CHAPTER 3 NUTRITION

Learning Outcomes:

1. To learn about the food classes
2. To learn about the importance of a balanced diet
3. To learn about the human digestive system
4. To learn about the process of absorption and transport of digestive products and defecation

3.1 Classes of food

1. We need food because it is necessary to provide us energy and material to repair tissues and build new cells to maintain good health.
2. Food can be divided into seven main classes, which are carbohydrates, protein, fats, fibre, vitamin, mineral and water.

Carbohydrates

1. Carbohydrates are organic compounds that contain elements of carbon, hydrogen and oxygen.

2. There are three types of carbohydrates:
    a. Starch: Food stored in plants
    b. Glycogen: Food stored in animals, muscles and liver
    c. Cellulose: Forms the cell walls of plants
3. Glucose is the basic unit of carbohydrates. Glucose molecules form starch, glycogen and cellulose.
4. The function of carbohydrates is to supply energy.

5. Food source:
    a. Starch: rice, bread, potatoes
    b. Cellulose: vegetables and fruits

Proteins

1. Proteins are organic compounds made up of carbon, hydrogen, oxygen and nitrogen elements. Some proteins contain sulphur and phosphorus elements.

2. Proteins are digested into their basic units, which are amino acids. Excess proteins (amino acids) cannot be kept in the body. They will change to urea and are eliminated through the process of urination and perspiration.
3. The functions of proteins include:
    a. Growth of new cells and tissues
    b. Repair damaged tissues
    c. Formation of enzymes, hormones, haemoglobin and antibodies
4. Food source:
    a. Meat, fish, eggs, cheese, soya beans and beans

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Fat

1. Fats are organic compounds that are made up of carbon, hydrogen and oxygen elements.
2. Fat molecules consist of glycerol and fatty acids with the ratio of 1:3.
3. There are two types of fats, which are plant fats and animal fats.

4. Oil is fat that exists in liquid form at room temperature.
5. The functions of fats are:
    a. Sources of energy
    b. Fats stored in adipose tissue helps to keep our body warm
    c. Transport fat-soluble vitamins like vitamin A, D, E and K
6. Food source:
    d. Butter, vegetable oil

Fibre

1. Fibre is a substance that cannot be broken down by the digestive system.

2. Fibre is comprised of cellulose found in the cell wall of plants.
3. The functions of fibre are:
    a. Provide bulk of the contents in the large intestine
    b. Prevent constipation
    c. Reduce blood cholesterol level and control sugar in the blood
4. Food source:
    a. Cereals, fruits and vegetables

Water

1. Water is made up of hydrogen and oxygen elements.

2. Water is very important compound for the body as roughly 65-70% of the body mass consists of water. It is in our blood, cytoplasm, organs and in between body cells.
3. The functions of water include:
    a. Transportation of digested food, gases and excretory products
    b. Solvent for chemicals to dissolve
    c. Medium for biochemical reactions
    d. Needed for the production of mucus
    e. Regulates body temperature
4. Food source:
    a. Drinking water, soup, juices

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Vitamin

1. Vitamins are organic compound that do not provide energy.
2. Vitamins can be categorised into two groups:
   - ❖ Water-soluble vitamins: vitamin B and C
   - ❖ Fat-soluble vitamins: vitamin A, D, E and K

Vitamin	Source	Function	Deficiency
A	Carrots, fish, egg yolk, tomatoes	➢ Maintain healthy skin ➢ Prevent night-blindness	➢ Skin disease ➢ Night blindness
B	Cereals, liver, milk, egg	➢ Maintain a healthy nervous system ➢ Form red blood cells	➢ Beri-beri ➢ Anaemia
C	Fruits, vegetables	➢ Maintain healthy skin, teeth and gums which prevent scurvy ➢ Increases the body's resistance to infection of disease ➢ Heal wound	➢ Scurvy
D	Dairy products, liver, eggs	➢ Formation of strong teeth and bones ➢ Helps in the absorption of calcium and phosphorus	➢ Rickets ➢ Osteomalacia ➢ Toothache
E	Green vegetables, wheat, cereals	➢ Maintain the health of skin, heart and eyes ➢ Maintain reproductive system functions ➢ Maintain position of foetus in the womb	➢ Infertility ➢ Hair loss
K	Green vegetables, liver, egg yolk, fish oil	➢ Blood clotting	➢ Prolonged bleeding

