concentration of the enzyme
- NB:** explain how each of the above affect enzyme activity

Using your knowledge about enzymes, complete the crossword puzzle below.

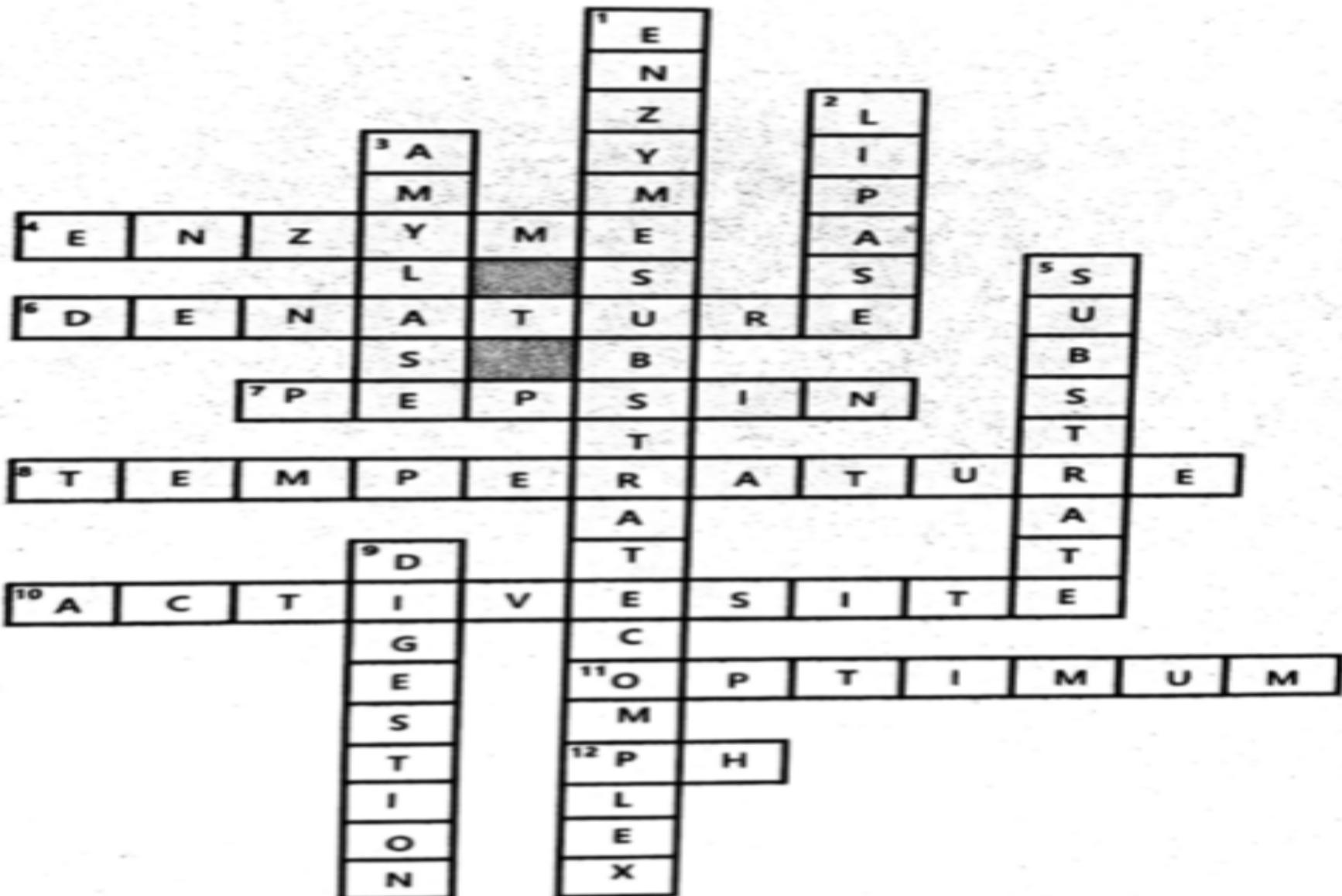


Across

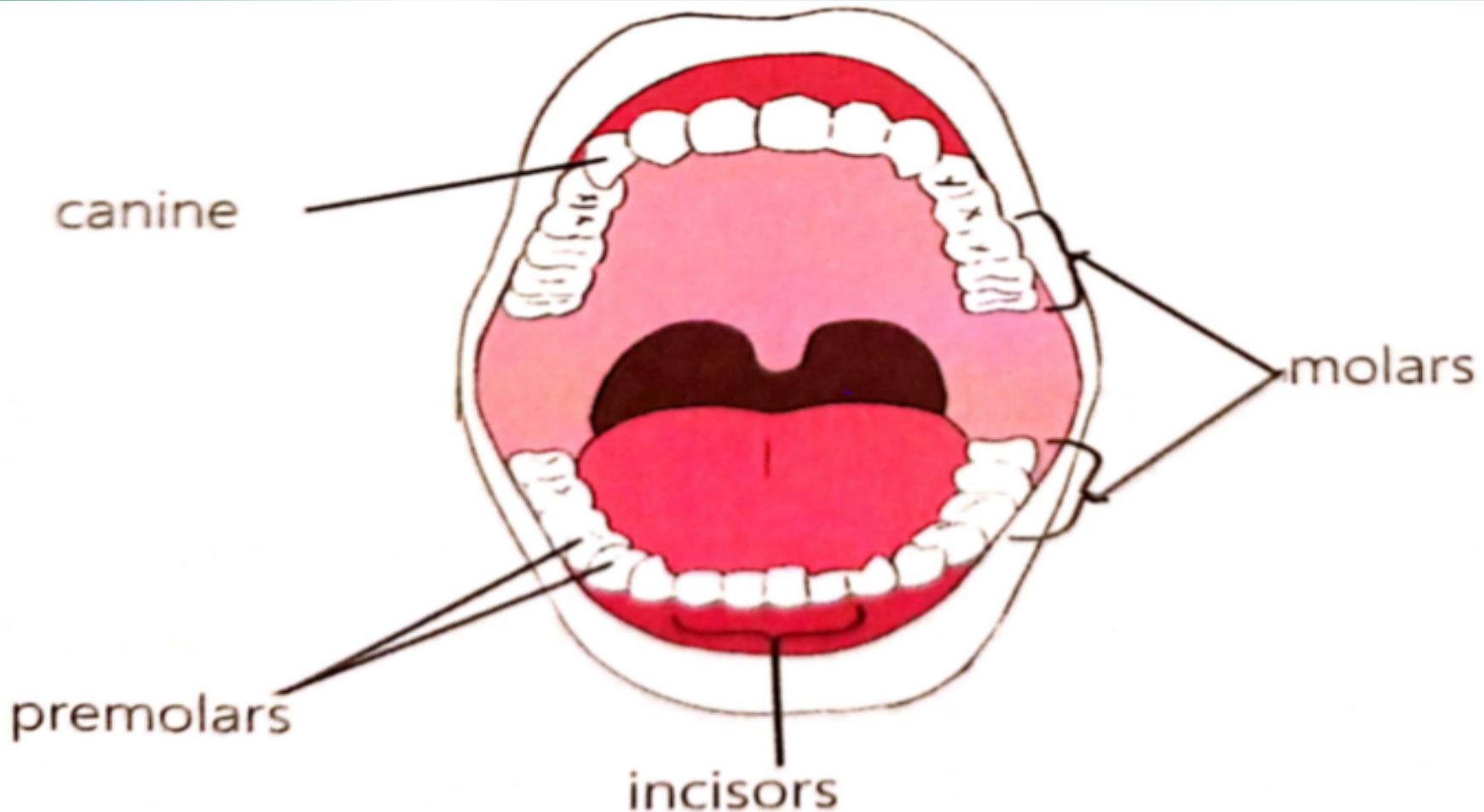
4. What substance is made by living beings and acts as a catalyst to bring about a biochemical reaction?
6. What is the name given to the process of destroying the properties of molecules by heat or acidity?
7. What digestive enzyme breaks down proteins into peptides?
8. What describes the intensity of heat in the atmosphere of a substance?
10. What is the place where an enzyme and a substrate molecule react?
11. What is the perfect temperature and pH for enzyme called?
12. What name is given to the acidity or alkalinity of a solution?

