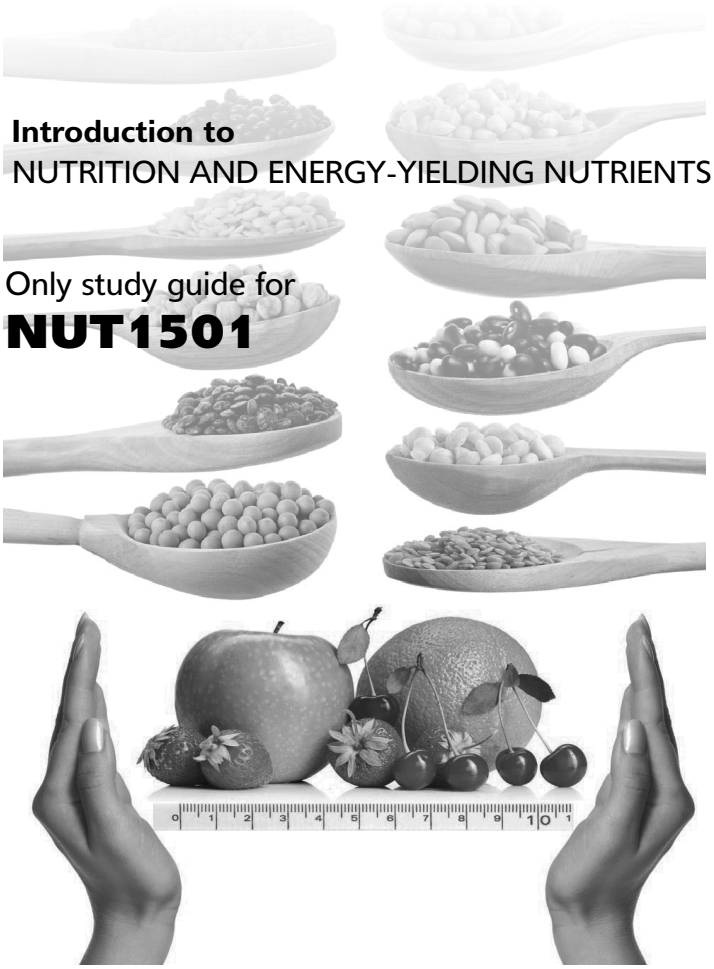
Department of Life and Consumer Sciences



Introduction to
NUTRITION AND ENERGY-YIELDING NUTRIENTS

Only study guide for
NUT1501

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FOREWORD

Welcome to the Introduction to Nutrition and Energy-yielding Nutrients (NUT1501). We hope that you will enjoy and benefit from the knowledge you will gain during this module. Just to whet your appetite, complete the following activity.

FIND 10 DIFFERENCES

FIND 10 DIFFERENCES

The studies of nutrition are intended to aid you in understanding the basic functions and processes of nutrients in the body, and to enable you to develop the necessary skills to make well-informed choices concerning the selection of quality food for yourself, family members and the community at large. The study will provide you with a framework of knowledge within which you will be able to work in the field of health, education, community nutrition, agriculture and the hospitality industry. The course will enable you to make wise decisions when planning well balanced meals. These are important skills to help you in preventing malnutrition.

The prescribed textbook for this module is as follows:

Understanding Normal and Clinical Nutrition
Rolfes, SR, Pinna, K & Whitney, E
9th edition – International student edition, 2012
USA: Wadsworth Cengage Learning
ISBN-13: 978-1-111-42714-6
ISBN-10: 1-111-42714-3

The purpose and outcomes of the module

This module aims to deepen your knowledge of fundamental concepts in the field of nutrition. It will also enable you to classify and describe the characteristics and functions of different energy-yielding nutrients. With this knowledge,

and by making use of the various food groupings and energy-yielding nutrients, you will be able to make sound nutritional recommendations. More specifically, this module was designed to provide you with the ability to

