CHAPTER 2

NUTRITION AND FOOD TECHNOLOGY

What are the concepts presented by the "*Pinggan Sihat Malaysia*" campaign introduced by the Ministry of Health Malaysia?

What is the importance of the nitrogen cycle to plants?

What are the benefits of using quality breeds in agriculture?

Do you know that there are acts or regulations which need to be adhered to in the preparation and sale of food in Malaysia?

Let's study

- Balanced diet and calorific value
- Nutrient requirements in plants
- Nitrogen cycle
- Food production technology
- Food processing technology
- Health foods and supplements

Science Bulletin

A smart consumer will always check the safety status of food products or health supplements. Are you a smart consumer?

A list of banned products is additional information prepared by the Pharmacy Enforcement Division, Ministry of Health (MOH) Malaysia. This list aims to inform traders, enforcement agencies as well as the public regarding health products, cosmetics and food products or beverages that are tainted with poison or prohibited chemical substances.

List of banned products
http://buku-teks.com/sc5047
(Medium: *bahasa Melayu*)

An example of label and QR code for a health supplement approved by MOH

Keywords

- Balanced diet
- Calorific requirements
- *Pinggan Sihat Malaysia*
- Food calorie
- Food Act 1983
- Bomb calorimeter
- Eating pattern
- Macronutrient
- Micronutrient
- Nitrogen cycle
- Food Regulations 1985
- Food production technology
- Food processing technology
- *Halal* status
- Malaysia Halal Certification Procedure

2.1 Balanced Diet and Calorific Value

Can you recall the meaning of a **balanced diet** studied in Form 2?

A balanced diet is a diet that includes all the classes of food in the right quantity according to the individual's body requirement.
Is this serving of *nasi lemak* an example of a balanced diet? Give your reasons.

Activity 2.1

21st Century Skills
- ICS
- Discussion

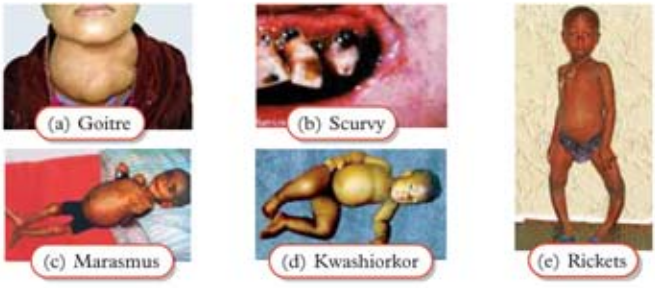
To gather information on balanced diet, factors that affect calorific requirements and the amount of energy needed by an individual

Instructions

1. Carry out this activity in groups.
2. Gather information on the following:
   (a) balanced diet and *Pinggan Sihat*
   (b) factors that affect calorific requirements
   (c) energy requirements for different individuals
3. Discuss the gathered information.
4. Present the outcome of your group discussion to the class using a multimedia presentation.

Malnutrition

A lack or an excess of any class of food can cause **malnutrition**. Several examples of health problems resulting from malnutrition are shown in Photograph 2.1. State the cause of each health problem.



Photograph 2.1 Several examples of health problems caused by malnutrition

Concept of *Pinggan Sihat Malaysia*

The Ministry of Health (MOH) Malaysia has introduced the concept of *Pinggan Sihat Malaysia* as shown in Figure 2.1.

Figure 2.1 The concept of *Pinggan Sihat Malaysia*

Applications of the Concept of *Pinggan Sihat Malaysia* in Daily Life

Applications of the concept of *Pinggan Sihat Malaysia* can be observed in daily life as shown in Figure 2.2.

Main Messages

- Eat 3 main healthy meals a day
- Eat 1 – 2 healthy snacks between meals if needed
- Eat more cereal foods
- Eat less fried food or food that contains coconut milk
- Eat home-cooked food more frequently

#SukuSukuSeparuh

Figure 2.2 Examples of *Pinggan Sihat Malaysia*

Calorific Value of Food

Calorific value (or **energy value**) of food is the amount of energy that is released from the complete oxidation or combustion of 1 g of that food.

Photograph 2.2 Apparatus set-up for measuring calorific value of food

Unit for Calorific Value

Energy that is released from the oxidation or combustion of food is normally measured in calorie (cal), kilocalorie (kcal), joule (J) or kilojoule (kJ). What is the S.I. unit for energy?

1 calorie (cal) = 4.2 joules (J)
1 kilocalorie (kcal) = 4 200 joules (J)
= 4.2 kilojoules (kJ)

The S.I. unit for calorific value is **joule per kilogram (J kg^{-1})**.

Measuring the Calorific Value of Food

The calorific value of food can be measured by using a special apparatus called **bomb calorimeter** (Photograph 2.3). Table 2.1 shows the calorific value of carbohydrate, fat and protein measured using a bomb calorimeter.

Table 2.1 Calorific values of carbohydrate, fat and protein

Class of food	Carbohydrate	Fat	Protein
Calorific value (kJ g^{-1})	16.7	37.6	16.7

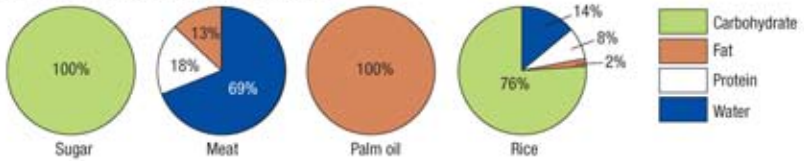
(Source: Grosvenor and Smolin, 2000)

Photograph 2.3 Bomb calorimeter

Different Kinds of Food and Estimation of Calorific Values

The calorific value of food is determined by the quantity of carbohydrate, protein and fat content in the food.

For example, observe Figure 2.3 and Table 2.2 which show several examples of food and their estimated calorific values.



(Source: Stone and Cozens, 1981)

Figure 2.3 Composition of carbohydrate, fat, protein and water in some food

Table 2.2 Different foods and their estimated calorific values

Class of food	Source	Calorific value (kJ g^{-1})
Carbohydrate	Rice	15.04
	White bread	10.60
	Coarse sugar	16.50
Fat	Palm oil	38.00
	Butter	31.20
Protein	Chicken	8.27
	Beef	13.11
Fibre	Cabbage	0.34
	Cucumber	0.55

(Source: Parkin, Simpkins, McCarthy and Reffin, 1996)

Thinking Skills

The table below shows the content of sandwiches A, B and C.

Sandwich	Content
A	• 2 pieces of white bread • 2 g of butter • 100 g of beef • 5 g of cucumber
B	• 2 pieces of white bread • 100 g of chicken • 5 g of cabbage
C	• 2 pieces of white bread • 2 g of butter • 100 g of chicken • 5 g of cabbage

Which of the sandwiches, A, B and C, is the healthiest choice? Explain your answer.

Experiment 2.1

Aim: To estimate the calorific value of several samples of food using a calorimeter

Problem statement: Which food sample has the highest calorific value?

Hypothesis: The calorific value of groundnuts is higher than that of bread and anchovies.

Variables:
(a) manipulated : Type of food sample
(b) responding : Change in temperature/calorific value of food
(c) constant : Mass of water

Materials: 1 g of groundnuts, 1 g of bread, 1 g of anchovies, cotton wool and distilled water

Apparatus: Retort stand, boiling tube, thermometer, shield, plasticine and needle

Procedure:

1. Prepare the apparatus set-up (Figure 2.4).

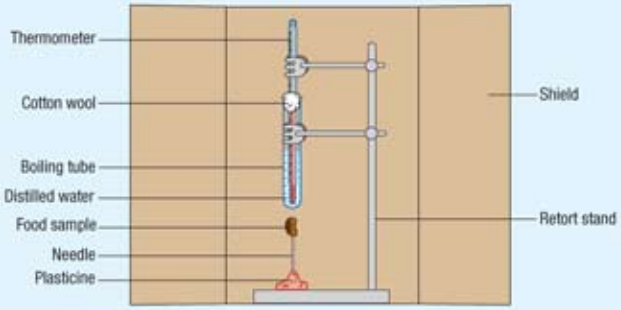


Figure 2.4

2. Record in the table the type of food sample and its mass, mass of water in the calorimeter and initial temperature, T_1, on the thermometer.
3. Use a lighter to set the food sample alight.
4. Observe and record the final temperature, T_2, after the food sample has been completely burnt.

