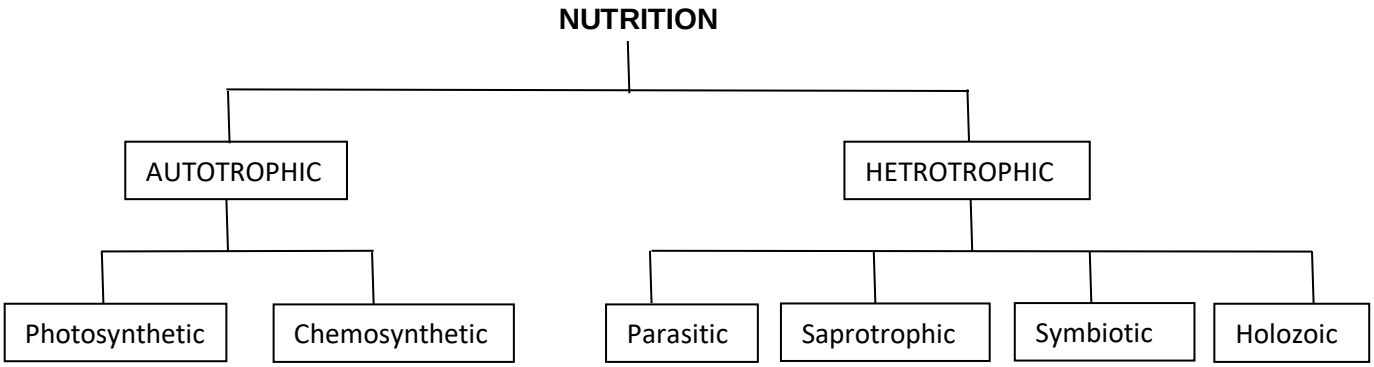
ANIMAL NUTRITION

Learning outcomes

- List the chemical elements that make up: carbohydrates, fats, proteins
- State that large molecules are made from smaller molecules, limited to: – starch and glycogen from glucose, cellulose from glucose, proteins from amino acids, fats and oils from fatty acids and glycerol
- Describe the use of: iodine solution to test for starch, Benedict's solution to test for reducing sugars, biuret test for proteins, ethanol emulsion test for fats and oils, DCPIP test for vitamin C
- Explain that different sequences of amino acids give different shapes to protein molecules
- Relate the shape and structure of protein molecules to their function, limited to the active site of enzymes and the binding site of antibodies.

TYPES OF NUTRITION



Nutrition is the way living organisms obtain their food and use the food for growth, metabolism and repair.

Autotrophic nutrition- organisms make their own food. There are two types of autotrophic nutrition.

1. **Photosynthetic nutrition**: organisms make their own food by trapping light energy. Example, green plants.
2. **Chemosynthetic nutrition**: Organisms make their own food by using energy stored in chemicals. Example, some bacteria.

Heterotrophic nutrition- organisms depend on other organisms for food. There are different ways of obtaining food from other organisms.

1. **Parasitic nutrition**- organisms (parasite) live in or on other living organisms (host) and feed from them as well causing harm to the host organism.
2. **Saprotrophic nutrition**-Organisms obtain food from dead and decaying organic matter. Example; fungus.
3. **Symbiotic nutrition**-two organisms live together and are mutually benefited. Example; leguminous plants and rhizobium (a type of bacteria) have a symbiotic relationship.
4. **Holozoic nutrition**-organisms take in solid food materials. Example: higher animals.

NUTRIENTS

All living organisms need food. Every living organism depends on nutrition (the taking in of food), and the use of that food for survival. In all living organisms food is used as follows:

- **As a source of energy**- energy is required for the chemical reactions which take place in living organisms to keep them alive.
- **For repair, growth and development of body cells and tissues**- it provides the raw materials needed for making new cells and tissues.
- **For providing the elements and compounds-** that enable the raw materials and energy to be used efficiently.