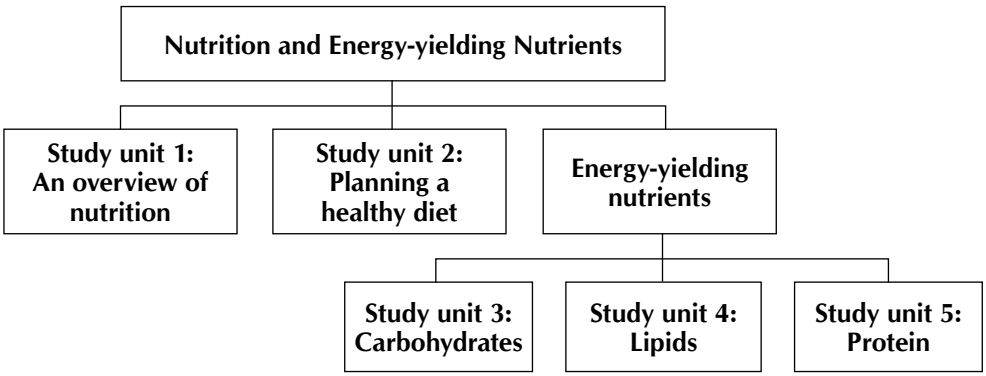
- explain and discuss the fundamental concepts and matters relating to the field of nutrition and apply given principles to evaluate nutrition-related information
- classify foods into main groups and make nutritional recommendations
- classify and describe the characteristics and functions of energy-yielding nutrients, and make dietary recommendations relating to these nutrients
- identify the health-related conditions associated with excesses and deficiencies of energy-yielding nutrients, and make suggestions for the nutritional treatment and prevention of these conditions

The purpose of this study guide

The purpose of this study guide is to help you to understand and apply the theory in the prescribed textbook better. It includes information that you will not find in the prescribed textbook, but which is important to know for the assignments and the examination. Therefore use both the prescribed textbook and study guide as study aids.

How is this study guide structured?

This study guide on nutrition and energy-yielding nutrients is divided into five study units, as illustrated in the diagram below.



As you can see, you will be learning more about the basics of nutrition, planning a healthy diet and the three energy-yielding nutrients, carbohydrates, lipids and proteins.

What are some of the main features of this study guide?

The main features of this study guide are the following:

- **Learning outcomes**

The learning outcomes of each study unit are like a check list of the things you should be able to do once you have studied the unit. In other words, they tell you what the purpose of your learning in that particular unit is. When you

are reviewing the module, you should again look at the outcomes and check whether you have achieved them all. This will give you an overview of the knowledge and skills you should have acquired in the module.

- **Activities**

It is important that you work through all the activities. The activities provide you with the opportunity to assess your progress. The purpose of the activities is to guide you through the outcomes of each study unit, to prepare you for the assessments and to explain important concepts. It is best to complete the activities while you are working through the study guide and the study material referred to in the text. In some of the assignments you might be asked to submit certain activities for formal assessment purposes.

Completing the activities will help you to acquire the knowledge and skills that are taught in each unit, and thus to achieve the learning outcomes. The activities are generally followed by reflection/feedback on possible answers you might have given to the questions in the activity. Please note, though, that you should try to complete the activities on your own first, before checking the feedback.

- **Appendices**

The information contained in the appendices at the back of the study guide provides additional information applicable to the activities, as well as theory not covered in the textbook.

How do I go about studying this module?

To study this module, you will need the following:

- Tutorial letter 101
- This study guide, which contains study units 1 to 5
- Your prescribed textbook
- Other tutorial letters that you may receive during the course of the year

You should start by reading Tutorial Letter 101, if you have not already done so. It will tell you more about the general arrangements relating to the module, and give you details about your assignments and assignment questions.

As a general guideline, you should spend **a total of at least 120 hours** on studying this module. I suggest that you draw up a study schedule to ensure that you will be able to achieve the module outcomes in the time you have available this semester:

- Skim through this study guide and look at some of the typical activities you will have to complete as you work through it. (There are some activities in the text of each unit and usually also a larger set of revision activities at the end of each unit.) Estimate how long it might take you to work through the guide.
- Also look at the assignments you have to complete and think about the time you will need to spend on them.
- Further, take into account that you will need to revise your study guide and the relevant passages in the textbook to prepare for the examination.