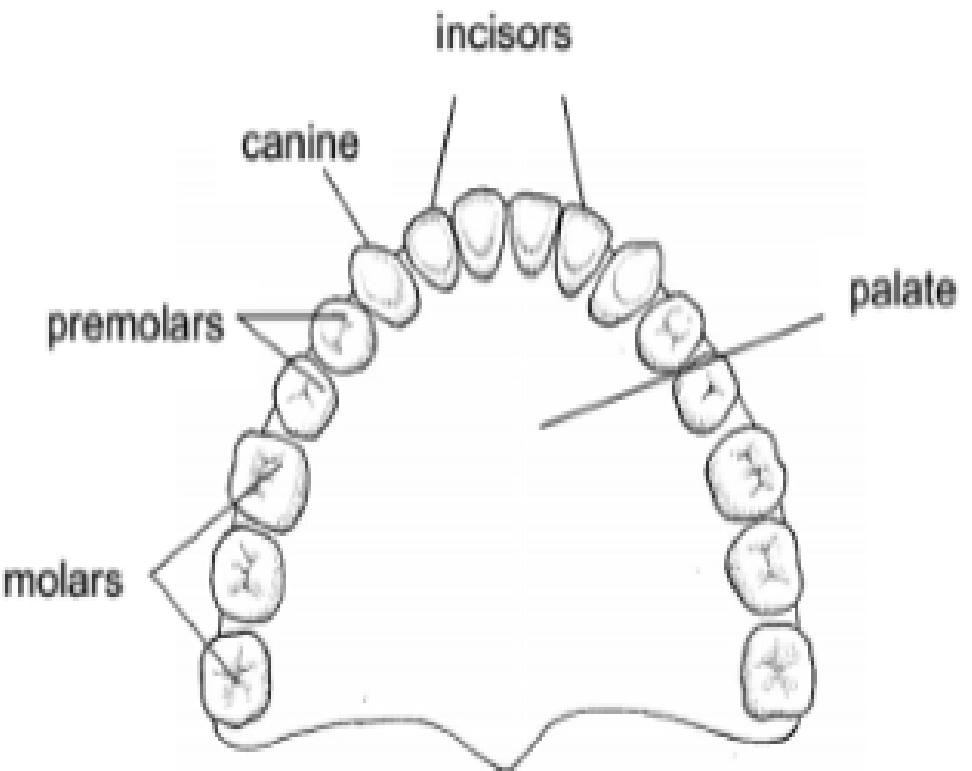
Down.

1. What term is used when substrate molecules interact with the active site of an enzyme?
2. What is the name of the enzyme in the pancreas that digests fat?
3. What is the enzyme in your mouth called?
5. What term is used to describe the substance which an enzyme acts on?
9. What term is used to describe the process of breaking down food?

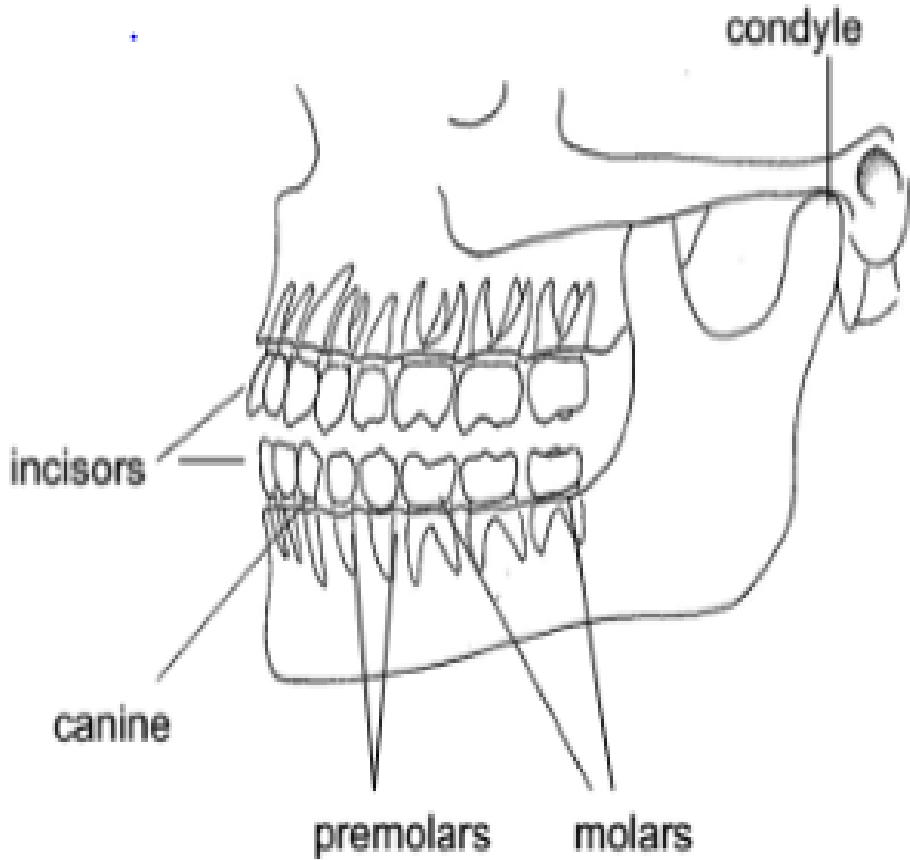


The Mammalian Teeth





Upper jaw seen from below



Position of teeth in jaws - side view

- ◆

Mammals have teeth embedded in the upper and lower jaws. The teeth and their jaws get adapted in different mammals for catching and chewing different kinds of food.

Mammals have different types of teeth modified to perform different functions depending on the diet.

Activity: identifying the different types of teeth and their roles

- a) Wash your hands, open your mouth and with the help of a plane mirror, use your index finger to feel the shape of your teeth
- b) How many kind of teeth can you find? Identify the different types of teeth in your upper and lower jaws.
- c) State the location of each type of tooth
- d) Identify which teeth are used for piercing and tearing and which teeth are used for biting and cutting. Also find out the teeth used for chewing and grinding.

Record your observations in the table below;

Table of results

Function	Number of teeth		Type of teeth
	Lower jaw	Upper jaw	
Piercing and tearing			
Cutting and biting			
Chewing and grinding			

Table of results

Function	Number of teeth		Type of teeth
	Lower jaw	Upper jaw	
Piercing and tearing	2	2	Canine
Cutting and biting	4	4	Incisor
Chewing and grinding	10	10	Molars and premolars