Table 3.1 Types, sources, functions and effects of vitamin deficiency

- **Minerals**
  1. Minerals are inorganic food needed by the body in small amount and does not provide energy.

Mineral	Source	Function	Deficiency
Phosphorus	Cheese, milk, egg, fish	➢ Form healthy bones and teeth ➢ Form nuclei acid in the DNA ➢ Help in muscle contraction	➢ Rickets ➢ Brittle teeth
Iodine	Seafood	➢ Synthesize hormones in the thyroid gland	➢ Goitre
Potassium	Fish, banana, nut, fruit	➢ Maintain body fluid balance ➢ Maintain normal functioning of nervous system and muscles	➢ Immobility ➢ Muscle cramps
Sodium	Table salt, cheese	➢ Maintain body fluid balance ➢ Maintain normal functioning of nervous system	➢ Muscle cramp
Calcium	Milk, egg, cheese, yogurt, anchovy	➢ Build strong bones and teeth ➢ Help in blood clotting ➢ Maintain normal functioning of nervous system and muscle activities	➢ Rickets ➢ Osteoporosis
Iron	Liver, meat, green vegetable	➢ Form haemoglobin in red blood cell	➢ Anaemia

Table 3.2 Types, sources, functions and effects of minerals deficiency

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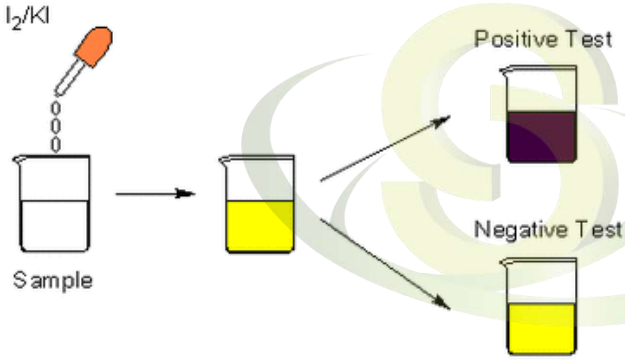
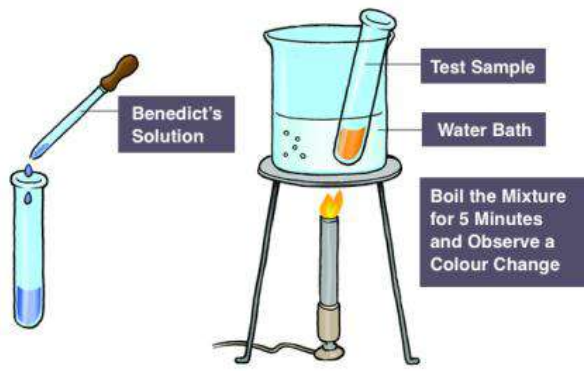
Food tests

Aim:
To determine the presence of starch, glucose, protein and fat in food samples

Materials and apparatus:
Iodine solution, 1% starch solution, Benedict solution, 10% glucose solution, Millon's reagent, albumen solution, ethanol, cooking oil, distilled water, cork stopper, test tube dropper, beaker, Bunsen burner, wire gauze, tripod stand, test tube and tongs.

Food tests	Observation	Inference
Iodine test for starch - Place 2ml of starch solution into a test tube. - Add a few drops of iodine solution into the starch solution. 	Starch solution turns blue-black. 	Starch is present.
Benedict's test for glucose - Place 2ml of 1% glucose solution into a test tube. - Add a few drops of Benedict solution into the test tube. - Boil the test tube together with its content in a water bath for five minutes. 	A brick-red precipitate is formed. 	Glucose is present.