The more thoroughly you have worked through the guide, the easier your revision process will be.

- Take into consideration the fact that by the time you go in to write the final examination paper you should be confident of performing the various activities given to you in the study guides and the assignments.

Once you have considered the above, you can draw up your study schedule. When you are allocating time to work through each of the study units in this guide, remember that the study units are not all of the same length, so you should assign more time for the longer units, to ensure that your schedule is achievable.

Once you have drawn up your schedule and skimmed through the study guide, you can start working through the study material in earnest. Please attempt to complete all the activities, since only by doing so will you find the material really meaningful. You may want to work through the study material first before starting your assignment, or you may prefer to work on the study material and the assignments simultaneously.

In Tutorial Letter 101 there is more information on how you should approach your assignments and answer the assignment questions. Information on the examination is also provided in Tutorial Letter 101.

A final word

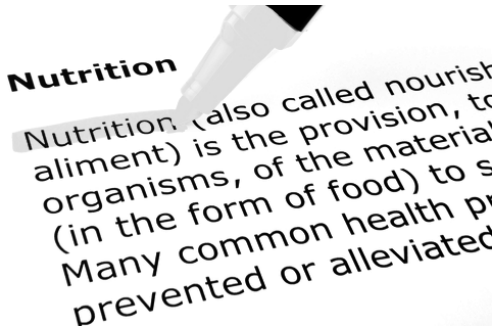
I hope that you will enjoy this module and that it will inspire you to pursue further studies in nutrition. I would like to wish you good luck with your studies. If you have any problems, you can contact me, your lecturer, Dr Tertia van Eeden at:

Tel: +27(0)11 471 2171

E-mail: veedets@unisa.ac.za

STUDY UNIT 1

An overview of nutrition



TIME ALLOCATION

You should spend at least 16 hours on this study unit.

Learning outcomes

On completion of this study unit, you should be able to

- explain and illustrate basic terms and concepts in the field of nutrition with appropriate examples
- evaluate and explain why food choices are made
- suggest appropriate food choices that support good health
- distinguish between different nutrient groups and explain the relationship between them
- identify and describe the various functions of the different food groups
- convert non-metric units to SI/metric units
- recall the energy values (in kilojoules) of the energy-yielding nutrients and alcohol
- calculate and interpret the energy provided by each of the energy-yielding nutrients
- calculate and interpret the percentage of kilojoules each of the energy-yielding nutrients contribute to the total energy
- calculate and interpret the energy density of the meal
- discuss each of the five components of nutrition assessments
- describe dietary nutritional risk factors and their relationship to disease
- apply appropriate principles to evaluate the quality of nutrition-related information

1.1 INTRODUCTION

Start this study unit by trying to find your way through the maze in figure 1.1.