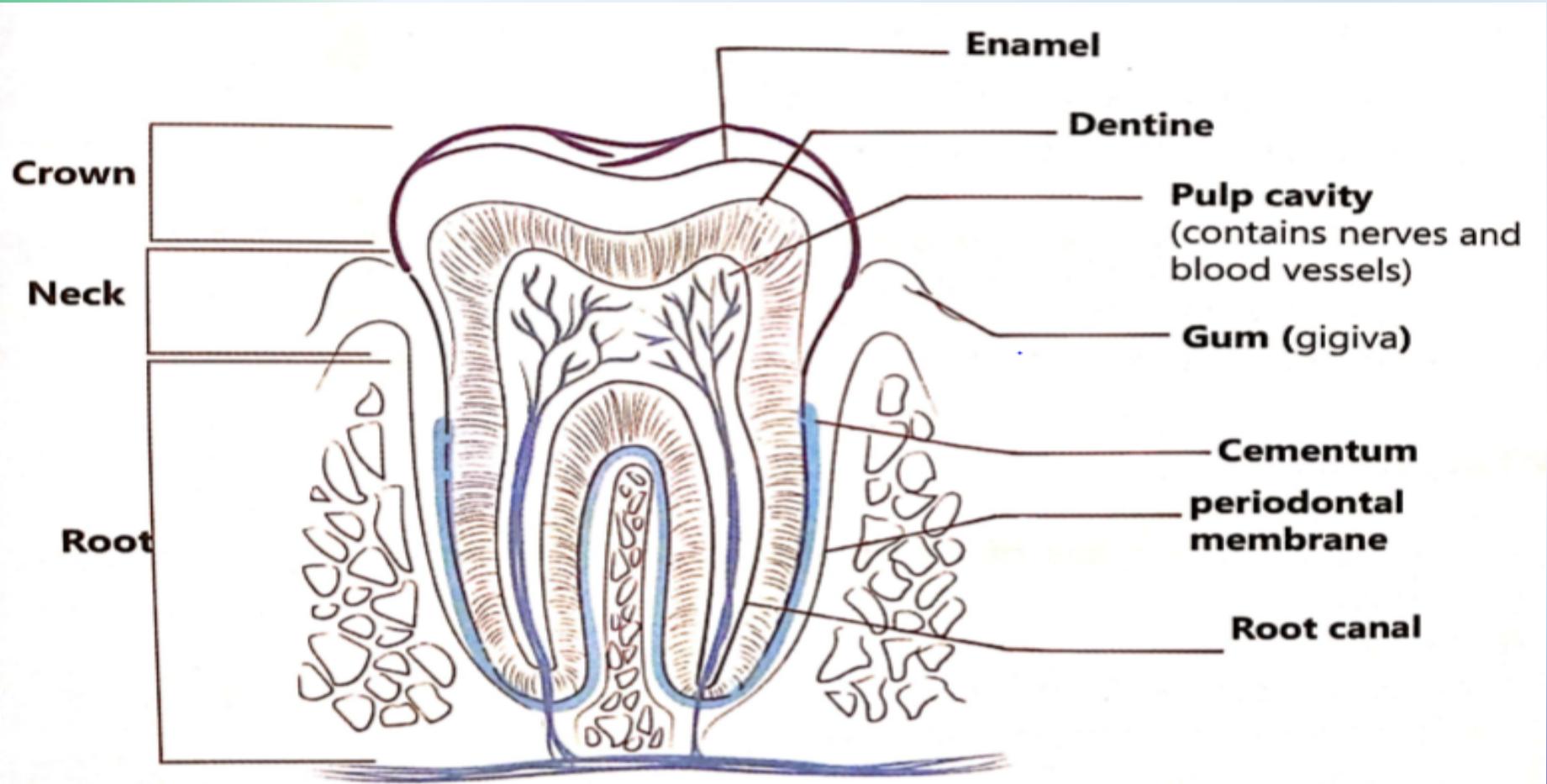
Quiz

Why are teeth performing the same role positioned together in the same region in the mouth?

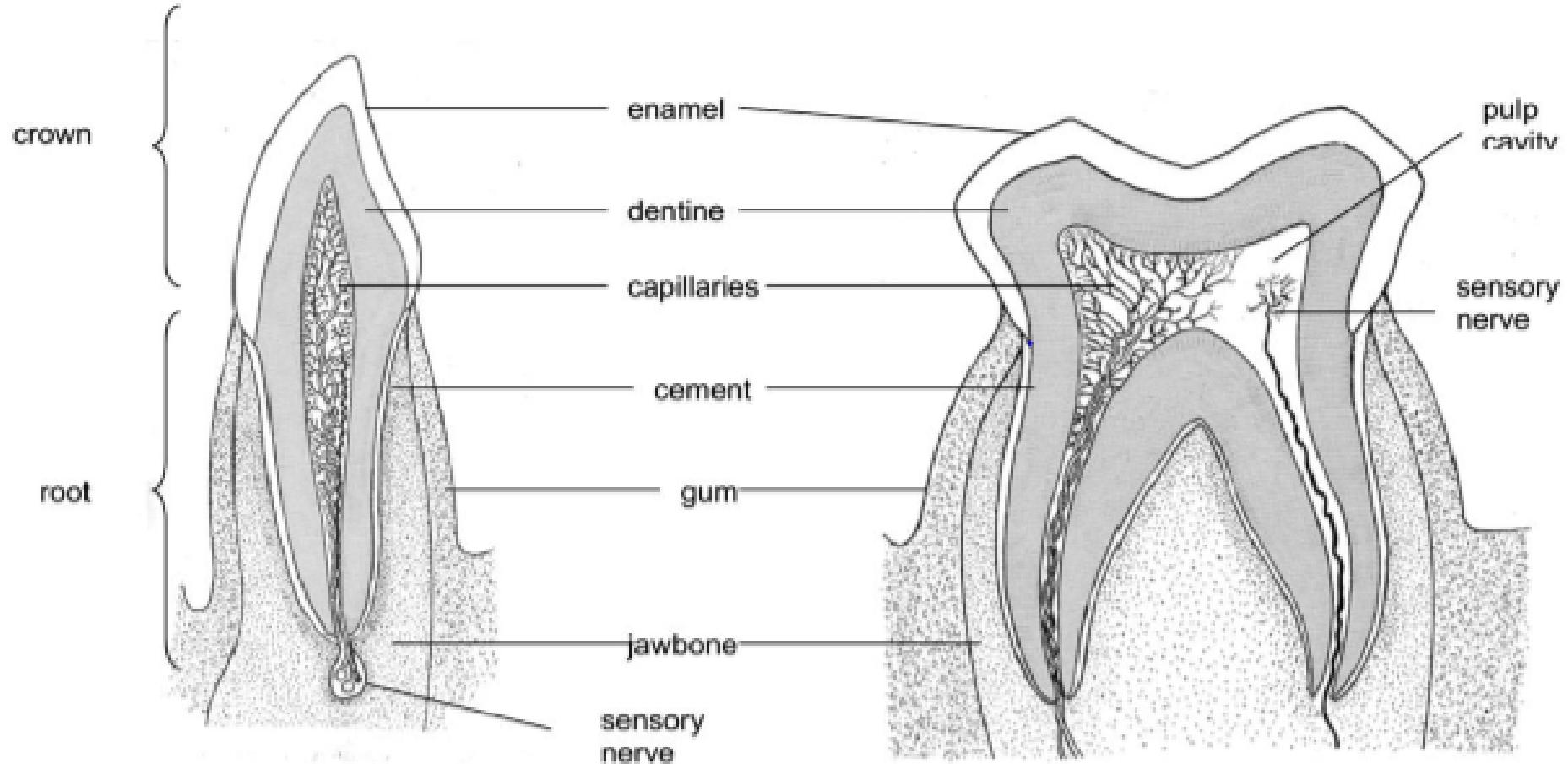
Soln

To provide a large surface area which increases their efficiency in pertaining their function

Teeth structure



Tooth structure



Vertical section through incisor

Vertical section through molar

Description

The tooth is divided into sections

- i) **Crown:** this is the portion that is visible above the gum level. It is usually white in colour and its used to bite.

The surface of the crown is covered by a very hard layer called **ENAMEL**. Below the enamel is the softer **Dentine** and inside the dentine is an open space called the **Pulp cavity** which contains **nerves** and **blood capillaries**.

- i) **Neck:** the part surrounded by the gum
- ii) **Root:** portion within the bony socket of the jaw.

Exercise

Using reference books or internet:

1. Find out the functions of the parts labeled in the drawing made.
2. Explain what would happen if your tooth lost;
 - i) The enamel
 - ii) cement

Soln

1. i) **crown:** for breaking down food
- ii) **neck:** forms a junction between the crown and root
- iii) **root:** fixes the tooth into the jaw bone
- iv) **enamel:** provides strength to the tooth
- v) **dentine:** protects teeth from heat and cold
- vi) **Pulp cavity:** contains nerves that provide sensitivity to the tooth and blood vessels that transport food and oxygen to the teeth
- vii) **gum:** resists friction or food passing over the teeth.
- viii) **cement:** covers roots of the teeth.

