UNIT 3
LESSON 1

TOPIC: HUMAN NUTRITION-FOOD

OBJECTIVES

1. **Identify** the components of a balanced diet.
2. **Explain** how nutrients are used for energy, growth, and repair.
3. **Describe** the effects of nutrient deficiencies on human health.

Human Nutrition – Introduction

Humans need food to stay healthy and alive
Unlike plants, humans cannot make their own food
Food provides:

- Energy
- Materials for growth and repair
- Replacement of worn-out tissues

Focus Questions

01

What is a balanced diet?

02

What nutrients do humans need?

03

Why are nutrients important?

04

What happens if key nutrients are missing?

The Need for Food

Food is needed:

- For growth (new cells and tissues)
- As a source of energy
- For the repair and replacement of damaged tissues

Energy is used for:

- Movement
- Heartbeat
- Nerve impulses
- Maintaining body temperature

What Is a Balanced Diet?

A balanced diet contains:

- Carbohydrates
- Fats
- Proteins
- Vitamins
- Minerals
- Fibre (roughage)
- Water

Nutrients must be in the correct proportions

A balanced diet ***is a diet that contains all the essential nutrients in the correct proportions to maintain good health.***

Energy Requirements

Energy comes from:

- Carbohydrates
- Fats
- Proteins

Energy is measured in:

- Kilojoules (kJ) or calories

An average adult needs about 12,000 kJ per day

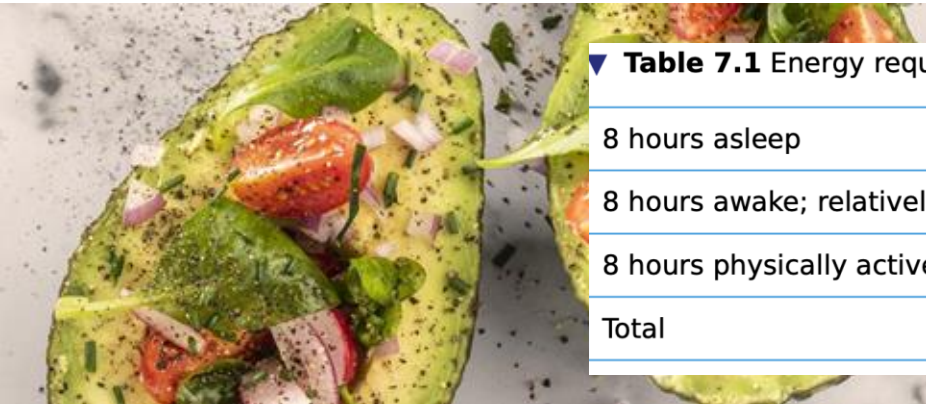


Table 7.1 Energy requirements in kJ

8 hours asleep	2 400
8 hours awake; relatively inactive physically	3 000
8 hours physically active	6 600
Total	12 000

Factors Affecting Energy Needs

- Age
- Body size
- Gender

- Level of physical activity
- Type of work or exercise

Classes of Food

Three main classes:

- Carbohydrates
- Fats
- Proteins

Other essential components:

- Vitamins
- Minerals
- Fibre
- Water

Carbohydrates

- Sugar and starch are important carbohydrates in our diet
- Starch is abundant in potatoes, bread, maize, rice, and other cereals
- Sugar appears mainly as sucrose (table sugar), added to drinks and many prepared foods, such as jam, biscuits, and cakes

Carbohydrates

- Glucose and fructose occur naturally in many fruits and some vegetables
- **Carbohydrates** are the cheapest and most readily available source of energy
- They contain carbon, hydrogen, and oxygen (e.g., glucose is $C_6H_{12}O_6$)
- **During respiration**, carbohydrates are oxidized and broken down to carbon dioxide and water
- One gram of carbohydrate provides about **16 kJ** of energy