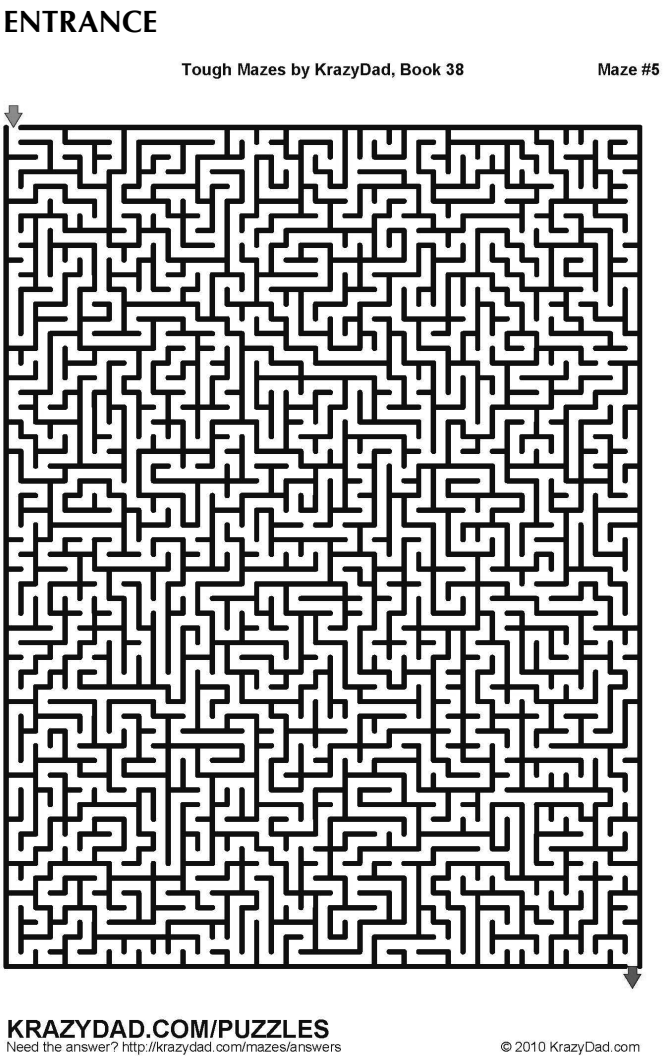


FIGURE 1.1
Maze puzzle

You will agree that this is not an easy maze to complete. It requires a bit of effort and more than one attempt. When you enter the maze, you are immediately confronted with choices, whether to turn left, right or go straight ahead. These choices influence whether you get to the exit of the maze or end up at a dead end. Food choices can be compared to a maze. All of us make food choices every day that will either benefit or harm our body and health.

The food we choose consists of components called nutrients and these nutrients have an important role in our body. For this reason we need food to

- **build** new body cells during growth/ replacement of new body cells
- **repair** damaged cells
- **maintain** the existing cells
- **supply** the energy which fuels all the body's activities
- **regulate** vital processes in the body
- **protect** us against diseases

Wrong food choices influence the above functions in the body, affecting our health and increasing our risk for disease. Therefore, you should not approach nutrition blindly as you would a maze, where you are not able to see where you are going. It is necessary to make conscious and informed decisions about the food you eat every day, so that it would be beneficial to your health.

READ

Read through the introduction of chapter 1, pages 2 and 3 of your prescribed textbook.

This study unit introduces you to the concept of food choices, the various nutrients found in food and the body, the healthy amount of nutrients that should be consumed, the basic analysis of a person's nutrient status, how unhealthy food choices affect our health, and how to evaluate nutrition-related information.

1.2 FOOD CHOICES

Decisions, decisions … We are all confronted with them on a daily basis and in various forms such as what to wear, which road to take to work to avoid traffic, which movie to watch, and the list goes on. One of the important choices we are confronted with every day is what food to eat. This decision should be made consciously and sensibly.

Activity 1.1

It is 15h00 and you are on your way home. You are hungry and decide to stop at Café Funda for lunch. Look at the menu below and place your order at the counter.

1.1.1 What did you order?
1.1.2 Give reasons for your specific choice from the menu.

Reflection on activity 1.1

Which factors influenced your choice/s of food from the Café Funda menu? Consider the following when answering the questions in activity 1.1:

- Is it because you like this type of food?
- Is it because you are craving it?
- Is it what you usually order?
- Did your ethnic background influence your choice?

- Did others influence your choice?
- Did the price influence you choice?
- Did certain previous positive or negative associations with food from the menu affect your choice?
- Did certain emotions influence your choice?
- Did certain beliefs influence your choice?
- Did you choose this food for the benefit of your health?

STUDY

Study the section on "Food choices" on pages 3 to 5 of your prescribed textbook.