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Millon's test for protein - Place 2ml of albumen solution into a test tube. - Add a few drops of Millon's reagent into the test tube. - Heat the test tube with its content inside a water bath.	Red precipitate is formed. 	Protein is present.
Alcohol-emulsion test for fats - Add a few drops of cooking oil into a test tube containing 2ml of ethanol and shake the mixture vigorously. - Add distilled water of the same volume. - Leave the mixture for two minutes.	An emulsion is formed. 	Fat is present.

3.2 Importance of a balanced diet

1. A balanced diet is a diet that consists of all the seven classes of food taken in right quantity and proportions to meet the needs of the body.
2. A balanced diet can:
    a. provide energy for daily activities
    b. provide substances for growth
    c. provide nutrient to maintain the body health.

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Food pyramid

1. Our food intake needs to be varied because there is no one type of food that can provide all the necessary nutrients to the body.
2. The food pyramid is a guide that shows the relative amount of different food groups in a balanced diet.

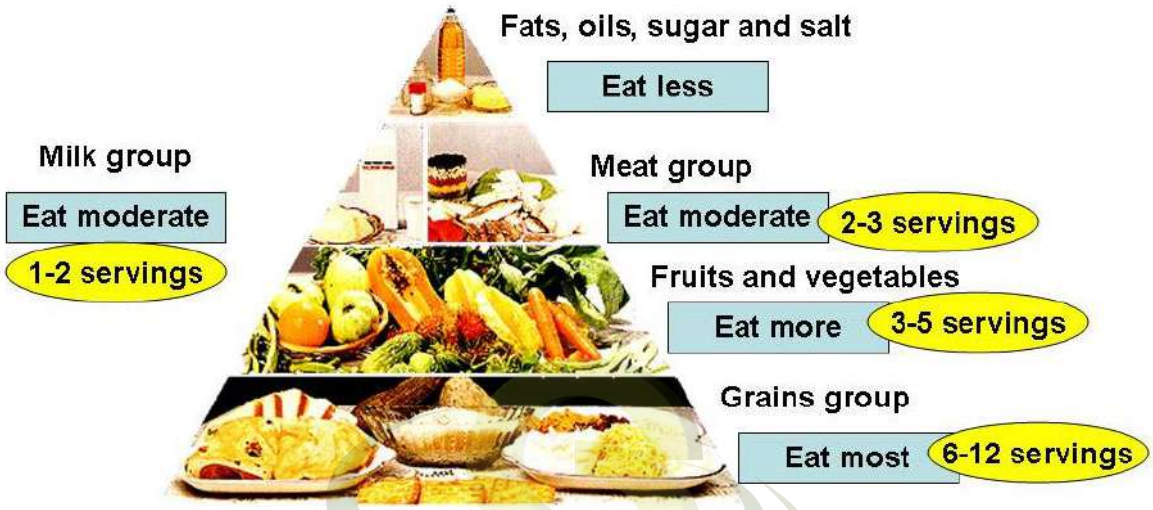

Diagram 3.1 Food pyramid

Factors that affect a balanced diet

No	Factors	Definition
1.	Age	Growing children and teenagers need more carbohydrates and proteins for growth than an elder person. They are usually more active than adults.
2.	Occupation	People who do heavy work like farmers and construction workers require higher amount of energy than those who work in an office.
3.	Body size	People with bigger body size require more energy for their activities compared to smaller sized people.
4.	Gender	Men need a higher energy intake compared to women from the same age group.
5.	Health condition	People who recover from illness need more energy and food rich in nutrient.
6.	Climate	People who live in cold countries need more energy to keep their body warm.