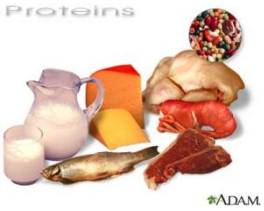
CLASSES OF FOOD

There are seven classes of food. Carbohydrates, proteins and lipids are three of the most important classes of food. In addition to these, vitamins, minerals, fibre and water are also important constituents of our diet.

1. Carbohydrates

- Carbohydrates are organic chemicals containing only the elements **carbon, hydrogen and oxygen.**
- The ratio of hydrogen atoms to oxygen atoms in a carbohydrate molecule is always **2:1**
- Carbohydrates such as **starch, cellulose and glycogen** are large, insoluble sugar molecules.
- Small carbohydrate molecules are soluble and occur as:
- **Complex** carbohydrates like **maltose, sucrose and lactose**, made from two simple sugar molecules.
- **Simple sugars** such as **glucose, fructose and galactose**. These are the **basic units** of carbohydrates.

2. Proteins



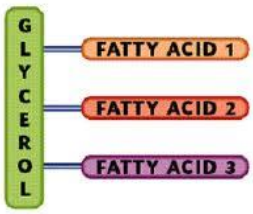
- Proteins contain the elements **carbon, hydrogen, oxygen and nitrogen** .Sometimes they also contain other elements such as **sulphur and phosphorous.**
- Proteins are large, usually insoluble molecules which are built up from simple soluble units known as **amino acids.**
- Amino acids are linked together by **peptide bond** to form **peptides.**
- Many peptides (polypeptides) link together to form a protein molecule.

Amino acids ⟶ pepetides ⟶ polypeptides ⟶ proteins

3. Lipids (fats and oil)

- Lipids contain the elements **carbon, hydrogen and oxygen**.

- Lipids are formed by joining a **glycerol molecule** with **3 fatty acid molecules**. They are insoluble in water.
- **Fats** are solids at room temperature and **oils** are liquids at room temperature.
- Food sources of fats include, butter, margarine, cheese.
- Food sources of oil include corn oil, coconut oil, and olive oil.



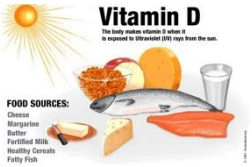
A summary of carbohydrates, proteins and lipids

	Carbohydrates	Proteins	Lipids
Chemical elements	Carbon, hydrogen, oxygen. Hydrogen: Oxygen is 2:1	Carbon, hydrogen, oxygen nitrogen and sometimes sulphur and phosphorous.	Carbon, hydrogen, oxygen.
Main sources	Potato, cereals, rice, bread, sugar cane, yam.	Meat, fish, milk, cheese, egg white, soy beans.	Egg yolk, butter, cream, cheese, oil, nuts.
Basic unit	Glucose	Amino acids	A glycerol molecule and 3 fatty acid molecules.
Functions	Main source of energy	For growth of new cells and tissues. To build up body structures like hair, nails, red blood cells. For formation of muscles, tendons and ligaments. For formation of hormones, enzymes and antibodies.	Component of cell membrane, hormones, myelin sheath around nerve fibres. Stored in adipose tissues beneath the skin and around the kidneys as an insulator. Also used as an energy reserve.
Energy supply	1 g of carbohydrate releases 17KJ of energy. Immediate source of energy.	1g of protein release 17kj of energy. Used when carbohydrate and fats have been used up.	1g of lipid releases 38KJ of energy. Used after carbohydrate energy store is used up.

4. Vitamins

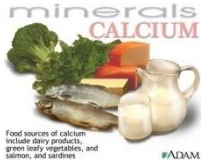
Vitamins are required by the body in small amounts to maintain health. Vitamins are organic substances needed for chemical reactions in the cells, working in association with enzymes. They are not digested or broken down for energy. Vitamins required by the body have to be consumed regularly. Lack of vitamins can cause deficiency diseases.