Carbohydrates

- Extra carbohydrates eaten beyond energy needs are converted in the liver to glycogen or fat
- Glycogen is stored in the liver and muscles
- Fat is stored in deposits in the abdomen, around the kidneys, or under the skin
- Cellulose in plant cell walls is also a carbohydrate
- We obtain little nourishment from cellulose
- **Cellulose** is important in the diet as a fibre
- Fibre helps maintain a healthy digestive system

Carbohydrates

- Elements: carbon, hydrogen and oxygen.
- Smallest unit: molecules such as glucose (a simple sugar, meaning it is made of one unit). Glucose contains six carbons and so can be drawn, for simplicity, as a hexagon.
- Macromolecule: starch, for example, is a macromolecule that is made from many units of glucose combined together. Other macromolecules include cellulose and glycogen.

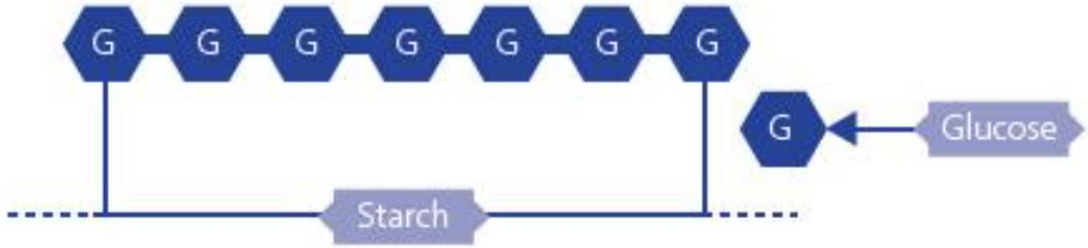


Figure 3.3 Starch is made from many glucose units

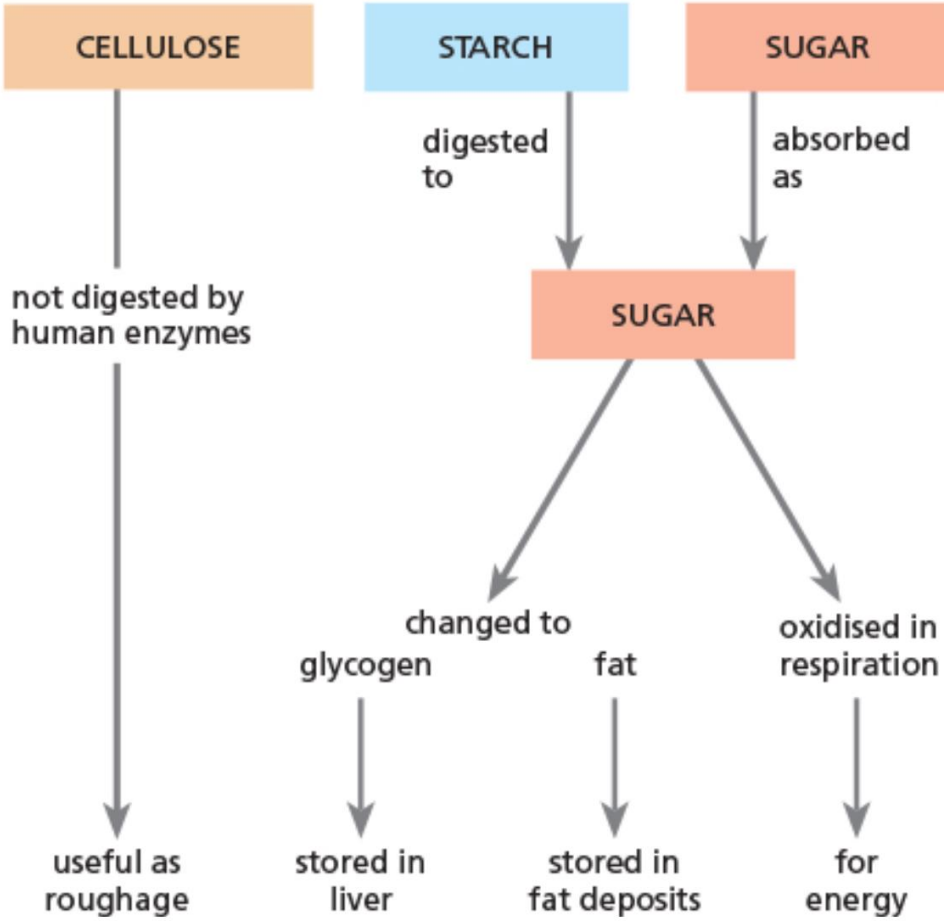


Figure 7.3 Digestion and use of carbohydrate

Fats and Oils (Lipids)

- Animal fats are found in meat, milk, cheese, butter, and egg yolk
- Plant fats occur as oils in fruits (e.g., palm oil) and seeds (e.g., sunflower seed oil)
- Plant oils are used for cooking and for making margarine
- Fats and oils are collectively called **lipids**

Functions and energy value

- Lipids form part of the **cell membrane** and other membrane systems
- Lipids can be oxidized in respiration to carbon dioxide and water
- When used for energy, **1 g of fat gives 37 kJ of energy**
- Fats provide **more than twice as much energy** as the same weight of carbohydrate or protein

Storage and insulation

- Fats can be stored in the body as **long-term energy stores** in fat deposits
- Fatty (adipose) tissue under the skin forms an insulating layer
- When the blood supply to this layer is reduced, it helps **reduce heat loss from the body**

Lipids

- Elements: carbon, hydrogen and oxygen.
- Smallest units: **glycerol**, and three **fatty acids** (long chains of carbon and hydrogen).
- Macromolecule: the glycerol molecule is combined with three fatty acids to make the fat molecule. Fatty acids can be **saturated** or **unsaturated**. In unsaturated fatty acids some of the carbons are joined by double bonds, giving a bend in the chain, whereas in saturated fatty acids all the carbons are combined with hydrogen atoms. Saturated and unsaturated fatty acids have different properties.