Result:

Food sample	Groundnut	Anchovies	Bread
Mass of food sample (g)	1	1	1
Mass of water (g)	10	10	10
Initial temperature, T_1 (°C)			
Final temperature, T_2 (°C)			
Change in temperature, $T_2 - T_1$ (°C)			

Data analysis:

Calculate and record the calorific value of each food sample using the following formula:

$$\text{Calorific value of food} = \frac{4.2 \text{ J g}^{-1} \text{ °C}^{-1} \times \text{Mass of water (g)} \times \text{Change in water temperature (°C)}}{\text{Mass of food sample (g)} \times 1\,000}$$

Food sample	Groundnut	Anchovies	Bread
Calorific value (kJ g^{-1})			

Conclusion:

Is the hypothesis accepted? What is the conclusion for this experiment?

Questions:

1. (a) Is the calorific value of the food sample determined using the calorimeter bigger or smaller than its actual calorific value?
   (b) Explain your answer.
2. Give **one** example of food sample used to estimate the calorific value for each of the following classes of food using a calorimeter:
   (a) carbohydrate
   (b) fat
   (c) protein
3. Name **one** class of food that has no calorific value. Give your reason.

Effects of Consuming Total Calories that Do Not Meet Individual Requirements

Besides a balanced diet, the total calories obtained from each meal should also meet the requirements of the individual to stay healthy. How does an individual determine whether the total calories consumed is sufficient, insufficient or in excess based on physical condition? How does the total calorie intake of an individual cause the effects shown in Photographs 2.4 (a) and (b)?

Unhealthy eating habits such as inappropriate mealtimes can cause problems such as malnutrition, obesity, anorexia nervosa, arteriosclerosis, diabetes mellitus, high blood pressure, thrombosis, stroke, heart attack and heart disease. Figure 2.5 shows the causes and effects of several health problems on individuals.

(a) Underweight

(b) Obese

Photograph 2.4 Examples of effects of total calorie intake which does not meet an individual's requirements

2.1.2 2.1.3

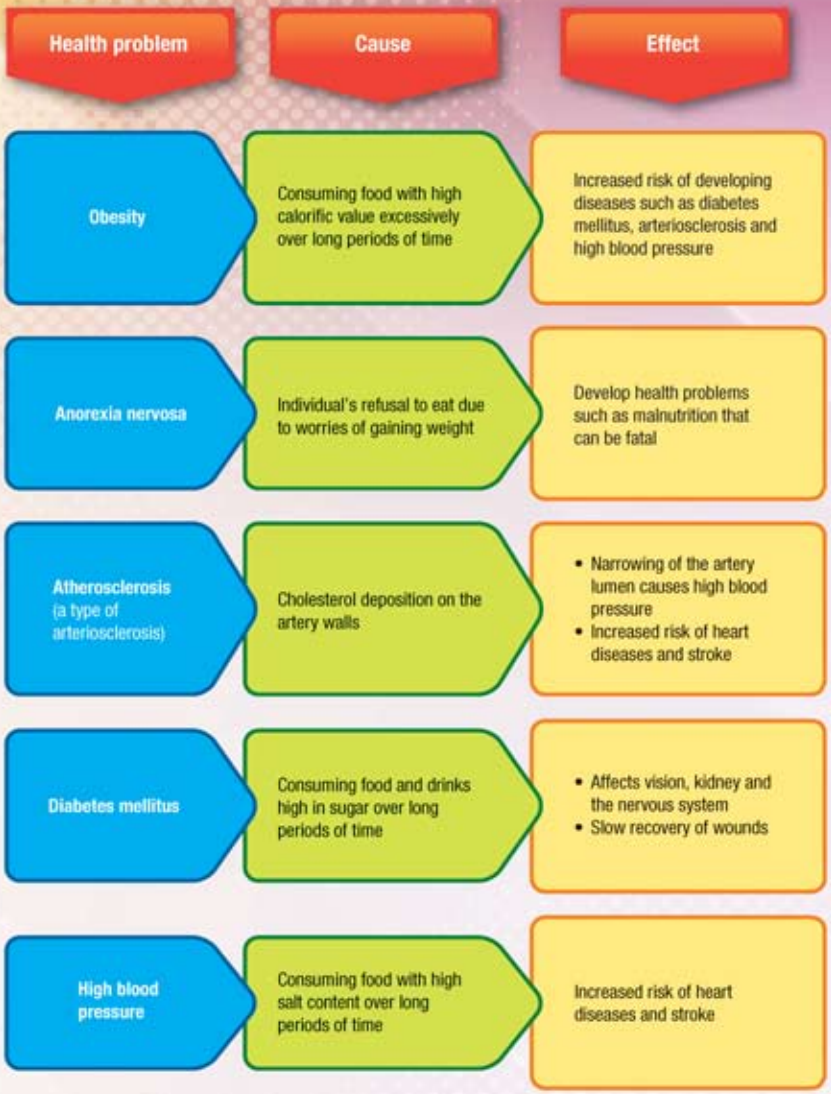


Figure 2.5 Causes and effects of several health problems

Eating Patterns of Malaysians and the Effects on their Health

The health of the human body is not only influenced by the total calorie intake which meets requirements but also depends on eating patterns such as mealtimes and types of food.

Photograph 2.5 Several local restaurants which operate 24 hours a day

In Malaysia, there are various types of restaurants especially fast food restaurants which operate 24 hours a day. Why do these restaurants operate 24 hours a day?

Can the calorie intake to meet your requirements be obtained from fast food and junk food?

BRAIN TEASER

Restaurants that operate 24 hours a day affect health negatively. Discuss.

Figure 2.6 Effects of fast food and junk food

Click@Web

Info about obesity
http://buku-teks.com/sc5056a

Junk food retards growth of human body and IQ
http://buku-teks.com/sc5056b
(Medium: *bahasa Melayu*)

Activity 2.2

21st Century Skills
- ICS
- Discussion

To study the effects of insufficient or excessive total calorie intake

Instructions

1. Carry out this activity in groups.
2. Search for information on the following:
   (a) effects of insufficient or excessive total calorie intake
   (b) relationship between the lifestyle and eating patterns of Malaysians and the effects on health
   (c) effects of 24-hour restaurants, fast food restaurants and junk food advertisements on the eating patterns and health of Malaysians
3. Discuss the information gathered.
4. Present the outcome of your group discussion to the class in the form of a multimedia presentation.

Formative Practice 2.1

1. (a) What is the concept presented by *Pinggan Sihat Malaysia?* Explain the concept.
(b) What is the importance of the concept stated in question 1(a)?

2. (a) What is meant by the calorific value of a food?
(b) Name the device used to measure the calorific value of food.
(c) Write the formula for calculating the calorific value of a food sample using the device in question 2(b).

3. (a) State **one** effect of insufficient total calorie intake.
(b) State **one** effect of excessive total calorie intake.

4. Explain how the total calorie intake of an individual is influenced by the following:
(a) 24-hour restaurants
(b) fast food restaurants

2.2 Nutrient Requirements in Plants

Besides humans and animals, plants also require certain nutrients for growth, development and reproduction. Nutrients required by plants can be classified into **two** groups, namely **macronutrients** and **micronutrients** (Figure 2.7).