People have various reasons and motivations for choosing certain foods. Our choices are influenced by personal preference, habit, need for social interaction, ethnic background or tradition, religious reasons, availability, convenience and cost, emotions, positive and negative associations with a particular food, or health reasons. These reasons should be taken into account when

- making your own food choices
- establishing another individual's reasons for choosing certain foods
- teaching/educating others about food choices and healthy eating
- planning a healthy diet for yourself or others

1.3 THE NUTRIENTS

Have you ever really considered the time-worn saying: "You are what you eat"? This statement is true, because our body consists of the different nutrients found in food. For example:

- **Proteins** are the building blocks of genes, cell membranes, muscles, blood, skin and organs.
- **Fat** is found underneath the skin and between the organs and forms part of the structure of cell membranes.
- **Carbohydrates** are the energy source of the body and excess energy is stored in the liver and muscles as glycogen, or as fat, for later use.
- **Vitamins** are essential components in the body. For instance, vitamin A is an essential component in the retina of the eye, and in the skin and linings of the mouth, stomach, intestines and lungs.
- **Minerals** are also essential components of the body. For instance, iron is a component of red blood cells.
- **Water** is the main component of all body fluids such as tears, urine, saliva and blood.

To understand the properties and functions of these nutrients, it is necessary to understand some of the basic concepts of chemistry. The basic unit of all existing matter (anything that takes up space and has mass) is an atom. If two or more similar atoms combine, for example two oxygen (O) atoms, an element is formed ($O + O = O_2$). On the other hand if two or more different atoms combine it is called a compound, for example one oxygen (O) plus two hydrogen (H) molecules combine to form water (H_2O). Both an element and a compound are molecules. We can therefore define a molecule as two or more similar or different atoms combined (O_2 and H_2O are molecules) (Rolfes, Pinna & Whitney 2012, p. B-1).

These atoms and molecules form the building blocks of the body and of food. Atoms combine through various different chemical reactions to form the nutrient molecules known as carbohydrates, protein, fat, vitamins, minerals and water. These nutrient molecules combine in different patterns so that their various functions in the body can be fulfilled. Figure 1.2 provides a summary of the nutrients found in both food and the body.

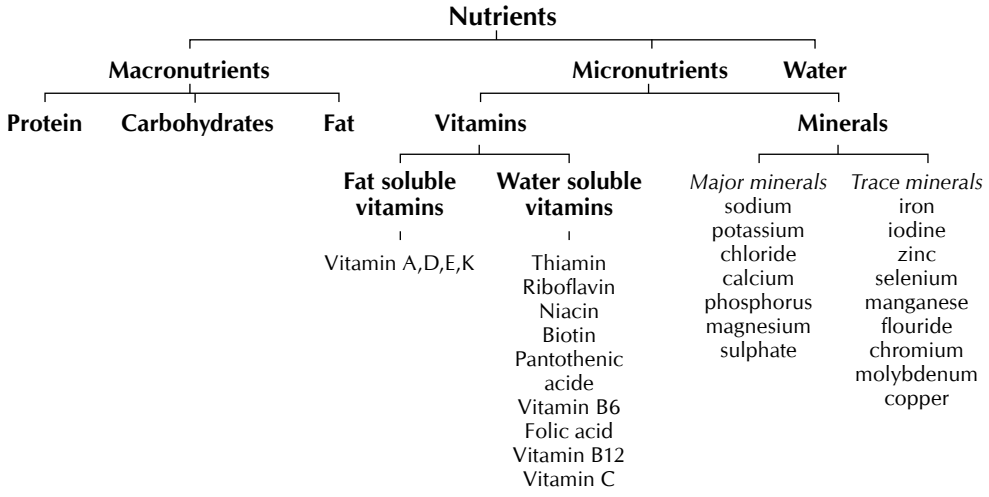


FIGURE 1.2

Summary of the six classes of nutrients

STUDY

Study the section "The nutrients" on pages 5 to 7 of your prescribed textbook. Study up to the section "Essential nutrients".

Activity 1.2

Consider the meal you ordered from Café Funda in activity 1.1.