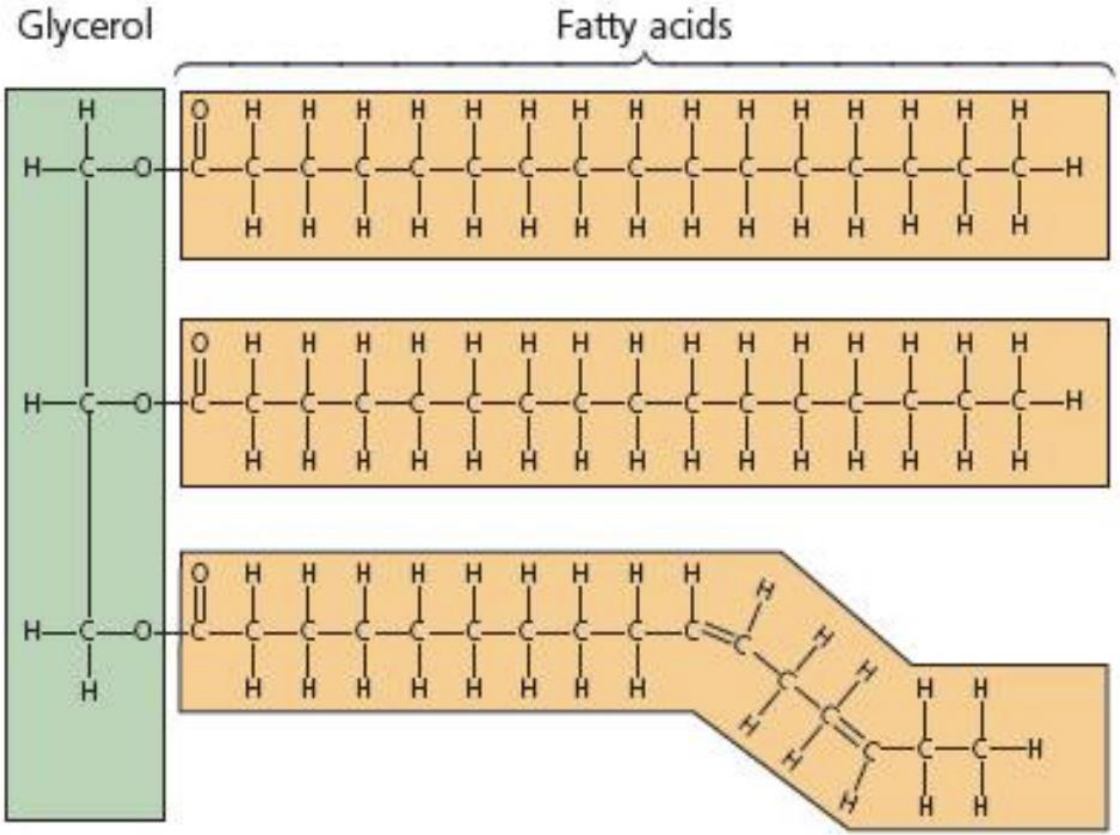


Figure 3.5 Lipids are made from glycerol and three fatty acids

Proteins

- Proteins are essential because they supply **the amino acids** needed to build body structures
- Important sources of **animal protein**: lean meat, fish, eggs, milk, cheese
- All plants contain some protein
- Best **plant sources**: soybeans, seeds such as pumpkin seeds, and nuts.

Table 7.2 Comparing the protein content of foods (various sources)

Food	Protein content/g per 100 g
soybeans	35
chicken breast	31
pumpkin seeds	30
peanuts	26
fish, e.g. rawas	24
bacon	20
cheese, e.g. paneer	19
Tofu	18
chicken sausage	17
Quorn sausage	14
eggs	13
falafel	13
wheat flour	13
yoghurt	4

Protein requirements

- Estimates of how much protein we need have changed recently
- The WHO/FAO/UNU report recommends **0.57 g of protein per kilogram of body weight**
- Example: a 70 kg person needs 70 × 0.57 = 39.9 g ≈ **40 g of protein per day**