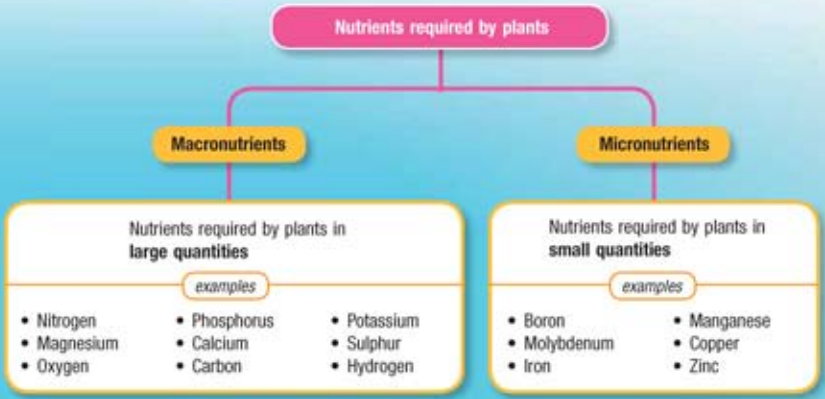


Figure 2.7 Classification of nutrients required by plants

Activity 2.3

21st Century Skills
- ICS
- Discussion

To gather information and classify the elements required by plants based on their quantities as well as functions

Instructions

1. Carry out this activity in groups.
2. Gather information from the Internet, print media and other electronic media about the classification of elements required by plants based on their quantities and functions.
3. Discuss the information gathered.
4. Present the outcome of your group discussion using a multimedia presentation.

Compare the outcome of your discussion from Activity 2.3 with the information given in Table 2.3 and Table 2.4 on page 58.

Macronutrients

Macronutrients are **elements** (or **minerals**) required by plants in **large** quantities.

Table 2.3 Examples of macronutrients and their functions

Macronutrient	Functions
Nitrogen	• Synthesises protein, chlorophyll, enzyme and nucleic acid • Helps the growth of branches and leaves • Increases the production of fruits and seeds
Phosphorus	• Synthesises protein and nucleic acid • Promotes cell division for the production of flowers and fruits
Potassium	• Synthesises protein • Promotes plant cell division • Strengthens resistance to infectious diseases
Magnesium	• Important component in chlorophyll
Calcium	• Synthesises spindle fibres during cell division • Helps growth of meristem at tips of shoots and roots
Sulphur	• Synthesises protein and chlorophyll • Helps development of fruits • Promotes plant cell division
Oxygen	• Involved in plant cell respiration to produce energy
Carbon Hydrogen	• Builds sugar or starch during photosynthesis • Builds cellulose

Micronutrients

Micronutrients are **elements** (or **minerals**) required by plants in **small** quantities.

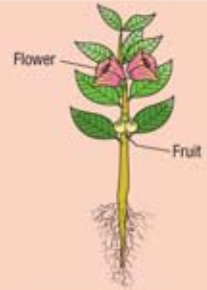
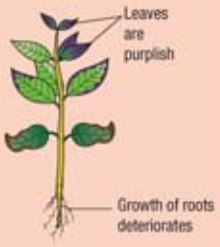
Table 2.4 Examples of micronutrients and their functions

Micronutrient	Functions
Boron	• Synthesises chlorophyll and cell wall • Helps the formation of fruits and seeds
Iron	• Helps growth of young tree parts • Helps cell respiration
Copper	• Involved in photosynthesis and respiration
Molybdenum	• Synthesises protein • Helps growth of plants
Manganese	• Involved in photosynthesis and respiration • Helps formation of amino acid
Zinc	• Helps synthesis of protein and formation of chlorophyll • Helps formation of leaves

Effects of Nitrogen, Phosphorus and Potassium Deficiency on Plant Growth

Table 2.5 shows the effects of nitrogen, phosphorus and potassium deficiency on plant growth compared to a plant that obtains all these nutrients.

Table 2.5 Effects of nitrogen, phosphorus and potassium deficiency on plant growth

Healthy plant	Plant with nitrogen deficiency	Plant with phosphorus deficiency	Plant with potassium deficiency
			
• Normal plant growth • Strong stem • Leaves at the top are small and light green • Leaves at the bottom are bigger and dark green • The production of flowers and fruits is normal • The growth of roots is normal	• Stunted plant growth • Weak stem • Leaves at the top are smaller and fall easily • Leaves at the bottom are pale green or yellow (lacking chlorophyll or chlorosis) • The production of flowers and fruits is stunted • The growth of roots is normal	• Stunted plant growth; slow to grow and mature • Weak stem • Leaves at the top are smaller and purplish • Leaves at the bottom are bluish green, curled and with brown edges • The production of flowers and fruits stops • The growth of roots deteriorates	• Stunted plant growth; dies before reaching maturity • Weak stem • Leaves at the top have brown spots, curled ends and chlorosis • Leaves at the bottom wilt and have dead tissues around the edges • The production of flowers is reduced and the production of fruit stops • The growth of roots is reduced

Experiment 2.2

Aim: To study the effects of macronutrient (nitrogen, phosphorus and potassium) deficiency on plant growth

Problem statement: What are the effects of macronutrient (nitrogen, phosphorus and potassium) deficiency on plant growth?

Hypothesis: Deficiency of macronutrients (nitrogen, phosphorus and potassium) stunts plant growth.

Variables:
(a) manipulated : Type of culture solution
(b) responding : Growth of plant
(c) constant : Volume of culture solution, size and type of seedlings, light and temperature

Materials: Distilled water, complete culture solution, culture solution without nitrogen, culture solution without phosphorus, culture solution without potassium, maize seedlings, black paper and cotton wool

Apparatus: Boiling tube, connecting tube, air pump and cork

Procedure:

1. Prepare the apparatus set-up (Figure 2.8).

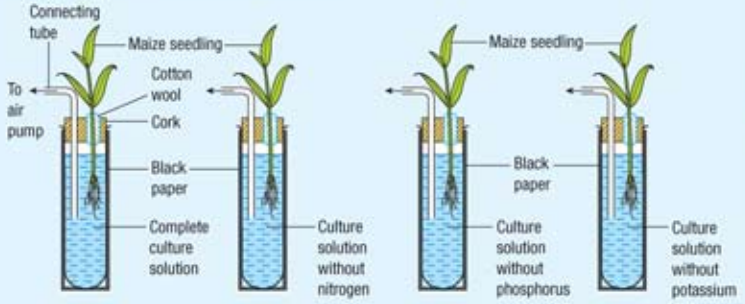


Figure 2.8

2. Place the apparatus set-up in a bright place such as near the laboratory window where there is sunlight.
3. Pump air into the culture solution in each boiling tube for 5 minutes every day.
4. The culture solution in each boiling tube is replaced once a week with the same type of culture solution.
5. After two weeks, observe and record the conditions of the seedlings in terms of size of plant, colour of leaves and growth of roots.

Observation:

Type of culture solution	Nutrient deficiency	Plant growth		
		Plant size	Colour of leaf	Root growth
Complete culture solution	None			
Culture solution without nitrogen	Nitrogen			
Culture solution without phosphorus	Phosphorus			
Culture solution without potassium	Potassium			

Conclusion:

Is the hypothesis accepted? What is the conclusion of this experiment?

Questions:

1. Why are the boiling tubes wrapped in black paper?
2. What is the importance of aerating the culture solutions every day?
3. Why is the culture solution in each boiling tube changed once a week with the same type of culture solutions?
4. State **one** factor, besides nutrient, that affects the growth of seedlings.

Formative Practice 2.2

1. (a) What is the meaning of macronutrient? Name **five** examples of macronutrients.
(b) What is the meaning of micronutrient? Name **five** examples of micronutrients.

2. What is the importance of macronutrients and micronutrients to plants?

3. Match the macronutrient with the effect of its deficiency on plant growth.

Macronutrient	Effect of macronutrient deficiency
(a) Phosphorus ▸	◂ Small leaves which fall easily
(b) Potassium ▸	◂ Stunted growth of roots
(c) Nitrogen ▸	◂ Brown spots on edges of leaves

2.3 Nitrogen Cycle

Nitrogen cycle is a **natural cycle** that recycles nitrogen between plants and animals, and the atmosphere, soil and water. Figure 2.9 shows the nitrogen cycle in an ecosystem.

Approximately 78% of air is made up of nitrogen. But plants cannot absorb nitrogen directly from the air. So how do plants obtain the nitrogen required for healthy growth?