- 2 i) exposes the dentine and nerves, making the tooth more sensitive to heat and cold
- ii) The tooth becomes loose in the jaw bone and is eventually lost

NB: mammalian teeth are classified based on the number of roots and the number of ridges on the surface of the enamel in a crown.

Drawing of the structures of different types of teeth and their adaptation

- Visit the library and make drawings of the 4 types of teeth in man.

Adaptations

Type of teeth	Adaptation	Function
Incisor	Sharp and pointed crown for tearing flesh	Biting
Canine	Wedge-shaped crown for cutting food	Piercing and tearing
Premolar	Two roots for firm anchorage into the jaw bone Cusps and ridges shaped for chewing food Flat broad surfaces for grinding food	Chewing and grinding
Molar	Three roots for firm anchorage into the jaw bone Wider crowns with more cusps and ridges for chewing	Chewing and grinding

Quiz

1. Why do teeth have different number of roots?
2. Which type of teeth do you use to eat meat and why?

soln

1. The teeth perform different functions and therefore require different forms of anchorage into the jaw bone
2. Premolars and molars have a crown with a wider surface having cusps and ridges which increase surface area for chewing food.

Dentition and dental formula in mammals

Dentition: is the number of teeth, their shape and arrangement in an animal.

Dental formula: is one obtained by counting the number of each type of teeth in one half of the upper and one half of the lower jaw.

NB: mammals e.g. humans develop 2 sets of teeth during their life time, milk teeth in the early stages of life and the permanent teeth which replace milk teeth later in life.

Activity

1. In groups, illustrate the dental formula of the following animals
 - a) cow or goat
 - b) dog or cat
 - c) human
2. Which teeth form carnassial teeth in cats and dogs? Why do such animals have carnassial teeth?
3. Explain the absence of canines and incisors in the upper jaws of goats and cows

Soln

1. a) I 0/3 C 0/1 Pm 3/3 M 3/3COW
- b) I 3/3 C 1/1 Pm 4/4 M 2/3.....DOG
- c) I 2/2 C 1/1 Pm 2/2 M 3/3.....MAN
2. Premolars and first molars. They act like a pair of scissors which slice through meat cutting it into smaller pieces for swallowing.
3. Goats and cows have a hard-horny pad for holding and plucking grass during feeding so they do not need canines and incisors

Oral hygiene

Do you like sweets? Are you aware that when sugars remain on teeth for long, they cause teeth **decay**?

People having yellowish marks near the gums have **Plague**. Usually formed when some **bacteria** in the mouth combine with substances from saliva. The plague cause **Gum disease** if not removed immediately. Plague can also be got if one uses water with excess amount of **fluoride**.

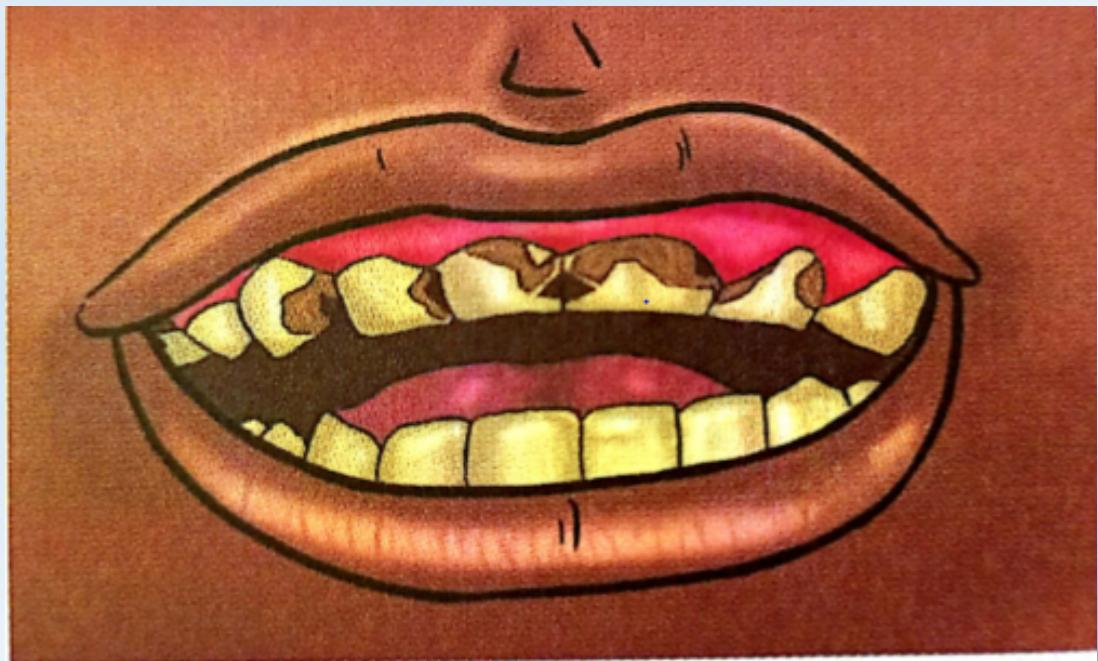


Figure 5.3: Deformed teeth due to poor dental care



healthy gum

A plaque builds up around the edges of the teeth and gums

If the plaque is not removed, it hardens to form tartar encouraging bacteria to attack periodontal membrane

When the periodontal membrane is destroyed further, tooth is loosened and may fall out

Figure 5.4(a): Process of development of gum disease



1
Sugary food trapped in depressions on the surface of the tooth; bacteria feed on food and form acids, which attack the enamel

2
Decay eats into the enamel; causing slight toothache

3
Decay and bacterial infection reach the pulp; causing severe toothache

4
5
Bacteria infect the base of the tooth forming an abscess; agony

Figure 5.4(b): How tooth decay happens

Activity

- In your groups , discuss the following
 1. Why you should practice dental hygiene?
 2. How dental hygiene is maintained in your community
 3. Consequences of poor dental hygiene
 4. How can constant eating of sweets be dangerous to your oral health?
 5. Why is it important to avoid using toothbrushes for a very long period of time without changing it?

1. Why practice good dental hygiene

- To keep teeth and gums healthy
- To prevent tooth loss
- To have a whiter and brighter smile
- To prevent certain diseases and complications e.g. periodontal diseases

2. Maintenance of dental hygiene

- ✓ Eat healthy foods and avoid sugary snacks
- ✓ Rinse your mouth after meals or chewing sugarless gum
- ✓ Brush at least twice a day
- ✓ Protect teeth with a mouth guard during athletics
- ✓ Make regular visits to the dentist for dental examination
- ✓ Floss your teeth after every meal
- ✓ Use a night guard if you tend to grind your teeth during sleep
- ✓ Use bottle openers to open bottle tops and not teeth