How to obtain this protein

•About **200 g of lean meat, or** about **500 g of bread**

•To get the same amount from **potatoes**, about **2 kg** would be needed

•Potatoes still **do not provide all essential amino acids**

Functions of Proteins

- During digestion, proteins are broken down into **amino acids**
- Amino acids are needed to build **cells and tissues** such as:
  - skin
  - muscle
  - blood
  - bones
- Proteins also form part of the **cytoplasm** of cells
- Proteins are important components of **enzymes**
- **Carbohydrates and fats cannot do this**, so protein in the diet is essential

Energy value of protein

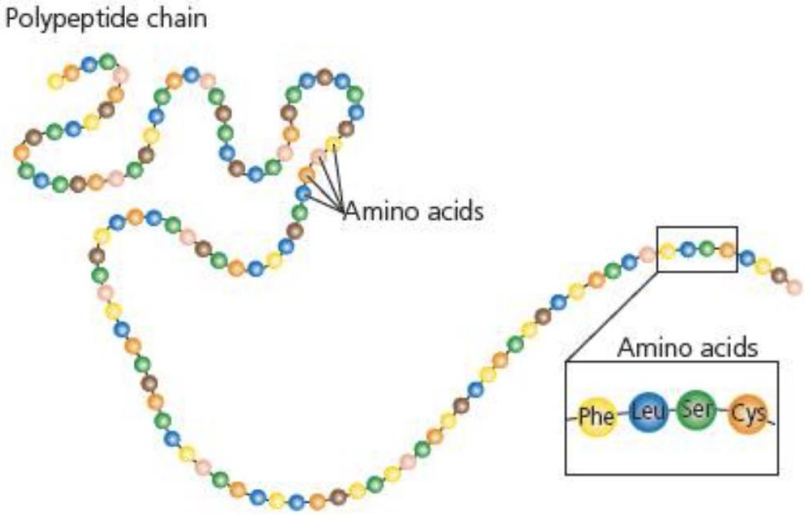
- Amino acids not used to make new tissues **cannot be stored**
- The liver removes its **amino groups ($-NH_2$)**
- The remaining part is converted to **glycogen**
- Glycogen may be **stored or oxidized** to provide energy
- **1 g of protein provides 17 kJ of energy**