1.2.1 Identify the main classes of nutrients found in this meal.
1.2.2 According to your prescribed textbook, which other compounds does food contain, apart from nutrients?
1.2.3 Measure your own body weight on a scale. Ensure that the scale is calibrated. This means that the scale measurement should start exactly at zero.
1.2.4 Calculate in kilograms (kg) the amount of a) water and b) fat contained in your body based on your body weight and the average percentages of water and fat in the human body given in the prescribed textbook.
1.2.5 Explain in your own words what macro- and micronutrients are.
1.2.6 Which of the nutrients in the meal you ordered from Café Funda are macronutrients?
1.2.7 Which of the nutrients in the meal you ordered from Café Funda are micronutrients?
1.2.8 Which nutrients in your ordered meal are organic and which are inorganic? Explain the difference between these two concepts. Note: Organic in this sense does not refer to organic farming.
1.2.9 Identify the essential nutrients in the meal you ordered.

Reflection on activity 1.2

1.2.1 If, for example, you chose the roasted chicken breast (with skin) and creamy mashed potato and a cream soda, the nutrients in this meal would be:

- *roasted chicken breast with skin: protein, fat, vitamins, minerals, water*
- *creamy mashed potato: carbohydrate, a small amount of protein, water, vitamins, minerals; fat could also be one of the nutrients found in mash – it depends on whether milk and/or margarine were/was added to the mashed potatoes*
- *cream soda: sugar, water and minerals*

In your assignments and examination, you should be able to identify the nutrient composition of different foods, based on the six classes of nutrients. For the purpose of this module, it won't be expected of you to know the vitamin and mineral content of different food items. This will be covered comprehensively in NUT1602.

At this stage don't be concerned if you don't know the exact nutrient composition of certain foods. In the following study units you will learn more about the nutrient composition of different food groups.

1.2.2 The answer is on page 6 of the prescribed textbook.

1.2.3 When you measure your own weight, ensure that the scale is on a flat, hard surface, that you are barefoot (without shoes and socks) with minimal clothing (if possible), and that you are standing still without support, feet slightly apart and your weight distributed on both feet.

1.2.4 The body consist of more or less 60% water, and 23–31% fat in young women and 13–21% fat in young men. The remainder of the body is made up of protein, carbohydrate, vitamins, minerals and other compounds. It is important to note that these are just average values for the body water and fat percentages of a healthy man or woman.

We don't all look the same and consequently our body composition differs as well. Athletes exercise more and have a lower fat percentage and a higher muscle mass. On the other hand, someone who is obese would have a very high fat percentage (far more than 21% in males and 31% in females). An elderly individual would have a lower muscle mass and a higher fat percentage than someone younger, because with age the muscle mass and strength diminish. Furthermore, in an individual who suffers from fluid retention, the percentage body water would be higher than 60%. In summary, body composition is influenced by the following factors:

- *Age*
- *Gender*
- *Level of physical activity*
- *Disease*
- *Growth in children, adolescents and pregnant women*
- *Nutrition status, for example being overnourished (eg overweight or obese) or undernourished (eg anorexia, protein energy malnutrition)*

Examples of calculations:

- *If you weigh 68 kg, your body consists of ± 41 kg water*
- *68 kg × 60/100 = 40.8 kg, which is rounded of to 41 kg*
- *If you are a young male of 68 kg, your body consists of ± 9–14 kg fat*
- *68 kg × 13/100 = 8.84 kg ≈ 9 kg; 68 kg × 21/100 = 14.28 kg ≈ 14 kg*
- *If you are a young female of 68 kg your body contains ± 16–21kg fat*
- *68 kg × 23/100 = 15.64 kg ≈ 16 kg; 68 kg × 31/100 = 21.08 kg ≈ 21 kg*
- *The wavy equal sign ≈ means "approximately equal to".*
- *Try to calculate the water and fat composition of an 80 kg male and see of you find the same answer: Water = 48 kg; Fat = 10.4–16.8 kg ≈ 10–17 kg*

1.2.5 The answer is on page 7 of the prescribed textbook.

1.2.6 The macronutrients in, for example, roasted chicken breast with skin, creamy mashed potato and a cream soda are carbohydrates, protein and fat.

1.2.7 The micronutrients in, for example, roasted chicken breast with skin, creamy mashed potato and a cream soda are vitamins and minerals.