Vitamin	Sources	Functions	Deficiency symptoms

Vitamin C (ascorbic acid)	Citrus fruits (lemon, orange), green vegetables, cabbage. 	For healthy growth and development of gums and skin repair. For formation and maintenance of healthy connective tissues. Helps in tissue healing.	**Scurvy** (bleeding gums), loose teeth.  Poor wound healing.
Vitamin D	Fish liver oil, dairy products (milk, cheese), egg yolk, and the action of sun on the skin. 	Helps in the absorption of calcium and phosphorous salts into the body. Important for bone and teeth formation.	**Rickets** in children (faulty growth of bones like bow legs or  knock knees), Bone can get easily fractured in adults.

5. Minerals

Minerals are not organic. Mineral salts like calcium is a component of bone tissue and iron activate enzymes and help in the formation of haemoglobin. Lack of minerals can also cause deficiency diseases.

Mineral	Sources	Functions	Deficiency symptoms
Calcium (ca)	Milk, cheese, soy beans, cereals. 	For blood clotting, muscle contraction, proper bone and teeth formation.	**Stunted growth.**  Rickets (bones become brittle).

Iron (Fe)	Liver, egg, red meat, spinach, sea foods, green leaves. 	For the formation of haemoglobin in red blood cells.	**Anaemia-**less amount of haemoglobin which reduces the oxygen carrying capacity. In severe cases leads  to coma and death.

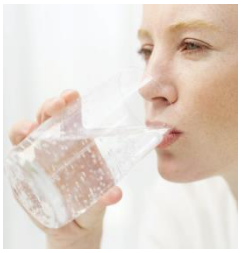
5. Dietary fibre (roughage)

We take in large quantities of plant cells when we eat vegetables and other fresh plant materials. The human alimentary canal has no enzyme to digest the cellulose in cell walls of plant material consumed.

The indigested cellulose fibres:

- Add bulk to the contents of food in the intestine. This helps in peristalsis movements in the intestine preventing constipation.
- Helps to retain water, absorb poisonous substances from the gut and soften faeces.
- Reduce the amount of fat absorption.
- Prevent bowel cancer.

7. Water

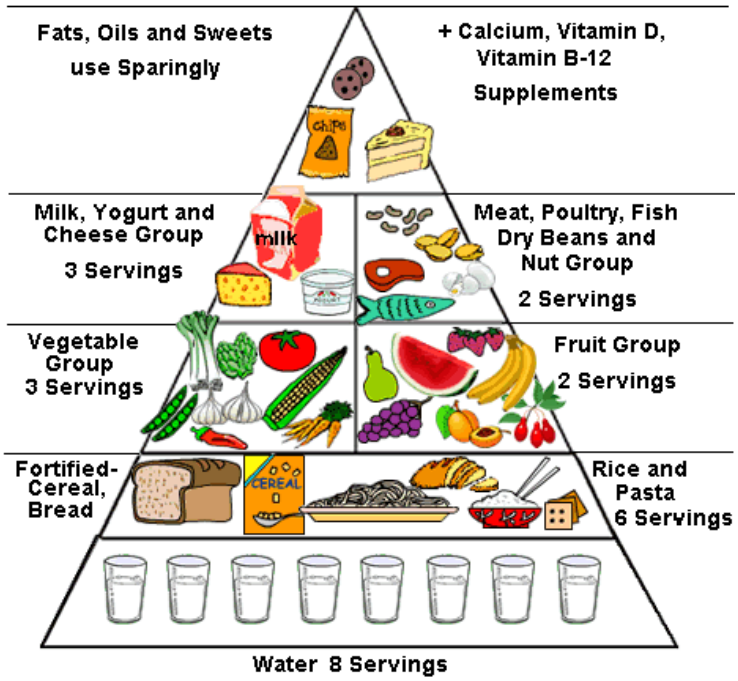


Water makes up about 70% of mammals body weight and it is an essential part of the cell cytoplasm. We lose water by sweating, urinating and breathing. We have to drink about 8 glasses of water each day. People living in hot climates should drink more water to compensate for the loss of water in sweat.