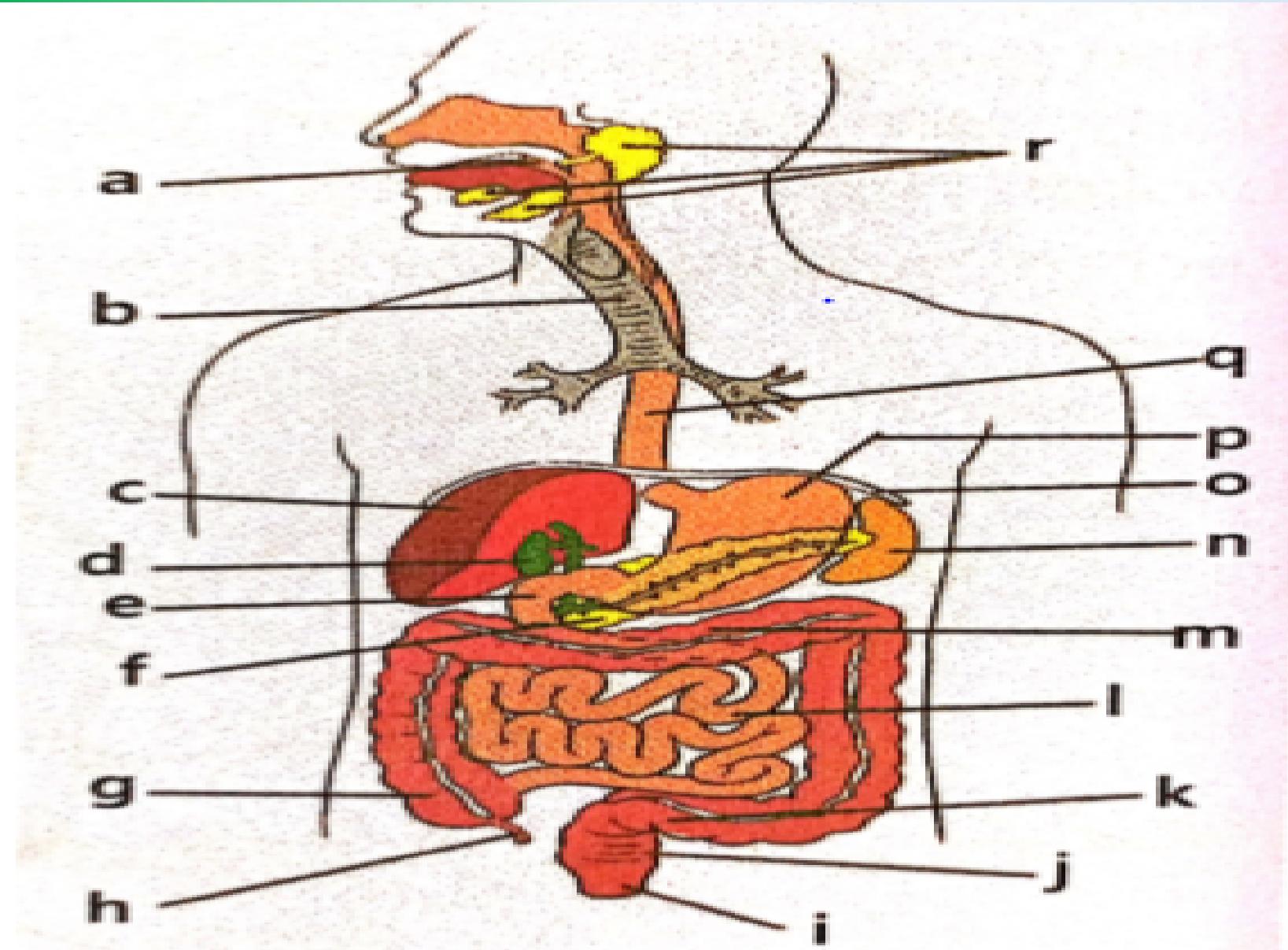
3. Consequences of poor dental hygiene

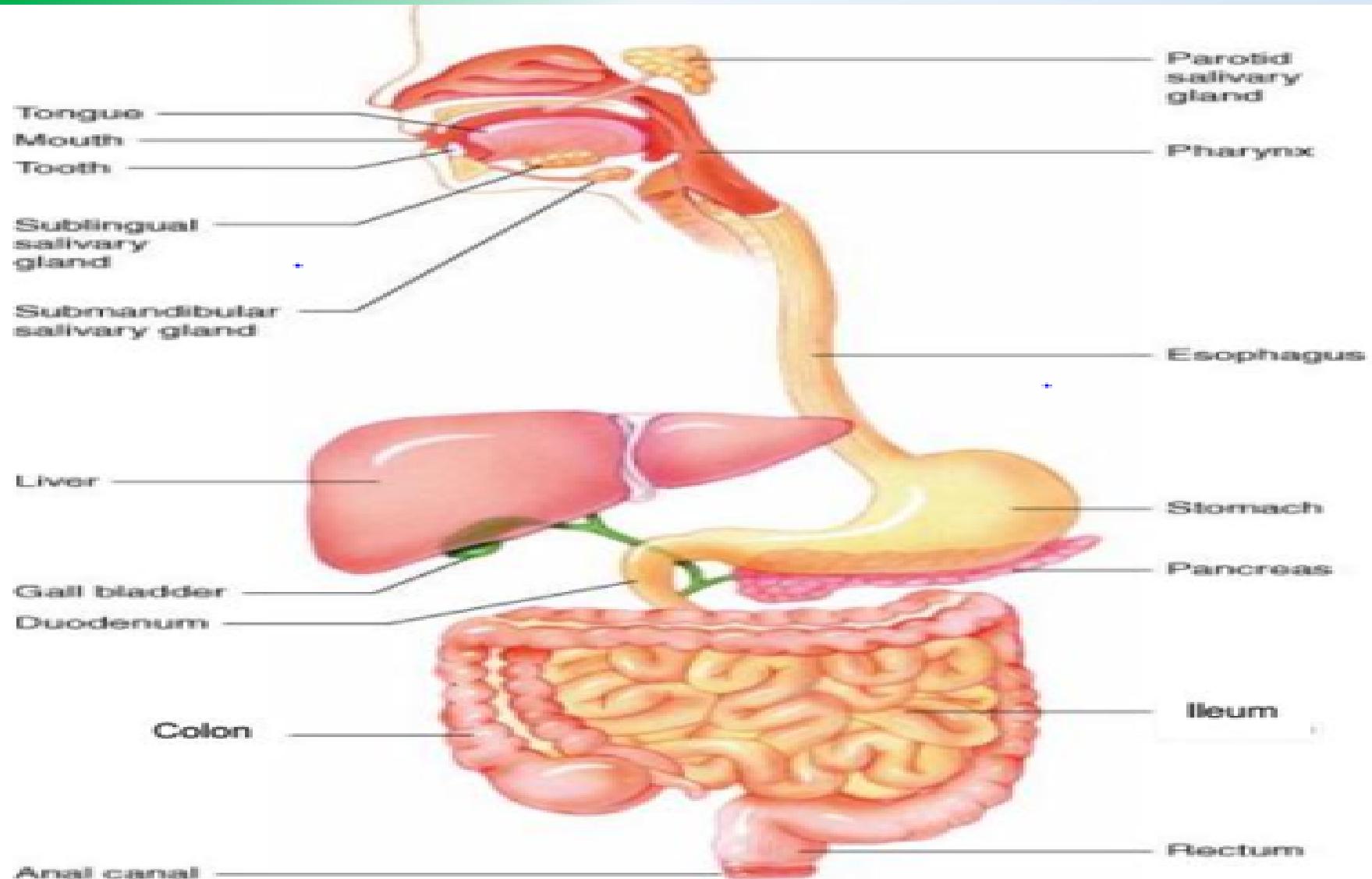
- ❖ Periodontal diseases e.g. gingivitis, bleeding gums
- ❖ Tooth loss when extracted by the dentist upon being diseased
- ❖ Tooth decay
- ❖ Tooth abscesses; painful and swollen gums which can lead to brain abscesses if not treated early