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Calorific value of food

1. Every type of food and drinks has its own energy value. Hence, the calorific value is the total amount of energy released when one gram of food is completely burnt.
2. The amount of energy is measured in calories (cal) or joules (J).

1 calories (cal) = 4.2 joules (J)

3. There are only three classes of food that provide energy to us, which are carbohydrates, protein and fat.

Class of food	Calorific value	
	Calorie value (kcal)	Energy value (kJ per gram)
Carbohydrate	4	17
Protein	4	17
Fat	9	37

Table 3.3 Energy value for carbohydrates, protein and fat

4. The calorific value of food in a meal can be estimated when we know the calorific value of each ingredient in the particular food. For example:

Food/drink	Serving size	Calorific value in kcal
Chicken rice	One plate	600
Laksa	One bowl	435
Fried chicken	One piece	290
Milo	One glass	200
Teh tarik	One glass	150
Coffee with milk	One glass	100

Table 3.4 Calorie value for several types of food and drink

5. Food labels provide information on nutritional value and total calorie for each serving.

Nutritional information			
		Per 65g bar	Per 100g
Energy	Kcal	260	464
	kJ	1089	1944
Protein	g	10.05	17.95
Total carbohydrates	g	28.72	51.29
Sugar	g	8.62	15.39
Total fat	g	11.39	20.34
Saturated fat	g	1.44	2.57
Trans fat	mg	0	0
Fiber	g	7.18	12.82
Sodium	Mg	71.8	128.2

Table 3.5 Nutritional information on food labels

6. A daily balanced diet can be planned according to several factors, for example age, gender, occupation, body size and health condition. These factors need to be taken into consideration to ensure we gain sufficient nutrients for healthy body.

3.3 Human Digestive System

1. Food digestion is the process of breaking down large and complex food molecules into smaller and soluble molecules so that they can be readily absorbed by body cells.
2. There are two types of digestion, which are physical digestion and chemical digestion.
   a. Physical digestion – Breaking down of large pieces of food into smaller pieces using teeth and the churning actions of the alimentary canal.
   b. Chemical digestion – Breaking down of complex molecules into smaller soluble molecules with the help of enzymes. This process involves organs along the entire digestive tract, which are oesophagus, stomach, duodenum, small intestine, large intestine, rectum and anus. Other than that, pancreas, liver and gall bladder also involves in the digestion process.

Complex molecules	Enzymes	End products of digestion
Carbohydrates (Starch)	Amylase, maltase	Glucose
Protein	Protease	Amino acids
Fats	Lipase	Fatty acids and glycerol

Table 3.6 End products of digestion for carbohydrates, protein and fats by specific enzymes

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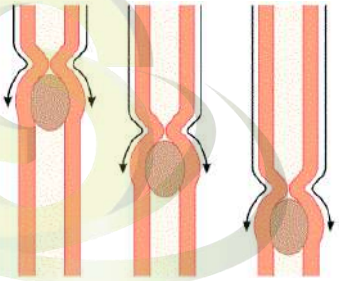
Digestive processes

1. Food digestion is a biochemical reaction that happens in the body at a very low rate. Hence, the enzymes are needed to accelerate the reactions.
2. Enzymes are made of protein. They are produced in the body by a group of cells called glands. Some examples of glands are:
   a. Salivary glands – secrete amylase
   b. Small intestine – secretes maltase
   c. Pancreas – secretes amylase, protease and lipase