The main functions of water are:

- For transport- water is the main constituent of blood and body fluids and water acts as the medium for transport of nutrients, waste substances, hormones, etc.
- For chemical reactions- water serves as a solvent for many chemical reactions of the body.
- For temperature regulation- evaporation of water in sweating causes the removal of heat from the body. This prevents overheating of the body.

FOOD PYRAMID

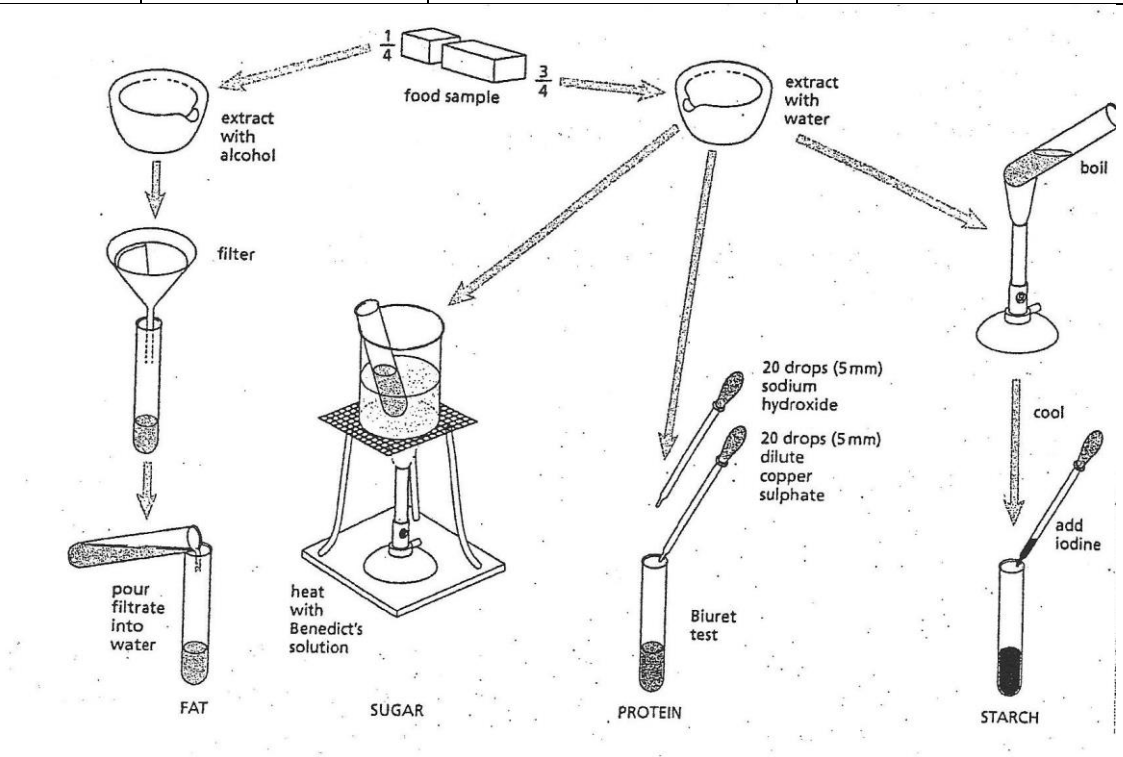


A food pyramid suggests the amount from each class of food to be consumed per day.