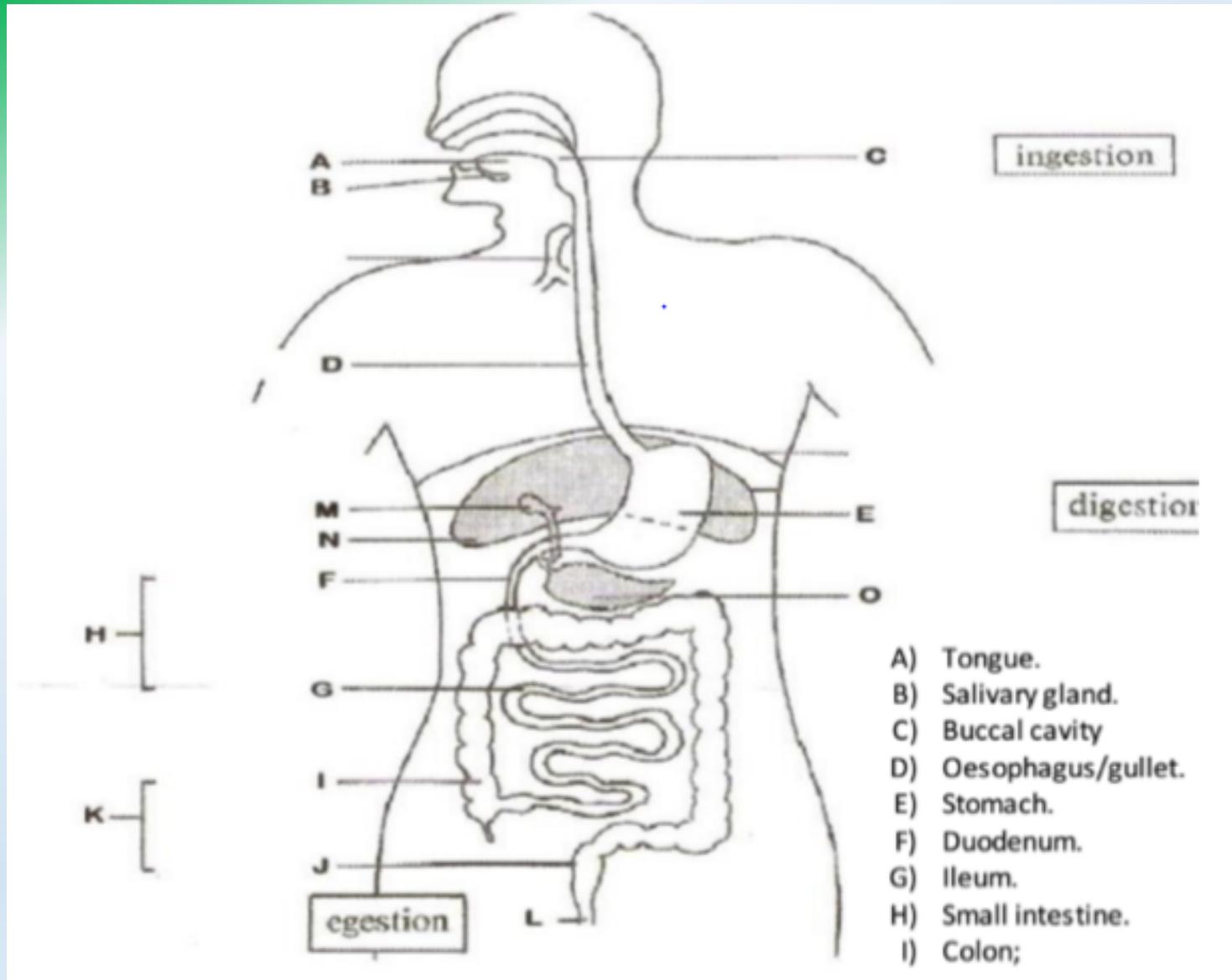
4. The sugar in sweets combines with saliva and bacteria in the mouth leading to formation of plaque on teeth, if not removed, teeth plaque can dissolve the enamel leading to cavities

- 5. A new tooth brush removes more plaque than one that is worn out .
 - o As bristles become worn, they become prone to bacterial or fungal growth
 - o Very old toothbrushes with worn out bristle can cause gum bleeding
 - o Using a toothbrush for morethan 3 months might cause you dental problems and bad breath.

Mammalian alimentary canal







- A) Tongue.
- B) Salivary gland.
- C) Buccal cavity
- D) Oesophagus/gullet.
- E) Stomach.
- F) Duodenum.
- G) Ileum.
- H) Small intestine.
- I) Colon;
- J) Rectum.
- K) Large intestine.
- L) Anus.
- M) Gall bladder.
- N) Liver.
- O) Pancreas.

Parts of the alimentary canal

a- mouth cavity secretes saliva for digestion of starch, **b-** trachea, **C-** liver produces bile, **d-** gall bladder secretes bile for emulsification of fats, **e-** duodenum for digestion of fats, proteins and starch, **f-** pancreas secretes pancreatic juice, **g-** caecum, **h-** appendix, **i-** anus allows exit of undigested food materials(egestion), **j-** rectum for temporary storage of undigested food, **k-** colon, **l-** small intestines for final digestion of food, **m-** large intestines for absorption of water from food, **n-** spleen, **o-** diaphragm, **p-** stomach for temporary storage of food, **q-** oesophagus for passage of food to the stomach, **r-** salivary glands secrete amylase enzyme

Quiz

1. Why is the alimentary canal tubular?
2. Why do the liver and pancreas appear in close association with the duodenum?
3. Explain why the ileum is coiled.

NB: the length of the alimentary canal varies depending on the type of diet the animal depends on.

It is longest in herbivores and shortest in carnivores.

Soln

1. To allow passage of food.
2. The liver produces bile while the pancreas produces digestive enzymes that catalyze the digestion of food in the duodenum.
3. To allow down movement of food giving it more time for efficient absorption of the end products of digestion.

Digestion of food

Digestion is the breakdown of large or complex food materials into smaller sized soluble materials that can be absorbed into the blood stream.

Physical digestion: This is the breakdown of food due to the mechanical action of teeth, muscular contractions and bile juice.

Chemical digestion: This is the breakdown of food due to enzyme action or enzymatic action.

The food components gradually get digested as food travels through the various components of the alimentary canal.

The inner walls of the stomach, the small intestines and the various glands associated with the canal e.g. **salivary glands**, the liver and the **pancreas** secrete **digestive juices**.

The digestive juices contain **enzymes** that convert **complex** substances of the food into **simpler** ones.