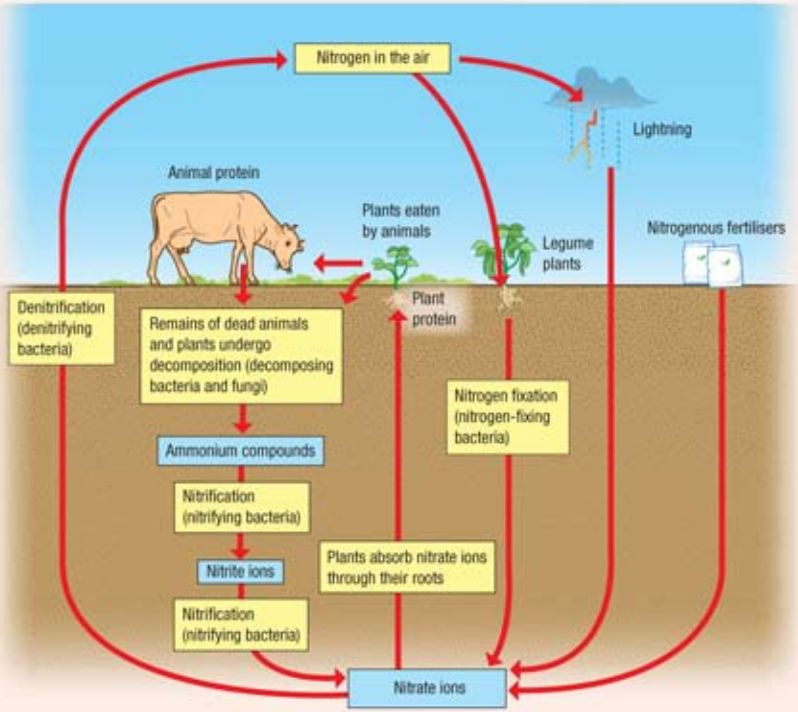


Figure 2.9 Nitrogen cycle

Plants can only absorb nitrogen in the form of nitrate ions from the soil through their roots. There are two processes in the nitrogen cycle, namely the **process of nitrate ion addition to the soil** and the **process of nitrate ion extraction from the soil** (Figure 2.10).

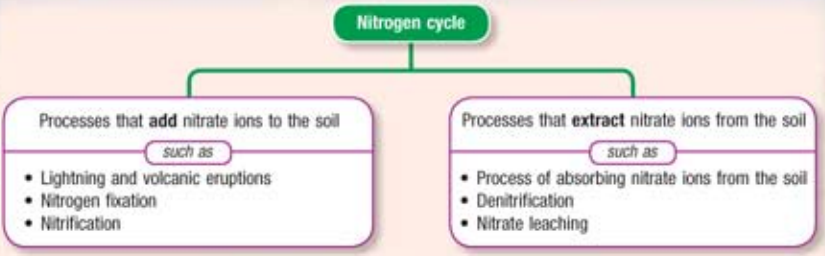


Figure 2.10 Processes in the nitrogen cycle

Processes that Add Nitrate Ions to the Soil

Lightning and Volcanic Eruptions

During lightning or volcanic eruptions, heat energy released at high temperatures oxidises nitrogen in the air to form nitrogen dioxide (Photographs 2.6 and 2.7).

When it rains, nitrogen dioxide in the air dissolves in the rainwater to form nitric acid which falls to the surface of the earth. This nitric acid seeps into the ground and reacts with minerals to form nitrate ions. As a result, the quantity of nitrate ions in the soil increases.

Photograph 2.6 Lightning

Photograph 2.7 Volcanic eruption

Nitrogen Fixation

Nitrogen-fixing bacteria in the soil, water or living symbiotically in legume plant root nodules (Photograph 2.8), convert nitrogen in the air into nitrate ions. The resulting action of nitrogen-fixing bacteria increases nitrate ions in the soil.

Nitrification

When animals and plants die, decomposing bacteria convert animal protein and plant protein into ammonium compounds through the process of decomposition. Then, nitrifying bacteria convert ammonium compounds into nitrite ions and then nitrate ions. The resulting action of nitrifying bacteria on ammonium compounds increases nitrate ions in the soil.

Photograph 2.8 Nitrogen-fixing bacteria in the root nodules of a legume plant

Processes that Extract Nitrate Ions from the Soil

Nitrate Ion Absorption from the Soil

Plants absorb nitrate ions from the soil to meet their nitrogen requirement. These ions are used to form plant protein. When animals eat plants, plant protein is transferred to the animals to form animal protein. What will happen to the protein in dead plants and animals?

Denitrification

There are also denitrifying bacteria in the soil which convert nitrate ions in the soil into nitrogen which then leaves the soil and returns to the air. This process is known as denitrification.

Nitrate Leaching

Nitrate leaching is a natural process. Through this process, nitrate ions in the soil dissolve in water and then flow into rivers or underground water. This process also removes nitrate ions from the soil.

Importance of Nitrogen Cycle

The nitrogen cycle maintains nature's balance by:

(a) **Maintaining nitrogen content in the air**
The nitrogen cycle helps to maintain the nitrogen content in the atmosphere by removing nitrogen from the air to form nitrate ions and returning it to the air by decomposing nitrate ions. Therefore, the concentration of nitrogen is maintained at 78% in the atmosphere to help ensure the continuity and sustainability of life on Earth.

(b) **Maintaining fertility of soil and increasing productivity of crops**
As you have learned in subtopic 2.2, nitrogen is an important macronutrient for plant growth and is obtained by plants in the form of nitrate ions absorbed from the soil. The removal of nitrate ions reduces the fertility of the soil. The problem of infertile soil can be solved through crop rotation and use of fertilisers (Photograph 2.9) to increase the content of nitrate ions in the soil again. As a result, plants become healthier. The productivity of crops rises and the income of farmers increases.

Photograph 2.9 Fertilisers that contain nitrate ions

(c) **Maintaining a continuous supply of plant proteins and animal proteins**
Nitrogen is an important component in the formation of protein. Protein is used to build new cells and repair damaged cells.
A continuous supply of protein is important to ensure the continuity and maintenance of life for all types of living things. Plants use nitrogen from the nitrate ions that are absorbed to form plant proteins. Animals obtain nitrogen by feeding on plants or other animals (Photograph 2.10).

Photograph 2.10 Examples of animal protein and plant protein

(d) **Reducing environmental pollution**
The remains of dead animals and plants undergo decay and decomposition to form ammonium compounds and then nitrate ions through bacterial and fungal actions. Processes in the nitrogen cycle such as **nitrification** help to reduce environmental pollution and are applied in green technology to produce compost (Photograph 2.11).

Photograph 2.11 Compost

Activity 2.4

21st Century Skills
- ICS, TPS
- Inquiry-based activity

To gather information on nitrogen cycle and its importance

Instructions

1. Carry out this activity in groups.
2. Gather information from the Internet, print media and electronic media on nitrogen cycle and its importance.
3. Discuss the gathered information.
4. Present the outcome of your group discussion to the class in the form of a multimedia presentation.

Formative Practice 2.3

1. What is nitrogen cycle?
2. (a) Name **three** processes in the nitrogen cycle which increase nitrate ions in the soil.
   (b) Name **three** processes in the nitrogen cycle which remove nitrate ions from the soil.
3. How does the planting of legume plants increase the fertility of the soil?
4. What happens to the content of nitrate ions in the soil during rainy season? Explain your answer.

2.3.1

2.4 Food Production Technology

Food production technology is applied to solve the problem of global food shortage. The measures used in food production technology include:

- increasing food quality
- increasing the quantity of food production
- producing and using quality breeds
- using various types of modern technology

Ways to Increase the Quality and Quantity of National Food Production

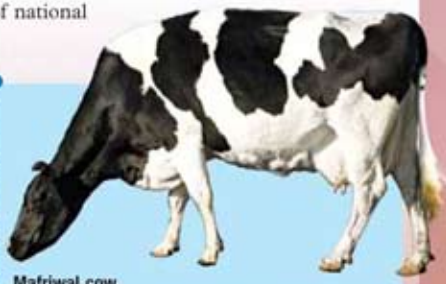
There are efforts undertaken by various government and private agencies in Malaysia to increase food quality and quantity of national food production (Figure 2.11).