Chemical composition

- Proteins contain **carbon, hydrogen, oxygen, and nitrogen**
- Sometimes they also contain **sulfur**
- This makes them chemically different from **carbohydrates and fats**

Proteins

- Elements: carbon, hydrogen, oxygen and nitrogen (some contain sulfur).
- Smallest unit: **amino acids**. There are 20 different amino acids in your diet – your body can make some of them but the majority must be contained in your diet.
- Macromolecule: protein molecules are made from many (up to thousands) of amino acids. The sequence of amino acids (i.e. the types of amino acid and the order in which they are joined together) determines the shape and properties of the protein.



Amino acids

Ala: Alanine	His: Histidine	Ser: Serine
Arg: Arginine	Ile: Isoleucine	Thr: Threonine
Asn: Asparagine	Leu: Leucine	Trp: Tryptophane
Asp: Aspartic acid	Lys: Lysine	Tyr: Tyrosine
Cys: Cysteine	Met: Methionine	Val: Valine
Gln: Glutamine	Phe: Phenylalanine	
Glu: Glutamic acid	Pro: Proline	

Figure 3.4 Proteins are made from long chains of amino acids. There are 20 different amino acids – the structure and function of the protein depends on the amino acids it is made from and the order in which they are put together

Vegetarian and Vegan Diets

Vegetarians:

- Can get protein from dairy, eggs, legumes

Vegans:

- Must combine plant foods to get all amino acids

Examples:

- Beans, peas, nuts, cereals, falafel

Summary table for carbohydrates, fats/oils, and proteins

Nutrient	Good food sources	Use in the body
carbohydrate	rice, potato, yam, cassava, bread, millet, sugary foods (cake, jam, honey)	storage; source of energy
fat/oil (oils are liquid at room temperature, but fats are solid)	butter, milk, cheese, egg-yolk, animal fat, groundnuts (peanuts)	source of energy (twice as much as carbohydrate); insulation against heat loss; some hormones; cell membranes; insulation of nerve fibres
protein	meat, fish, eggs, soya, groundnuts, milk, Quorn, cowpeas, falafel	growth; tissue repair; enzymes; some hormones; cell membranes; hair; nails; can be broken down to provide energy

Fibre (Roughage)

- Made of cellulose
- Cannot be digested
- **Functions:**
  - Prevents constipation
  - Keeps the digestive system healthy
- **Sources:**
  - Vegetables
  - Fruits
  - Whole meal bread

Dietary fibre (roughage)

- When we eat vegetables and other fresh plant material, we take in a large quantity of plant cells.
- The cell walls of plants are made of cellulose, but we do not have enzymes for digesting this substance.
- The result is that the plant cell walls reach the large intestine (colon) without being digested.
- This undigested part of the diet is called **fibre or roughage**.

Dietary fibre (roughage)

The fibre increases the contents of the colon and help it to retain water. This softens the faeces and reduces the time needed for the undigested material to pass out of the body. Both effects help to prevent constipation and keep the colon healthy.

Most vegetables and whole cereal grains contain fibre, but white flour and white bread do not contain much. Good sources of dietary fibre are vegetables, fruit and wholemeal bread.

Vitamins

All proteins are like each other in their chemical structure, as are all carbohydrates. However, vitamins are a group of organic substances that have a different chemical structure.

There are some features that are shared by all vitamins:

- They are not digested or broken down for energy.
- Usually, they are not built into the body structures.
- They are vital in small quantities for health.
- They are needed for chemical reactions in the cells, working with enzymes.