Digestion in the mouth

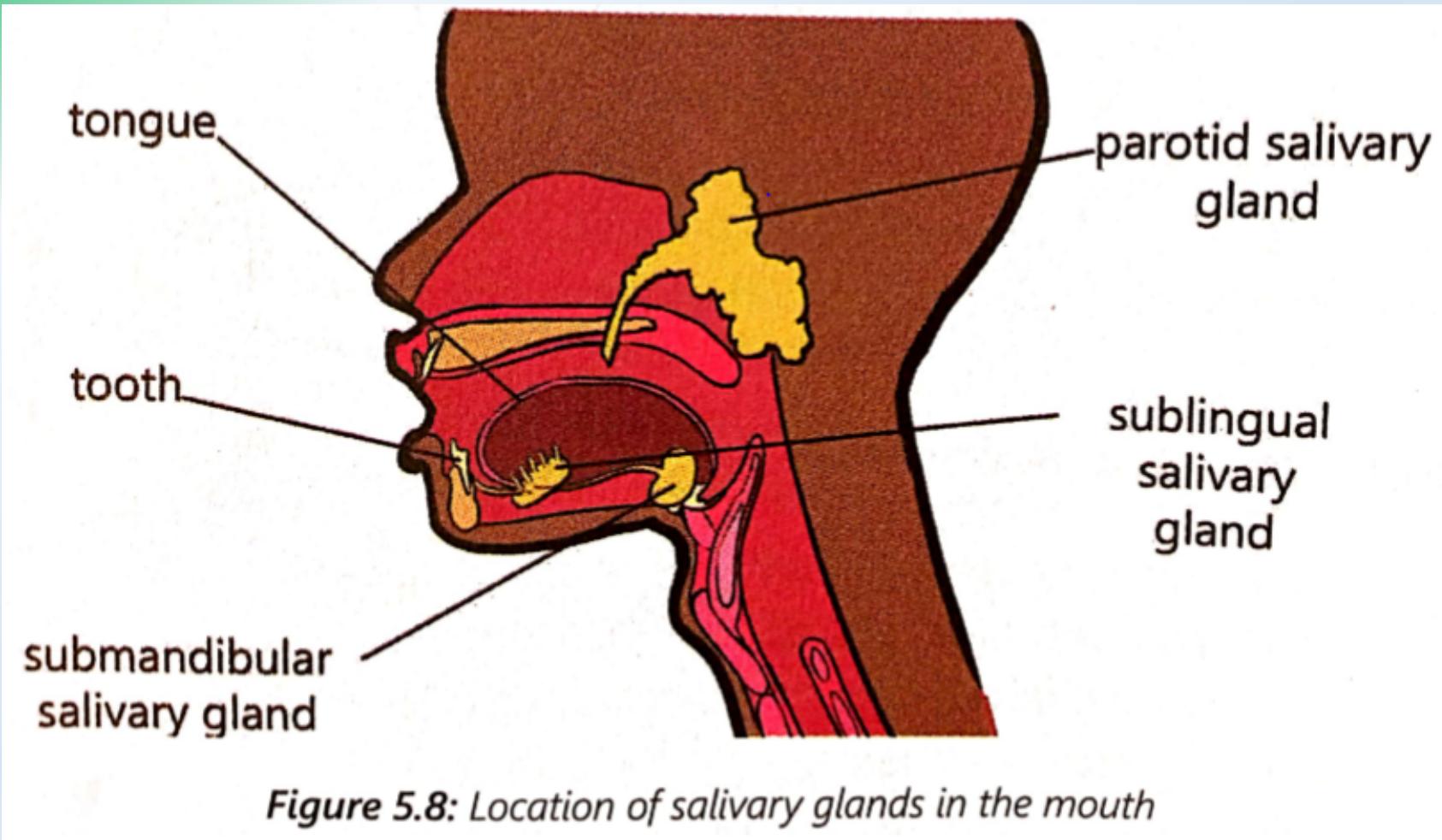


Figure 5.8: Location of salivary glands in the mouth

Ctd

Food is taken into the body through the mouth by the process called ingestion.

When food is in the mouth, it is chewed with the teeth and broken down mechanically into small pieces while the tongue mixes food with saliva and rolls it into the bolus for easy swallowing.

The mouth has **salivary glands** which secrete saliva

Chemical digestion is carried out by the enzyme **salivary amylase**. Saliva is an alkaline watery solution and it provides the **optimal PH** for the action of amylase i.e. a high PH. Salivary amylase acts only on cooked starch breaking it down to disaccharide called **Maltose**.

Cooked starch

Maltose.

Salivary amylase (Ptyalin)



DIGESTION IN THE STOMACH

Digestion in stomach is mainly chemical.

In the stomach, there is only **protein digestion**.

Gastric juice is secreted and it contains two enzymes, (pepsin and renin), hydrochloric acid, mucus and water.

Pepsin acts upon **proteins** breaking them down into **polypeptides**.

Pepsin works at **low pH** i.e. **acidic** conditions provided by the presence of Hydrochloric acid (HCl).

Renin coagulates **milk**. (Makes it insoluble) i.e. it converts the **soluble** milk protein **Caseinogen** to an **insoluble** curd, **casein** which is then acted upon by **pepsin** breaking it down to polypeptide.

Rennin is an important enzyme especially in young mammals since they feed on only milk.

Caseinogen (Soluble protein)  **Renin** **Casein (Insoluble protein)**

Proteins (Soluble protein)  **pepsin** **polypeptides**

Physical digestion in stomach is due **peristaltic** movements of thick stomach wall against food. The peristaltic movements mix food with gastric juice to form acidic chyme

Importance of: i) HCl

- ✓ Activates pepsinogen to enzyme pepsin
- ✓ Creates adequate pH medium for action of pepsin
- ✓ Kills microorganisms that escape into stomach
- ✓ Stops action of ptyalin (salivary amylase)

ii) **Mucus:** Mucus forms a barrier between stomach walls and Gastric juice thus protecting the stomach walls from the action of hydrochloric acid

DIGESTION IN THE DUODENUM

There are accessory organs which release digestive juices into duodenum; pancreas releasing pancreatic juice and gall bladder releasing bile

Functions of bile

- i) It's alkaline and neutralizes the HCl in chyme to stop the action of the stomach enzymes and allow enzymes in the pancreatic juice to begin working.
- ii) It reduces the surface tension of fats and breaks them into minute droplets i.e. emulsifies fat.
- iii) Provides suitable pH for action of pancreatic enzymes

The arrival of food in the duodenum stimulates the production of a hormone called **secretin** to the pancreas and stimulates secretion of **pancreatic juice**. It contains a number of enzymes which are called the **pancreatic enzymes** as shown in the table below.

Enzymes	Food acted upon	Products
Trypsin	Proteins/ polypeptides	Peptides
Pancreatic amylase	Starch	Maltose
Pancreatic lipase	Lipids	Fatty acids and glycerol

DIGESTION IN THE ILEUM

This is where final digestion takes place.

Food moves down from the duodenum into the ileum by peristalsis. The presence of food in the ileum stimulates the secretion of the **intestinal juice, Succus entericus** by walls of the ileum.

Succus entericus contains several enzymes which complete the process of digestion forming a milky fluid substance called **chyle**(food after final digestion is called chyle).

Enzymes	Food acted upon	Products
Sucrase	Sucrose	Glucose and fructose
Maltase	Maltose	Glucose and glucose
Lactase	Lactose	Glucose and galactose
Peptidase	Polypeptides	Amino acids
Lipase	Lipids	Fatty acids and glycerol

ABSORPTION

Absorption is the process by which soluble products of digestion diffuse through the cellular lining of the villi into the blood stream.

The food that remains undigested and unabsorbed enters into large intestines forming faeces which are temporarily stored in the rectum and later expelled through a process called egestion.