Figure 2.11 Ways to increase quality and quantity of national food production

Use of Quality Breeds

The use of quality breeds in Malaysia can diversify food sources, increase food quality and quantity of national food production (Photograph 2.12).

Tenera oil palm yields more fruits with larger kernel, thicker pulp, thinner shell and higher oil content



Mafriwal cow
A hybrid dairy cow that produces a lot of milk and can adapt to tropical areas

***Bintang Mas* starfruit** (MSTAR 1, MARDI) is golden yellow, sweet and crunchy

***Eksotika* papaya** is big and tastes sweet

***Akar Putra* chicken**
A hybrid chicken that grows rapidly and has the same meat texture as that of the *kampung* chicken

Photograph 2.12 Use of quality breeds to increase the yield of crops and livestock

Quality plant and livestock breeds are obtained through cloning techniques, cross-breeding, genetic engineering and mutagenesis technology. Characteristics of quality breeds are shown in Figure 2.12.

Figure 2.12 Characteristics of quality breeds

Use of Modern Technology

Modern technology is applied to increase the quality and quantity of food production (Figure 2.13).

Grinding machine and liquid filling machine speed up processing and manufacturing of food.

Cloning can retain good characteristics in crop and livestock breeds.

Modern technology

Figure 2.13 Various types of modern technology used to increase the quality and quantity of food production

2.4.1

Machinery such as tractors, bulldozers and harvesters speed up the rate of crop planting and harvesting.

Biotechnology such as embryo transfer, cloning and genetic engineering is used to increase the quality and quantity of food.

The use of the drone to spray pesticides can save time and reduce labour cost.

Education and Guidance for Farmers

Various agencies and institutions provide education and guidance to farmers to increase their knowledge and skills in the agricultural field in order to increase quality and quantity of national food production (Photograph 2.13).

Photograph 2.13 Oil palm farmers are given guidance and educated by the staff of Advanced Biotechnology and Breeding Centre (ABBC)

My Malaysia

Several agencies or institutions are tasked with providing education and guidance to farmers as follows:

- Ministry of Agriculture and Food Industries
  https://www.mafi.gov.my/alamat-jabatan-dan-agensi
- Malaysian Agricultural Research and Development Institute (MARDI)
  https://www.mardi.gov.my/
- Malaysian Palm Oil Board (MPOB)
  http://www.mpob.gov.my/

Click@Web

How does Advanced Biotechnology and Breeding Centre (ABBC) help farmers in agriculture especially food crops like oil palm?
http://buku-teks.com/sc5070

Research and Development

Research and development to increase food quality and quantity of food production is continuously conducted worldwide to overcome global food shortage. Name four examples of research and development agencies or institutions which increase the quality and quantity of food in Malaysia.

Several universities in Malaysia also conduct research and development to increase food quality and quantity of food production. Name these universities.

Photograph 2.14 An innovative product to tenderise meat (a research by the students of Faculty of Food Science and Technology, Universiti Putra Malaysia)

Optimal Use of Land and Water Resources

As suitable agricultural land and water resources are limited, the use of land and water resources need to be optimised to increase agricultural and livestock yields. Some of the ways to optimise the use of land and water resources are as follows:

- develop idle land into land suitable for agricultural or livestock activities
- fertilise barren land
- develop abandoned mining pools into areas suitable for freshwater aquaculture activities
- develop marshland that is easily flooded by seawater into areas suitable for marine aquaculture activities
- build dams and canals for agricultural or livestock land that experiences water shortage

Science Info

Two farming techniques, namely aeroponic and hydroponic do not require soil.

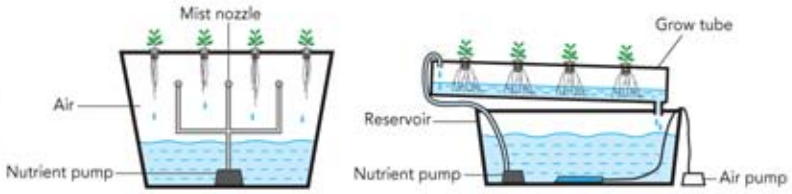


Figure 2.14 Two farming techniques without soil

My Malaysia

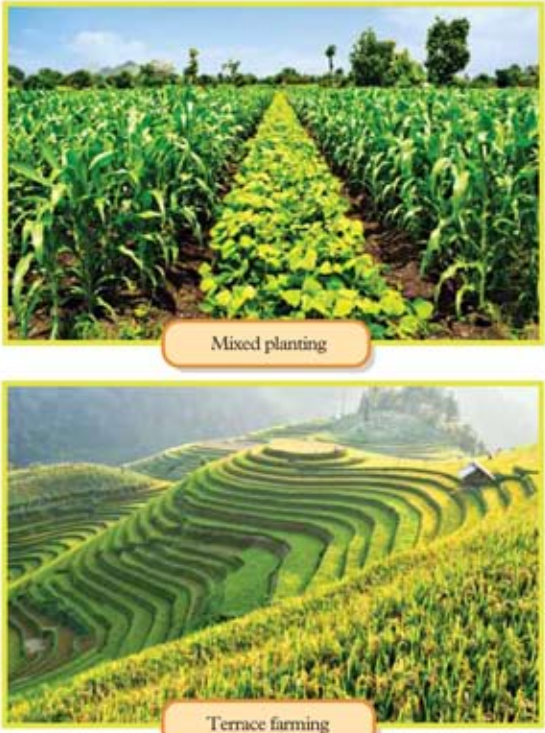
FELDA (Federal Land Development Authority) is responsible for restoring idle land into fertile land suitable for agriculture.

Efficient Land Management

Efficient land management involves the use of various approaches to:

- maintain land fertility
- increase quality of crop yield
- increase quantity of crop yield

Approaches for efficient land management are shown in Photograph 2.15.



Photograph 2.15 Various approaches for efficient land management

Activity 2.5

21st Century Skills
- ICS, TPS
- Discussion

To study the efforts of various agencies in diversifying food sources to increase food quality and quantity of national food production

Instructions

1. Carry out this activity in groups.
2. Gather information from the Internet, print media and electronic media on efforts to diversify food sources by various agencies or institutions to increase food quality and quantity of national food production as follows:
   (a) use of quality breeds
   (b) use of modern technology
   (c) education and guidance for farmers
   (d) research and development
   (e) optimal use of land and water resources
   (f) efficient land management
3. Discuss the information gathered.
4. Present the outcome of your group discussion to the class using a multimedia presentation.

Use of Insecticides

The elimination of crop pests plays an important role in ensuring the quality and quantity of crop yields. Photograph 2.16 shows several examples of crop pests.

Pesticides such as insecticides are easily used to control the population of crop pests (Photograph 2.17). However, the use of pesticides such as insecticides has side effects like polluting the environment, increasing the pesticide resistance of crop pests, killing earthworms and useful microorganisms in the soil, and contaminating the land and crop yields.

Photograph 2.16 Rat, grasshopper and snail are crop pests

Photograph 2.17 Spraying insecticides on crops

2.4.1 2.4.2

Biological Control

Apart from the use of pesticides, **biological control** is a method which applies the interaction between organisms such as prey-predator and parasitism in order to control crop pests in a habitat. Examples of biological control are shown in Photographs 2.18 and 2.19. Table 2.6 shows the advantages and disadvantages of biological control.

Photograph 2.18 Barn owl hunts rats for food (Type of interaction: Prey-predator)

Photograph 2.19 Wasps lay eggs in the eggs of butterflies and destroy them (Type of interaction: Parasitism)

Table 2.6 Advantages and disadvantages of biological control

Advantages of biological control	Disadvantages of biological control
• More environmental-friendly • Does not harm the health of other organisms except crop pests • Does not cause crop pests to become resistant • Cheaper	• Takes a longer time to control the population of crop pests • Difficult to predict the results of biological control which involves living organisms • Needs more detailed and effective planning and management • Disrupts the balance of ecosystem if populations of the predator species or parasite become uncontrollable

Biological control used without proper planning can cause various problems. For example, the use of mongoose (Photograph 2.20) to control the population of rats in sugarcane plantations on the islands of Hawaii failed because the mongoose is active during daytime while the rat is active at night. This resulted in the mongoose feeding on birds and turtle eggs.