- Plants can make these vitamins in their leaves, but humans have to eat plants or animals to get them ready-made.
- At least 15 vitamins have been identified, and they are sometimes grouped into two classes: **water-soluble and fat-soluble**.

➢ The **fat-soluble** vitamins are mainly found in animal fats or vegetable oils, which is one reason why our diet should include some of these fats.

➢ The **water-soluble** vitamins are present in green leaves, fruits, and cereal grains.

Vitamin C

Sources:

- Citrus fruits, guava, mango, cabbage

Function:

- Healthy skin and gums

Deficiency disease:

- **Scurvy**

Symptoms:

- Bleeding gums
- Weakness
- Joint pain

Vitamin D

Made in skin using sunlight

Also from food:

- Oily fish, egg yolk, milk

Function:

- Helps absorb calcium

Deficiency disease:

- **Rickets** (children)
- Weak bones (adults)

The vitamins you need, and sources of each, and why you need them, are summarized in the following table.

Table 3.1 Vitamins needed as part of a balanced diet

Vitamin	Source	Function
A	Fish liver oils, animal liver, made in body from carotene	Required for normal **immune system** function and for production of cells in the retina of the eye
D	Fish liver oils, butter, egg yolk, made in the body by action of sunlight	Needed for the absorption of calcium in the body
E	Plant oils	Antioxidant
K	Dark green leafy vegetables, made by bacteria of gut	Needed for blood clotting
B_1	Widely occurring	Needed for an enzyme used in respiration
B_2	Widely occurring	Needed for an enzyme used in respiration
B_3	Meat, yeast extract, potatoes, made from the amino acid tryptophan	Needed to make enzymes involved in respiration
B_5	Widely occurring	Needed to make an enzyme involved in respiration
B_6	Meat, fish, eggs, some vegetables	Needed to make an enzyme involved in the formation of amino acids

B_{12}	Liver, yeast, not found in plants	Needed to make an enzyme involved with cell division; for nerve function
folic acid	Liver, white fish, raw leaf vegetables	Needed to make an enzyme involved in DNA replication
H (biotin)	Liver, yeast, egg white, made by bacteria in the human gut	Used to make an enzyme involved with metabolic reactions
C (ascorbic acid)	Potatoes, green vegetables, fruits	Used to make an enzymes needed for protein metabolism; involved in iron absorption

Mineral Ions

- These are sometimes referred to as mineral salts or minerals.
- Proteins, carbohydrates, and fats provide the body with
- carbon, hydrogen, oxygen, nitrogen, sulfur, and phosphorus, but there are several more elements that the body needs.
- These mineral ions are present in the food we eat.

Mineral Ions

Important minerals include:

- ❖Iron
- ❖Calcium

Iron

- •Needed for haemoglobin
- •Function:
  - Oxygen transport
- •Sources:
  - Red meat, eggs, spinach, and whole grains
- •Deficiency:
  - **Anaemia**
- •Symptoms:
  - Tiredness
  - Weakness

Calcium

- •Needed for:
  - Strong bones and teeth
  - Muscle contraction
  - Blood clotting
- •Sources:
  - Milk, cheese, yoghurt, fish
- •Deficiency:
  - Weak bones
  - Muscle cramps

Table 3.2 Minerals needed as part of a balanced diet

Major minerals	Daily intake
Calcium	0.9 g
Phosphorus	1.5 g
Potassium	3.2 g
Sodium	3.4 g
Chloride	5.2 g
Magnesium	0.3 g
Iron	14.0 mg
Zinc	11.4 mg
Trace elements	**Daily intake**
Fluoride	1.82 mg
Copper	1.63 mg
Selenium	0.06 mg
Iodine	0.024 mg
Manganese	5.0 mg
Chromium	0.09 mg
Cobalt	0.3 mg

Examples of why minerals are needed by the body:

- Phosphorus is needed in the production of DNA and cell membranes.
- Calcium is needed for healthy teeth and bones.
- Sodium and chloride ions are used in the control of the composition of body fluids.
- Iron is needed to make hemoglobin – the oxygen-carrying molecule in red blood cells.