THE VILLI

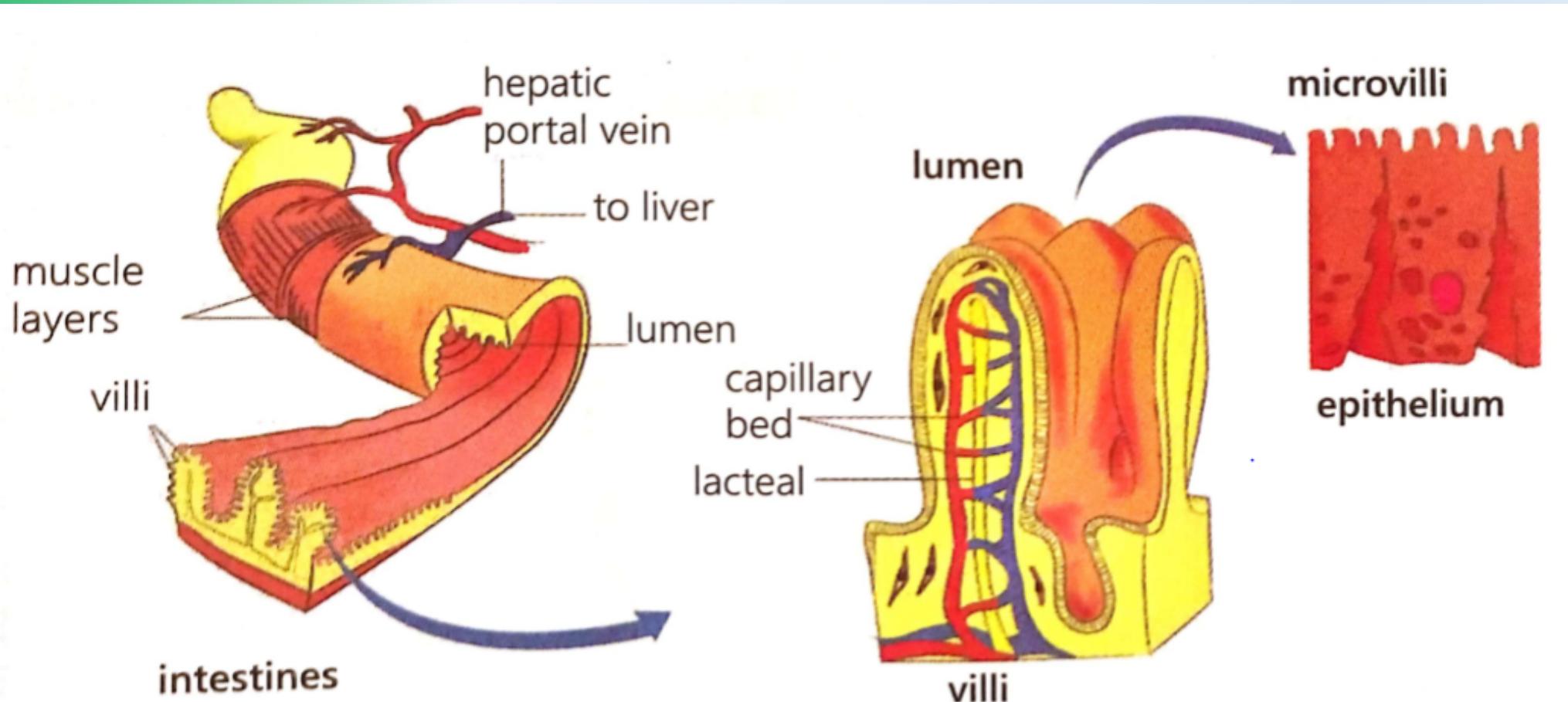
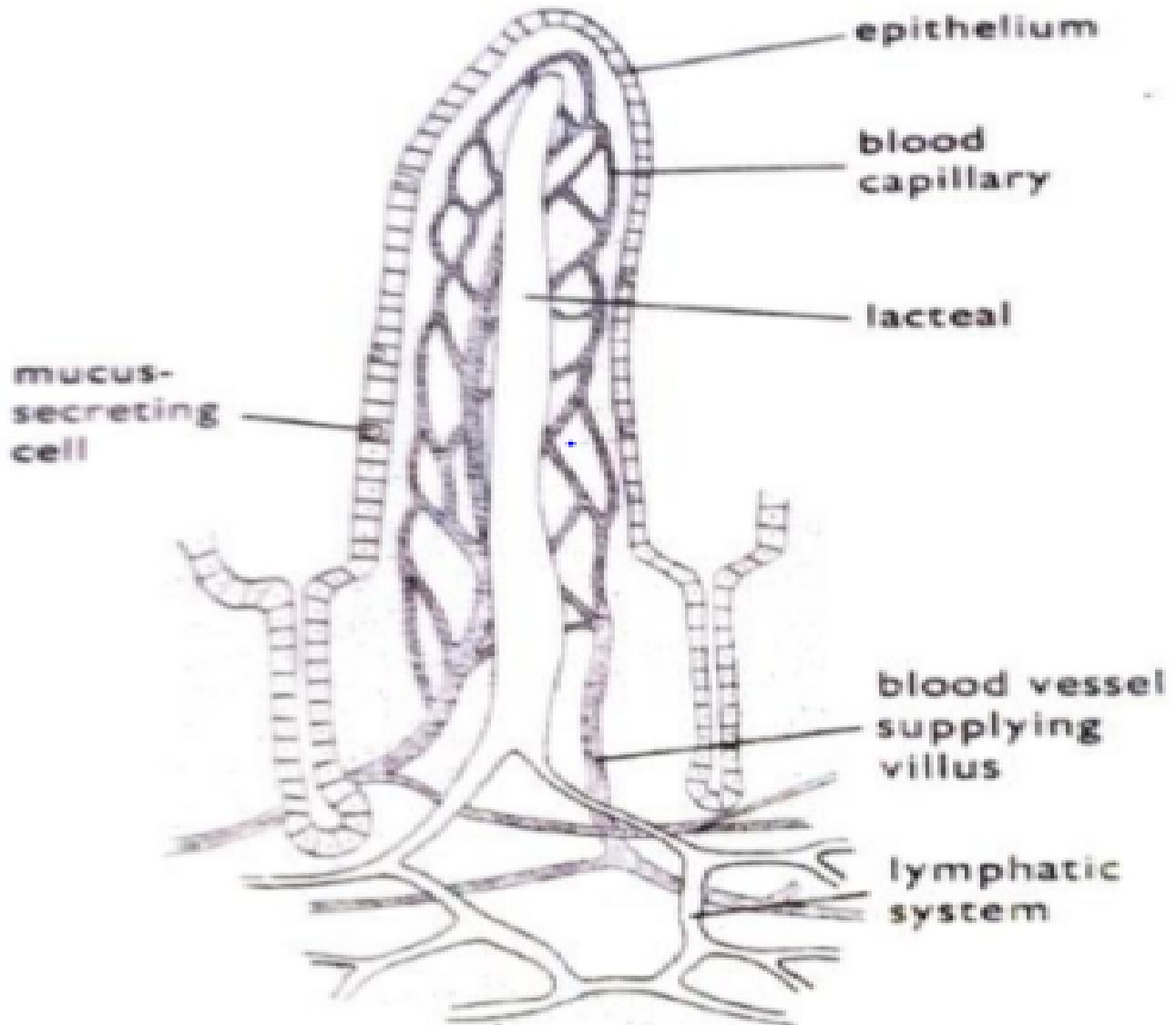


Figure 5.9: Structure of Villi in the small intestines
@PETEROKION 778001502/ 758795415

Diagram of Villus



Adaptations of ileum for absorption

- ✓ Long to increase surface area over which absorption can take place
- ✓ Is coiled to reduce distance of movement of food substances, increasing time for absorption
- ✓ Has villi, which are finger like projections that increase surface area for absorption of nutrients
- ✓ The villi also have hair like extensions called the micro villi which further increase the surface area for absorption of soluble food products.
- ✓ Supplied with adequate blood by numerous blood capillaries which transport away absorbed nutrients.
- ✓ Lacteals into which fatty acids and glycerol is absorbed
- ✓ Thin wall to reduce diffusion distance for absorption of food nutrients.

ASSIMILATION

This is the process by which absorbed food materials are used to form complex components of cells of organism as well as incorporation in tissues of an organism.

THE FATE OF ABSORBED FOOD NUTRIENTS IN THE BODY

Glucose	Proteins	Lipids (Fatty acids & Glycerol)
<ul style="list-style-type: none"> ✓ Glucose is mainly broken down in the process of respiration to provide energy for the body's metabolic process. ✓ Excess glucose is stored as Glycogen (animal starch); however, the liver has the ability to reconvert back the glycogen to Glucose in periods of starvation. 	<ul style="list-style-type: none"> ✓ Amino acids are used in the synthesis of enzymes e.g. pepsin. ✓ Amino acids are used in the synthesis of hormones e.g. insulin. ✓ Amino acids are used in the synthesis of antibodies. ✓ Some Amino acids are used in body growth and repair. ✓ Amino acids can instead be used in the process of respiration to produce energy during starvation. ✓ Excess Amino acids are deaminated by the liver to form urea and carbohydrate residue. <p>NB: Deamination is the removal of the amino group from Amino acids to form urea (which is a toxic waste product).</p>	<ul style="list-style-type: none"> ✓ Fatty acids and glycerol in the absence of Glucose can be oxidized to release energy. Fats produce much more energy compared to glucose considering the same amount by mass. ✓ Fats may be stored in adipose tissue. The fat tissue formed insulates the body against heat loss and also protects vital body organs like the liver and intestines from mechanical damage. ✓ Lipids are used in the formation of structures like the cell membrane.

TEST YOURSELF

1. What is an enzyme?
2. Complete the table below which illustrates the digestive process.

Region of digestion	Active enzyme	Substrate	Product(s)
Mouth	Amylase
Stomach	Proteins
Duodenum	Polypeptides
.....	Fats

Ctd

3. A patient suffering from gall bladder disease has had his gall bladder removed. Suggest and explain the type of diet and lifestyle that he should adopt.
4. A certain disease of the alimentary canal destroys the villi in the small intestine. Explain how this would affect the digestion and absorption of food.
5. What are the benefits of brushing your teeth regularly?
6. How does the structure of each of the following teeth suit its function?
 - i) Canine
 - ii) Incisor
 - iii) Molar

END