Why does the biological control using barn owls to hunt rats in urban areas also fail? Give your reasons.

Photograph 2.20 Mongoose

Activity 2.6

21st Century Skills
- ICS, TPS
- Discussion

To evaluate the use of insecticides and biological control to increase the quality and quantity of national food production

Instructions

1. Carry out this activity in groups.
2. Discuss and evaluate the use of insecticides and biological control to increase the quality and quantity of national food production based on the following aspects:
   (a) advantages of using insecticides and biological control
   (b) disadvantages of using insecticides and biological control
3. Present the outcome of your group discussion to the class in the form of a multimedia presentation.

Click@Web

An integrated crop pest management system using Integrated Pest Management (IPM) by Sarawak Land Consolidated and Rehabilitation Authority (SALCRA).
http://buku-teks.com/sc5075

Formative Practice 2.4

1. State **four** characteristics of quality breeds.
2. How are quality breeds obtained using modern technology?
3. Name the agency which promotes the marketing of our country's crop yields.
4. State **three** ways of efficient land management.
5. What is biological control?

2.5 Food Processing Technology

According to nutritionists, fresh raw food is better as it is healthier for our body. However, not all raw food substances can be eaten fresh. As such, most raw food is converted into other forms using **food production technology**. Processed food lasts longer, is more delicious and attractive, and can be digested easily.

Food Processing Technology

The **methods** and **examples of food products** processed through **food processing technology** are shown on pages 76 to 79.

Cooking

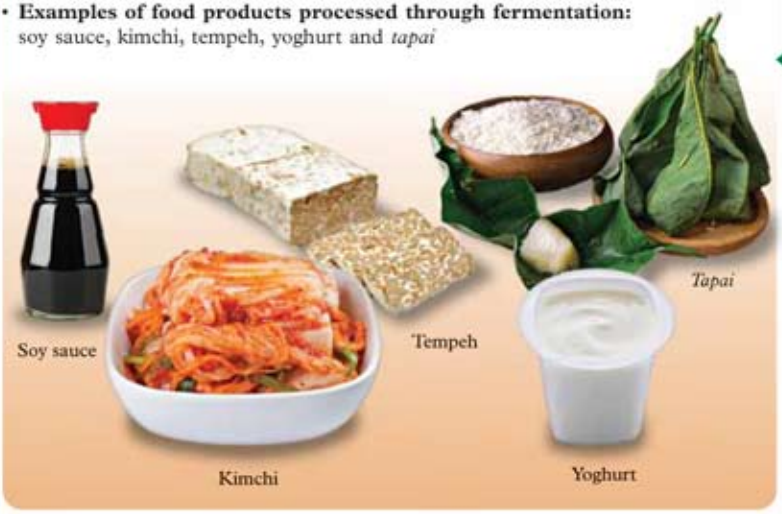
- **Method**
  Food is processed by heating food using techniques such as blanching, frying, grilling, smoking, braising, stir-frying, baking and steaming.
- **Examples of food products processed using cooking techniques:**
  chicken curry, fried fish, grilled chicken, rice, vegetables and cakes

Fermentation

- **Method**
  The breakdown of complex substances into simpler substances through the action of bacteria, yeast or other useful microorganisms. For example, the fermentation of glucose using yeast is used in the making of bread.

$$\text{Glucose} \xrightarrow{\textit{Yeast}} \text{Ethanol} + \text{Carbon dioxide}$$

- **Examples of food products processed through fermentation:**
  soy sauce, kimchi, tempeh, yoghurt and *tapai*

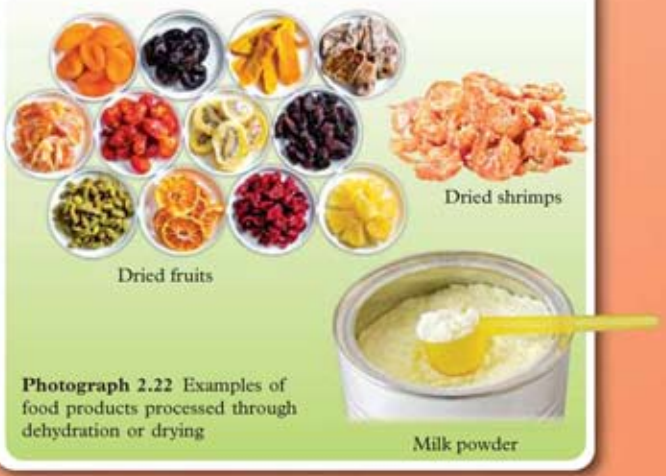


Photograph 2.21 Examples of food products processed through fermentation

Dehydration or Drying

- **Method**
  Water is removed from food through dehydration or evaporation by drying under the sun, using flame or smoke or in the oven.
- **Examples of food products processed through dehydration or drying:**
  dried shrimp, dried squid, dried fish, dried fruits, cereal, mushroom and milk powder

Food processing technology



Photograph 2.22 Examples of food products processed through dehydration or drying

Pasteurisation

- **Method**
  Liquid is heated to a temperature below its boiling point to kill pathogens and then cooled quickly. For example, fresh milk is heated to a temperature of 63°C for 30 minutes or to a temperature of 72°C for 15 seconds and then cooled immediately.
- **Examples of food products processed through pasteurisation:**
  milk, dairy products and fruit juices

Photograph 2.23 Examples of food products processed through pasteurisation

Canning

- **Method**
  Food is kept in cans which are sterilised and heated to a temperature exceeding 115°C under high pressure to kill microorganisms and their spores. The air in the can containing the sterilised food is removed before the can is sealed. The can is then heated again to kill any remaining microorganisms before being cooled quickly.
- **Examples of food products processed through canning:**
  meat, soup, beans, fish, fruits, sauce and canned milk

Lychee Milk Meat

Photograph 2.24 Examples of food products processed through canning

Freezing

- **Method**
  Food is kept at a temperature of 0°C or lower so that it can last longer. For example, meat is frozen at a temperature of –18°C to –24°C. At temperatures less than –18°C:
  - enzyme action stops
  - the growth and reproduction of microorganisms are inhibited
- **Examples of food products processed through freezing:**
  seafood, meat, chicken and fish

Photograph 2.25 Freezing of food

Food processing technology

Irradiation

- **Method**
  Food is exposed to ionising radiation such as gamma ray, ultraviolet ray and X-ray to kill microorganisms such as *Salmonella* sp. and *Campylobacter* sp. in raw meat, and insects such as weevils in rice, which spoil the food. Ionising radiation can also slow down seed germination, budding of root vegetables and ripening of fruits.
- **Examples of food products processed through irradiation:**
  vegetables, cereal and fruits

Photograph 2.26 An example of food product processed through irradiation

Vacuum Packaging

- **Method**
  Air is removed completely from the container or plastic bag used to pack the food before the package is sealed tight. The absence of air in the package prevents the growth of microorganisms in the package and stops food oxidation.
- **Examples of food products processed through vacuum packaging:**
  nuts, rice, durian and vegetables

Photograph 2.27 Examples of food products processed through vacuum packaging

Chemical Substances Used in Food Processing and their Impacts on Health

Chemical substances used in food processing are shown in Table 2.7.