FOOD TESTS

Food	Chemical reagent	Procedure	Observation and conclusion
Carbohydrate 1.Starch	Iodine solution **(brown)**	Add a drop of iodine solution to the food to be tested.	**Blue black** colour indicates starch is present. Solution remains brown if starch is absent.
2.Reducing sugar(glucose/ maltose)	Benedicts solution **(blue)**	Add equal volumes of food sample and benedicts solution into a test tube and heat gently using a water bath.	The solution changes from blue colour to **green**, then to **yellow**, **orange** and finally forms a **brick red precipitate** if reducing sugar is present. The solution remains blue if reducing sugar is absent.
Proteins	Biuret solution (sodium hydroxide and copper (II) sulphate solution **(blue)**	Add equal volumes of food sample and biuret solution into a test tube and shake gently.	A **violet** or **purple** colour indicates protein is present. Solution remains blue if protein is absent.
Lipids	Ethanol **(colourless)**	Mix the food to be tested with ethanol. Pour this mixture into a test tube of water.	**A cloudy solution** (milky emulsion) indicates the presence of lipids. The solution remains clear (colourless) if lipid is absent.

Vitamin C	DCPIP	Take DCPIP in a test tube. Keep adding food suspension into it.	The colour of DCPIP changes from Blue to colour less.



Balanced diet and special dietary requirements

- A diet which contains food from all the seven classes in the correct amount and proportion is called a balanced diet.
- A balanced diet for any individual person depends on their age; body mass, sex, lifestyle and life activities.

Age: babies and young children have a higher basal metabolic rate and require more energy for growth. So they require more carbohydrates for energy, enough protein for their growth and sufficient calcium for the proper development of bones and teeth.

Sex (gender): women need less energy than men. The average body mass of a woman is smaller than man, and men have less fatty tissue in their body. The basal metabolic rate of man is higher than woman. So a man needs to include enough carbohydrates in their diet for energy.

Pregnancy: a pregnant woman requires more iron salts for the formation of haemoglobin in red blood cells, sufficient amount of calcium for the growth of baby's bones and more protein for the formation of baby's cells. A pregnant woman also has a higher basal metabolic rate than a non-pregnant woman. So they require more carbohydrate as well.

Activity: if a lot of work is to be done, more energy is required. The energy requirement of a manual worker is higher compared to an office worker with a desk bound job. So a heavy worker requires enough carbohydrates for energy, more protein to build up muscles and more water to replace the water lost in sweat.

Basal metabolic rate: all the basic chemical reactions that goes on in our body just to keep us alive. For example: functions of heart, brain and lungs.

PROBLEMS CAUSED BY UNBALANCED DIET

A person's diet may be unsuitable for healthy growth for two main reasons:

- The balance of food is incorrect-leading to malnutrition
- There is insufficient amount of food-leading to starvation.

MALNUTRITION

Malnutrition arises when an organism has an excess of one or more essential nutrients or lacks one or more nutrient in the diet.

Effects of malnutrition

Constipation- this is a result of insufficient fibre in the diet. Fibres add bulk to the contents of the intestine and assist in peristalsis movement. Fibre deficient food move very slowly and as a result more water is absorbed from it, forming dry hard lumps which get stuck causing constipation. A diet lacking in fibre may, over several years, lead to bowel cancer.

Heart diseases-this can occur when fats and cholesterol form deposits called atheroma on the cells of the coronary artery (the vessel that carry blood to the heart muscles). The diameter of the arteries decreases, restricting the blood flow and hence decreasing the oxygen supply to the heart muscles. In severe cases, the artery may become blocked, leading to cardiac arrest (heart attack).

Obesity- when a person consumes more food than the body requires for its energy needs, excess food is stored under the skin and around the belly as fat, leading to obesity (overweight). Obesity is associated with high blood pressure and heart diseases. It may also lead to diabetes, stress on joints and social rejection.

STARVATION

Not getting enough food to keep a person alive is called starvation. Starvation is often the result of famine. Famine is lack of adequate amount of food to support a population.

Famine is caused by a number of interrelated events like poverty, overpopulation, drought, flooding, and crop failure due to diseases, poor farming techniques, unequal distribution of food, war and political instability.