Digestive Organ	Functions
Mouth	➢ Physical digestion: Food is chewed and crushed into smaller pieces. ➢ Chemical digestion: Salivary amylase breaks down starch into maltose. Starch $\xrightarrow{\text{Amylase}}$ Maltose
Oesophagus	➢ It is a tube connecting the mouth with stomach. ➢ It transports the bolus from mouth to the stomach by peristalsis movement. 
Stomach	➢ Physical digestion: The stomach walls contract and relax to digest food. ➢ Chemical digestion: The stomach walls produce gastric juice which contains - Hydrochloric acid to kill bacteria and provide an acidic medium for the action of enzymes in the stomach. - Protease enzymes that breakdown protein into polypeptides. Protein $\xrightarrow{\text{Protease}}$ Polypeptides
Duodenum	➢ The chyme will move from stomach to the duodenum. ➢ The liver produces bile, which is stored in gall bladder. Bile emulsifies fats and oil into small globules to increase the surface area for the action of the lipase enzyme. ➢ The pancreas produces pancreatic juice that contains: - Pancreatic amylase that breaks down starch into maltose. - Protease that breaks down polypeptides into dipeptides. - Lipase breaks down fats into fatty acids and glycerol.

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Small intestine	➢ The wall of the small intestine secretes intestinal juice that contains: - maltase enzyme that breaks down maltose into glucose - protease enzyme that breaks down peptides into amino acids ➢ The last part of the small intestine is the ileum where absorption of the end products from digestion takes place.
Large intestine	➢ Food that is not digested enters the large intestine. ➢ Reabsorption of water occurs.
Rectum	➢ Stores food that is not digested before being eliminated from the body.

Table 3.7 Digestive processes.

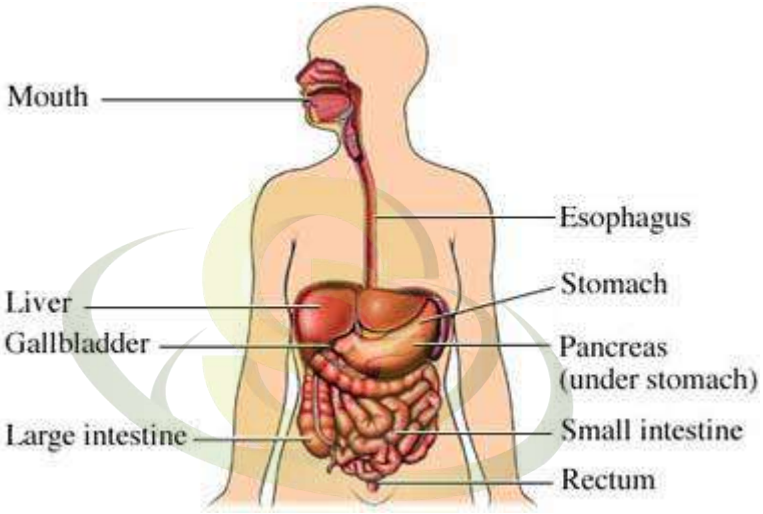

Diagram 3.2 Digestive system

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3.4 Process of absorption and transportation of digested food and defecation.

1. End products of digestion are absorbed via diffusion through the walls of the small intestines into the villus.
2. Villi are very tiny finger-like projections, which increase the surface area of the ileum for food absorption.
3. The small intestine has few features to increase efficiency of the absorption process:
   a. The long small intestine, which is about 6 metres to ensure that digested food is absorbed before it reaches the large intestine.
   b. Villi increase the surface area for the rapid absorption of digested end products.
   c. The network of blood capillaries in the villi transport digested food.
   d. The thin intestinal wall allows digested food to enter the blood capillaries.