Table 7.5 Minerals

Name and source of mineral	Importance of mineral	Diseases and symptoms caused by lack of mineral	Notes
calcium: milk, cheese, fish, some sources of water, e.g. 'hard' water	Needed to form healthy bones and for normal blood clotting.	Early signs are muscle aches, cramps and spasms, with numbness of hands, feet and around the mouth. Teeth and bones become soft and more easily breakable. Deficiency can lead to rickets (linked to vitamin D deficiency) and osteoporosis.	Most foods contain small amounts of calcium. A shortage of calcium in the diet at first results in calcium being removed from bones so no symptoms are apparent.
iron: red meat, liver, kidney, eggs, green vegetables (spinach, cabbage, cocoyam, groundnut leaves), chocolate	Needed for formation of haemoglobin in red blood cells (for transport of oxygen).	Anaemia. The symptoms are constant tiredness and a lack of energy.	In women, heavy periods can result in a loss of iron, which can result in anaemia.

Water

- About 70% of most tissues consists of water; it is a vital part of **cytoplasm.**
- The **body fluids, blood, lymph, and tissue fluid** are composed mainly of water.
- Digested food, salts, and vitamins are carried around the body as a watery solution in the blood, and **excretory products like excess salt and urea** are removed from the body in solution by the kidneys.
- Water is a solvent and a transport medium for these substances.
- **Digestion** uses water in a chemical reaction to break down insoluble substances into soluble ones.
- These products then pass, in solution, into the bloodstream. Water plays a vital part in many reactions in cells, as a reactant and a solvent.
- We lose water by evaporation, sweating, urinating, and breathing, so we have to replace this by taking in water with the diet.

ACTIVITY: Food tests

ATL

- Critical-thinking skills: Interpret data

Food can be tested for carbohydrates, protein and lipids, using the following food tests.

Testing for starch (a complex carbohydrate)

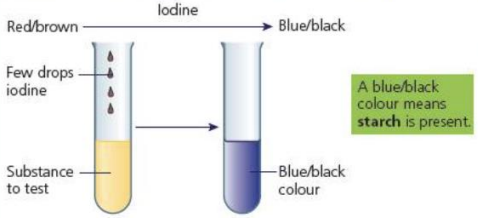


Figure 3.6 Starch test

Testing for glucose (a simple carbohydrate)

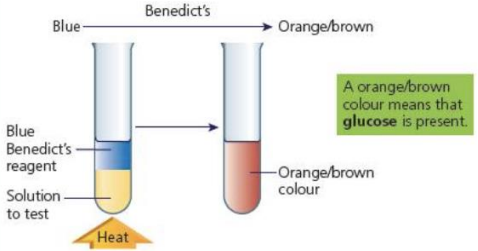


Figure 3.7 Test for glucose – a simple sugar. A water bath set at 70°C can be used to heat the solution

Testing for protein

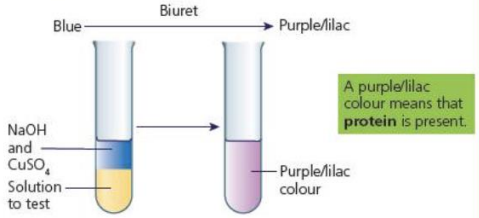


Figure 3.8 Test for protein

Testing for lipids

A simple test for lipid is to put a little of your sample onto a piece of paper. If it leaves a greasy mark when it is dry, lipid is present.

Alternatively, an emulsion test can be carried out. A small quantity of alcohol is added to the test solution – the mixture is shaken vigorously. A milky-white emulsion is formed if fats are present.

Your teacher will provide you with a 'mystery solution' containing at least two different food groups. Can you work out which groups it contains?

Safety: Wear eye protection. Take care with the water bath when carrying out the Benedict's test. Wash your hands at the end of the practical.