Table 2.7 Chemical substances used in food processing

Chemical substance	Functions	Examples of chemical substance (natural or artificial)	Examples of food
Preservative	• Prevents growth and reproduction of microorganisms • Reduces food spoilage • Makes food last longer	Salt (natural)	Seafood, vegetables
		Sugar (natural)	Fruits
		Vinegar (natural/artificial)	Pickled food
		Sodium nitrite and sodium nitrate (artificial)	Meat, sausage
		Benzoic acid (artificial)	Fruit juice, ketchup
		Boric acid (artificial)	Noodles, fish ball
		Sulphur dioxide (artificial)	Fruit cordial
Colouring	• Adds colour to food • Makes food look more attractive	Pandan leaf, turmeric, milk, caramel, coconut milk (natural)	Cakes, drinks, candy, turmeric rice, ice cream
		Tartrazine (artificial)	Soft drinks, candy
		Sunset yellow (artificial)	Orange-coloured cordial
		Carmoisine (artificial)	Red-coloured cordial
Bleach	• Bleaches unwanted natural colour from food	Activated carbon (natural)	Palm oil, cane sugar
		Benzoyl peroxide (artificial)	Sugar, white rice, flour, rice noodle
Flavouring	• Improves the taste of food • Makes food more delicious and fragrant • Enhances the natural flavour of food	Sugar, salt, vinegar, pandan leaf, vanilla (natural)	Cakes, ice cream
		Monosodium glutamate (MSG) (artificial)	Instant noodle, soy sauce, potato chips
Stabiliser	• Prevents deposition of granules in liquid food • Improves texture and thickens food	Starch (natural)	Chilli sauce, ketchup
		Gelatine (natural)	Jelly
		Agar (natural)	Ice cream, instant soup, jelly
		Acacia gum (natural)	Ice cream, candy, jelly

Chemical substance	Functions	Examples of chemical substance (natural or artificial)	Examples of food
Sweetener	• Sweetens food and drinks	Sugar, palm sugar, honey (natural)	Cakes, drinks
		Aspartame (artificial)	Cordial, drinks, jam
		Sorbitol (artificial)	Food for diabetic patients
Antioxidant	• Slows down the oxidation of fatty food • Prevents fruits and vegetables from turning brown	Ascorbic acid, vitamin C (natural)	Cooking oil
		Tocopherol, vitamin E (natural)	Margarine, biscuit
		Butylated hydroxyanisole (artificial)	Vitamin pills
Emulsifier	• Emulsifies substances which do not mix such as fat and water in food • Improves homogeneity, stability and texture of food	Lecithin from egg yolk or soya beans (natural)	Ice cream, chocolate
		Pectin (natural)	Mayonnaise, pudding
		Fatty acid such as monoglyceride (natural), magnesium stearate (artificial)	Yoghurt, cheese

The impacts of excess chemical substances in food processing on human health are shown in Table 2.8.

Table 2.8 Impacts of excess chemical substances in food processing on human health

Chemical substance	Impacts on health	
Preservative	• Cancer • Disrupts the human digestive system • Allergy, rash and itchy skin	• Foetal defects in mother's womb • Damages liver and kidney
Colouring	• Cancer • Infertility	• Food poisoning • Damages liver and kidney
Bleach	• Cancer	• Food poisoning
Flavouring	• Cancer • High blood pressure • Heart diseases	• Mental retardation in children • Damages liver and kidney
Sweetener	• Cancer • Diabetes mellitus • Allergy, rash and itchy skin	• Obesity • Damages liver and kidney
Antioxidant	• Retards body growth • Damages liver and kidney	• Rash and itchy skin

Activity 2.7

21st Century Skills
- TPS, ISS, ICS
- Technology-based activity

To make a multimedia presentation on food processing methods, chemicals used in food processing and the impacts of using these chemical substances on human health

Instructions

1. Carry out this activity in groups.
2. Create a multimedia presentation on one of the following topics:
   (a) processing methods
   (b) chemical substances used in food processing with examples
   (c) the impacts of using chemical substances excessively in food processing on human health

Formative Practice 2.5

1. What is food processing?
2. State **four** purposes of processing food.
3. Name **four** methods of food processing.
4. Name the chemical substances used in processing the following food:
   (a) turmeric rice
   (b) chilli sauce
   (c) white rice
5. What is the use of activated carbon in the preparation of palm oil as cooking oil?
6. Figure 1 shows a method of food processing.

Figure 1

   (a) Name the food processing method.
   (b) Give **two** other examples of food that also use this food processing method for export purposes.
   (c) Give **one** reason for using this method of food processing.

2.6 Health Foods and Health Supplements

Health Foods

Health foods are natural food substances in a normal diet that maintain health and do not contain chemical substances.

Among the issues related to health foods are availability, high price, processing method and chemical substances used in food processing.

Photograph 2.28 Examples of health foods

Health Supplements

Health supplements are nutrients taken in the form of capsule, pill, liquid and powder in pre-determined doses.

Photograph 2.29
Examples of health supplements

Nutrients such as minerals, vitamins, carbohydrate and fibre found in health supplements are usually in small quantities but high in concentration. What is the importance of taking health supplements in recommended doses?

Among the issues related to health supplements is taking dosage according to health requirements. As individual body requirements vary, it is difficult to accurately determine the required dosage of health supplements. Consequently, taking insufficient or excessive health supplements frequently occurs and this may affect the user negatively.

BRAIN TEASER

If an individual experiences lack of red blood cells, what type of mineral in health supplements should be consumed? Give a reason.

National Food Safety Policy

The National Food Safety Policy is enforced by the Food Safety and Quality Division, Ministry of Health through food safety programmes. This policy is aimed at protecting the public from:

- risks of consuming food and drinks which endanger health
- fake health foods and health supplements

Furthermore, this policy promotes the local and global food trade.

The Drug Control Authority (DCA) is entrusted to register and monitor health supplements and traditional medicine before being marketed. Stickers with labels and QR codes will be affixed to bottles or boxes of health supplements and traditional medicine which have been approved and registered (Photograph 2.30).

In addition to the use of labels and QR codes, emphasis is also placed on efforts to raise public awareness through consumer education.

Advertisements and marketing methods on the quality of health foods and supplements are often confusing which makes it difficult for consumers to choose the right health food for their needs. To protect the welfare and facilitate the food selection process of consumers, the Malaysian government monitors food quality through the **Food Act 1983** and the **Food Regulations 1985**.

Photograph 2.30
Example of label and QR code for health supplements approved by MOH

Click@Web

National Pharmaceutical Regulatory Agency
http://buku-teks.com/sc5084a

Registration of health supplements
http://buku-teks.com/sc5084b

Food Act 1983

The **Food Act 1983** is a Malaysian legislation enforced by the government to protect the public from dangers of health and fraud related to the preparation, sale and use of food, as well as any matters related to them. In short, any parties found selling poisoned food or food that damages the health of users will be fined or jailed, or both if found guilty by the court of law.

Click@Web

Food Act 1983
http://buku-teks.com/sc5084c

Food Regulations 1985

Food Regulations 1985 are laws drafted under the **Food Act 1983** which are enforced by the Ministry of Health Malaysia and local authorities to help the public obtain food that is safe, of good quality, clean and free from any poisonous contaminants.

For example, according to Food Regulations 1985, the information on food labels should contain details as in Figure 2.15.

Click@Web

Food Regulations 1985, updated January 2018
http://buku-teks.com/sc5085

BRAIN TEASER

Why is Food Regulations 1985 frequently updated?

EXAMPLE OF FOOD LABEL

NUTRITIONAL QUALITY
Shows the nutritional quality of the product.

NAME OF FOOD
The name of food must be clear, accurate and not confusing.

NUTRITIONAL LABEL
Information about the nutritional content of the product.

LIST OF INGREDIENTS
Ingredients used in the product listed according to weight in descending order.

STATEMENT ON FOOD ADDITIVES
All permitted food additives such as preservatives, colouring, flavouring, additional flavours, antioxidants and conditioners should be stated.

STORING INSTRUCTIONS
Follow the recommended storing instructions.

STATEMENT ON QUANTITY/ WEIGHT/VOLUME
Statement on the net weight or volume or minimum quantity of contents.

MANUFACTURING INFORMATION
Name and address of manufacturer/packaging/agent (including imported product).

EXPIRY DATE
Make sure that the chosen food is not past its expiry date.

(Source: Food Safety and Quality Division, Ministry of Health Malaysia)

Figure 2.15 Food label

Halal Food Status

Recall eateries or food products which display the Halal Malaysia logo (Photograph 2.31). Eateries or food products which display the Halal Malaysia logo certify that the food sold in the eatery or the food product is *halal*.