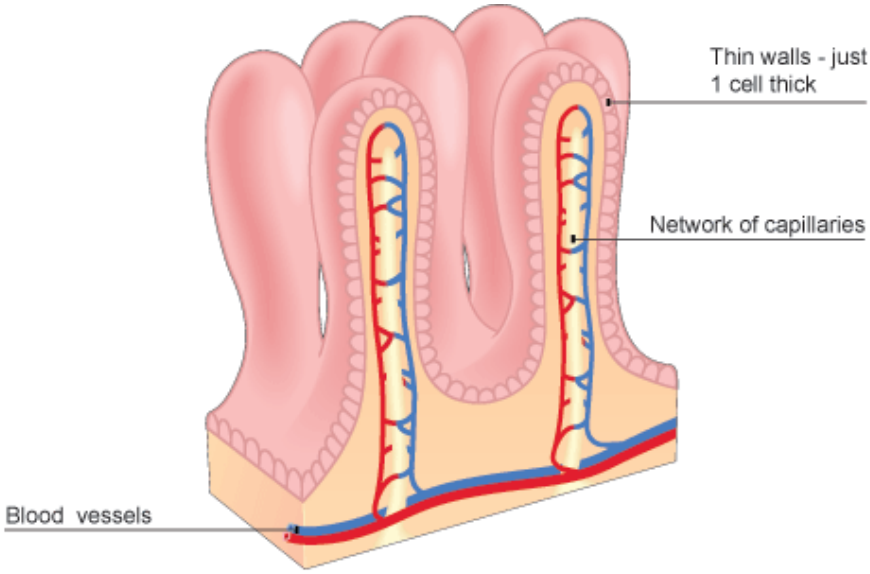

Diagram 3.3 Structure of villi

- **The transport of digested products**

1. Digested food that is absorbed into villus is then transported to body cells.
2. Assimilation is the process of distributing the end products of digestion for body cells to be used and kept.
    a. Amino acids are used to make plasma protein in the liver; they are used to produce enzymes, antibodies and hormones in the body cells. Excessive amino acids will be converted to urea and eliminated through urine and sweat.
    b. Glucose is oxidised through cell respiration to produce energy, water and carbon dioxide. Excessive glucose will be converted to glycogen and stored in the liver.
    c. Fatty acid and glycerol are used to build cell membranes. Excess fatty acids and glycerol will be converted to fatty tissues, which is then stored under the skin to control body temperature and stored around organs for protection.
3. There are three systems that work together to ensure digested food molecules reach body cells:
    a. Digestive system – Break down large and complex food into smaller and soluble molecules to be absorbed by the villus.
    b. Blood circulation system – Transport the digested food molecules to body cells.
    c. Assimilation – Distribute end products of digestion for respiration, formation of new cells and regulation of body temperature.

Defecation

1. Water is reabsorbed into the bloodstream when undigested food moves along the large intestine.
2. Hence, the food waste is processed to become semi-solid known as faeces.
3. Faeces are stored temporarily in the rectum before being pushed through anus. The process of removing faeces from the body is called defecation.

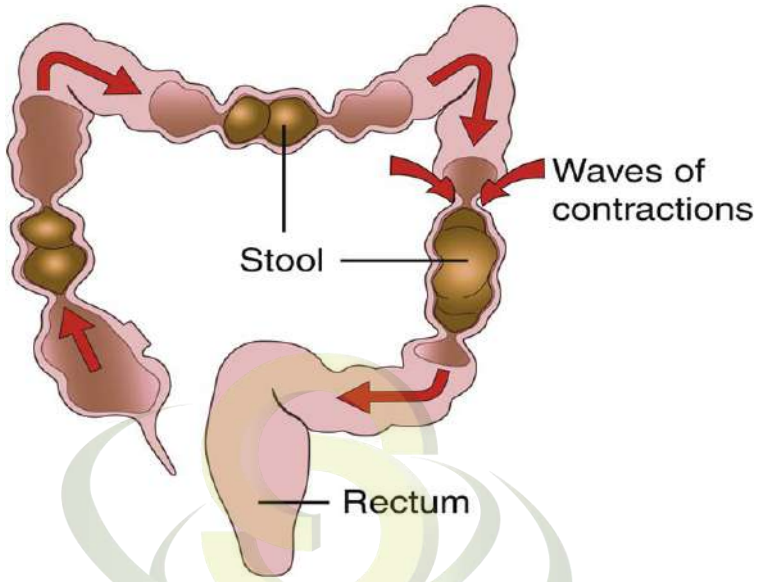

Diagram 3.4 Defecation process in large intestine

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