- **Carry out each of the food tests on the mystery solution and observe the results.**
- **Accurately interpret your data and explain results using correct scientific reasoning.**

Assessment opportunities

- In this activity you have practised skills that are assessed using Criterion C: Collect data; Interpret data and explain results using scientific reasoning.

Video on food test

https://youtu.be/sLP8dcnWnJg?si=uQWqJrAconWcMwDL

https://youtu.be/2fPwfvbBRT0?si=Y8a_xcf8uhyxVPy2

Special Nutritional Needs – Pregnancy

No extra food needed if the diet is adequate

Energy and protein needs increase

Extra intake needed if deficient in:

- Protein
- Calcium
- Iron
- Vitamin D
- Folic acid

Importance:

Protein → baby's tissue growth

Calcium & Vitamin D → bone development

Iron → haemoglobin formation

Special Nutritional Needs – Lactation

Lactation = production of breast milk

High demand for:

- Proteins
- Vitamins
- Calcium

Adequate diet → metabolism adapts

Poor diet → increased intake needed for healthy milk production

Special Nutritional Needs – Growing Children

Children need:

- Less food than adults
- More food per kg body weight

Higher protein needs for growth

Additional needs:

- Calcium → bones
- Iron → red blood cells
- Vitamin D → bone calcification
- Vitamin A → disease resistance

Malnutrition – Meaning

Malnutrition includes:

- Too little food
- Too much food
- Wrong type of food

Leads to poor health and disease

Effects of Undernutrition

- Body tissues are broken down for energy
- Results in:
- Weight loss
- Muscle wastage
- Weakness
- Starvation
- Extreme dieting can cause:
- Anorexia nervosa

Overnutrition and Disease

- Too much fat intake can cause:
- Coronary heart disease
- Fat deposits narrow the arteries
- Can lead to:
- Angina
- Heart attack

Deficiency Diseases in Malnutrition

- Protein and vitamin deficiency can cause:
- Anaemia
- Rickets
- Scurvy
- Vitamin C deficiency → scurvy
- Symptoms:
- Bleeding gums
- Poor wound healing
- Weakness

Causes of Malnutrition

- Poverty
- Famine (drought or floods)
- Wars
- Soil erosion
- Overpopulation
- Lack of nutrition knowledge

World Food Problems

- The world population is increasing rapidly
- Food production is not keeping pace
- 15% of the world population is undernourished
- 180 million children are underweight

Challenges in Food Production

- The Green Revolution increased yields
- High cost of fertilizers and pesticides
- Loss of farmland due to:
- Erosion
- Urbanization
- Over-irrigation → soil salinity

Sustainable Solutions

- Grow crops suited to the local climate
- Reduce erosion and deforestation
- Use land for food crops, not just cash crops
- Conservation of land, water, and energy
- Vitamin and mineral supplementation

Western Diets and Malnutrition

- Food is plentiful, but the diet may be unhealthy

High intake of refined sugar leads to:

- Obesity
- Tooth decay

Sugar is found in:

- Soft drinks
- Sweets
- Biscuits

Obesity

Caused by excess energy intake
Extra energy is stored as fat
Health risks:

- High blood pressure
- Heart disease
- Diabetes

Prevention:

- Balanced diet
- Regular physical activity

Activity 3

Classify foods into **healthy** and **unhealthy**. Drag and drop images into the corresponding categories

Foods

Healthy

Unhealthy

END!

Do you have any questions?

Reference

- **Hodder Education (MYP):**
  Hodder Education. *MYP Biology by Concept*. Hodder Education, 2018, pp. 56–59.
- **Cambridge IGCSE Biology:**
  Jones, Mary, and Geoff Jones. *Cambridge IGCSE™ Biology*. 3rd ed., Cambridge University Press, 2014, pp. 86–95.
- **Slide Template:**
  Slidego. *Biology Presentation Template*. Slidego, www.slidego.com. Accessed 27 Dec. 2025.