Photograph 2.31 Halal Malaysia logo

My Malaysia

Malaysia's success and its global recognition in *halal* certification is well known amongst the *halal* industries. Why is halal certification important for Malaysia's economy?
http://buku-teks.com/sc5086a
(Medium: *bahasa Melayu*)

Click@Web

Definition of halal
http://buku-teks.com/sc5086b
(Medium: *bahasa Melayu*)

Activity 2.8

21st Century Skills
- ICS, ISS
- Discussion

To gather information and discuss health foods, health supplements, Food Act 1983, Food Regulations 1985, *halal* food status and Malaysia Halal Certification

Instructions

1. Carry out this activity in groups.
2. Gather information on health food, health supplements, Food Act 1983, Food Regulations 1985, *halal* food status and Malaysia Halal Certification from the Internet, print media and electronic media.
3. Discuss the information gathered.
4. Present the outcome of your group discussion using a multimedia presentation.

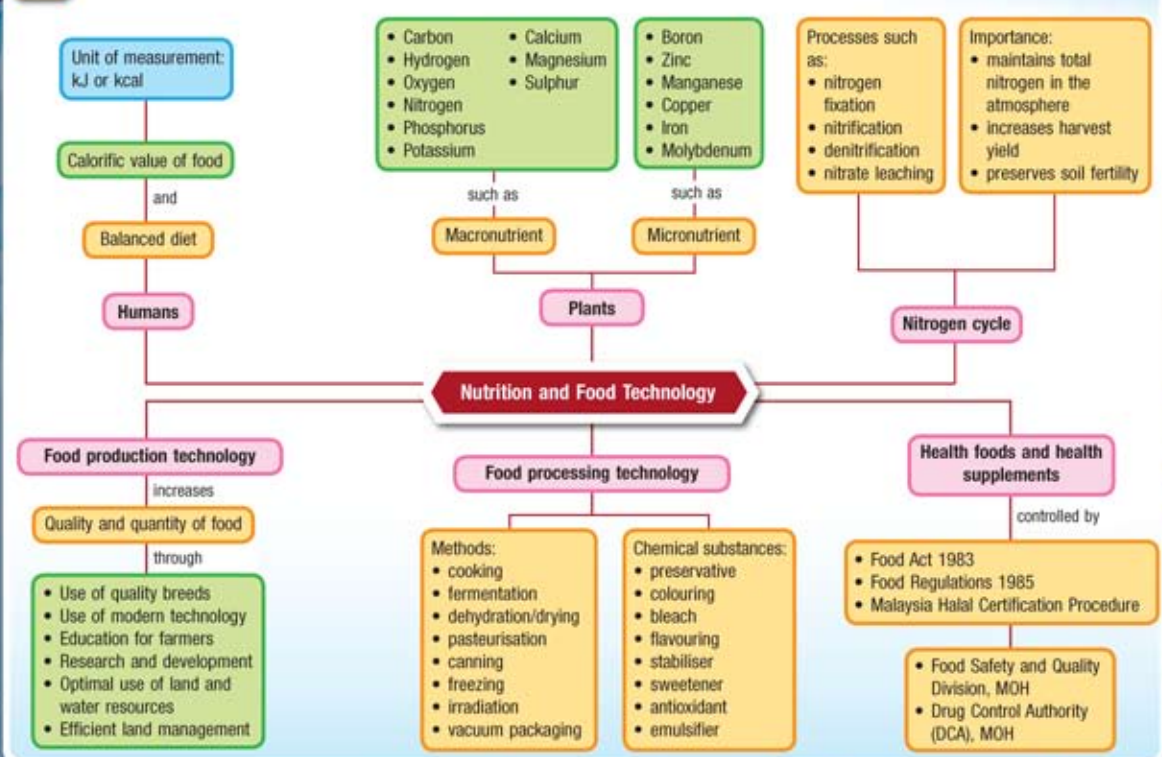
Click@Web

Malaysian Halal Certification Procedure Manual
http://buku-teks.com/sc5086c

Formative Practice 2.6

1. What is health food? Give **one** example of health food.
2. What is health supplement? Give **one** example of health supplement.
3. Name the body which monitors national food safety and approves the marketing of health supplements and traditional medicine in Malaysia.
4. What act was drafted in Malaysia to protect the welfare of users from dangers of health and fraud related to food?

Summary


Unit of measurement: kJ or kcal
Calorific value of food
and
Balanced diet
Humans
• Carbon
• Hydrogen
• Oxygen
• Nitrogen
• Phosphorus
• Potassium
• Calcium
• Magnesium
• Sulphur
such as
Macronutrient
• Boron
• Zinc
• Manganese
• Copper
• Iron
• Molybdenum
such as
Micronutrient
Plants
Processes such as:
• nitrogen fixation
• nitrification
• denitrification
• nitrate leaching
Importance:
• maintains total nitrogen in the atmosphere
• increases harvest yield
• preserves soil fertility
Nitrogen cycle
Nutrition and Food Technology
Food production technology
increases
Quality and quantity of food
through
• Use of quality breeds
• Use of modern technology
• Education for farmers
• Research and development
• Optimal use of land and water resources
• Efficient land management
Food processing technology
Methods:
• cooking
• fermentation
• dehydration/drying
• pasteurisation
• canning
• freezing
• irradiation
• vacuum packaging
Chemical substances:
• preservative
• colouring
• bleach
• flavouring
• stabiliser
• sweetener
• antioxidant
• emulsifier
Health foods and health supplements
controlled by
• Food Act 1983
• Food Regulations 1985
• Malaysia Halal Certification Procedure
• Food Safety and Quality Division, MOH
• Drug Control Authority (DCA), MOH

Self-Reflection

After studying this chapter, you are able to:

2.1 Balanced Diet and Calorific Value
- ☐ Describe a balanced diet.
- ☐ Conduct an experiment to estimate the calorific value in food samples.
- ☐ Justify the effects of consuming calories that do not meet an individual's requirements.

2.2 Nutrient Requirements in Plants
- ☐ Explain with examples the functions of macronutrients and micronutrients in plants.
- ☐ Conduct an experiment to study the effects of macronutrient deficiency in plants.

2.3 Nitrogen Cycle
- ☐ Communicate about the nitrogen cycle and its importance.

2.4 Food Production Technology
- ☐ Communicate about ways to improve resources, food quality and quantity of food production.
- ☐ Evaluate the use of pesticides and biological control to increase the quality and quantity of food production.

2.5 Food Processing Technology
- ☐ Communicate about food processing technology.

2.6 Health Foods and Health Supplements
- ☐ Communicate about issues related to health foods and health supplements.
- ☐ Communicate about issues related to *halal* food status.

Summative Practice 2

Quiz
http://buku-teks.com/sc5088

Answer the following questions:

1. Study the following situation.

> The diet of Eskimos normally contains meat rich in fat such as whale meat. The consumption of whale meat can warm the body.

(a) Suggest **one** hypothesis to investigate the above situation.

(b) Based on the situation given, plan and describe an experiment to compare the calorific values of fat and another type of food such as carbohydrate and protein using a calorimeter.

Your description should contain the following aspects:
(i) aim of experiment
(ii) identification of variables
(iii) list of materials and apparatus
(iv) procedure or method
(v) tabulation of data

2. Table 1 shows the average daily energy requirements of females aged between 5 and 40 years old.

Table 1

Age (years)	Average daily energy requirement (kJ)
5	5 500
10	8 000
15	9 500
20	11 000
25	13 500
30	12 000
35	10 500
40	10 000

(a) Using the data in Table 1, draw a graph of average daily energy requirement against age.

(b) Based on the graph in question 2(a), state the average daily energy requirement for a 12-year-old individual.

(c) What is the relationship between average daily energy requirement and age between 30 and 40 years?

Enrichment Practice

3. Nowadays, Malaysia exports local durians to other countries like China and Singapore. The exported durians are processed using vacuum packaging to prevent the release of its strong smell into the air. Besides durian, other fruits such as jackfruit and *cempedak* also release strong smells into the air.

(a) Using the items shown in Figure 1, explain the vacuum packaging method for *cempedak*.

(b) Explain how the bicycle pump functions as a vacuum pump.

(c) How is the effectiveness of the vacuum packaging evaluated?

Cempedak

Bicycle pump

Plastic bag

Sealing machine for plastic bag

Figure 1