1.2.8 The answer is on page 7 of the prescribed textbook.

1.2.9 To be able to answer this question, you need to look closely at the definition of an essential nutrient, which is described as a substance provided by food, because adequate amounts to maintain health are not produced by the body.

An insufficient intake of certain proteins (essential amino acids), essential lipids (omega 3 and 6), water, vitamins and minerals will affect your health. Note that carbohydrate is not an essential nutrient, because it can be produced through different metabolic pathways in the body (see study unit 3) (Dominiczak 2007, p. 116).

1.3.1 The energy-yielding nutrients

A car requires fuel as energy source and without it the car won't drive. The body works in a similar way. Our body needs energy from food so that it can perform all its tasks. Food is therefore our fuel which enables our bodies to function optimally.

In the following section you will learn more about units of measurement (eg energy is measured in kilojoules), the conversion of one unit to another (eg converting kilocalories to kilojoules), and energy-yielding nutrients, the amount of energy each provides, their role in our body and the basic functions of vitamins, minerals and water in the body.

(a) Think metric

For the purpose of this module, you have to understand the concept of units of measurement and how to convert one unit to another. Measurements are an important part of the subject of nutrition. A measurement gives meaning to different values used. The number 100 on its own is just the value of 100 – nothing else. But adding a measurement after the number makes the value more descriptive, for example, when adding "kilogram" to the number, it becomes a weight measurement of 100 kg, when adding "centimetre", it becomes a length/height of 100 cm, when adding "kilojoules", it becomes an energy value of 100 kJ. The unit of measurement therefore indicates the value of the measurement.

In South Africa we use **SI units** of measurement, "SI" being the abbreviation of the French phrase 'Le Système International d'Unités' (the International System of Units). These units are also known as the metric units. You will note that the textbook (which is of American origin) uses the non-metric system, with includes measurement units such as calories (cal), kilocalories (kcal), and pounds (lb). The SI units for these are kilojoules (kJ) and kilogram (kg). If you come across any non-metric units, you will have to convert them to metric measurements.

STUDY

Study the section "Energy measured in kCalories" and the "How to: think metric" block on pages 7 and 8 of the prescribed textbook and ensure that you are able to convert non-metric units to metric units.

Note

Answers given in **non-metric units** in assignments or the examination are **incorrect** and **no marks** will be awarded for such answers.

Always **remember** the **units of measurement** when you give numerical answers or when doing calculations in assignments and the examination. The answer has no meaning if the unit of measurement is not given. For example: If you are asked how many kilojoules 1 gram (g) of carbohydrate provides and you write 17, the 17 on its own has no meaning and you will not be awarded a mark. The correct answer is 17 kilojoules (kJ). The correct unit of measurement must **always** be written at the end of any numerical answer.

Ensure that you use the **correct abbreviation** for the unit of measurement, for example, the abbreviation for kilograms is kg and not g.

Remember to always use the **same units of measurement** throughout calculations.

The section "Weights and measurements" (page X) at the back of your prescribed textbook provides a summary of the important units of measurements you will come across in this module.

Throughout the module it will be expected of you to do conversions, as well as calculations. The last page of the textbook (page Y), "Aids to calculation", will give you some additional practise in these calculations.

Table 1.1 gives a summary of the conversion factors required to convert non-metric units to metric units.

Example 1: A healthy and active 23-year-old female consumes 2403 kcal/day.

- kcal is a non-metric unit and should be converted to kJ.
- What we know: 1 kcal = 4.2 kJ
- Therefore: 2403 kcal $\times$ 4.2 = 10 092.6 kJ $\approx$ 10 093 kJ

Example 2: A 260-year-old male weighs 200 lb and is 5 ft 6 inches in height.

- Pounds (lb), feet (ft) and inches (in) are non-metric units and should be converted to kilograms (kg) and centimetres (cm).
- What we know about the weight: 1 kg = 2.2 lb
- Therefore: 200 lb $\times$ 0.454 = 90.8 kg $\approx$ 91 kg
- What we know about the height: 5 ft 6 in is equal to 66 inches. To convert 66 inches to centimetres multiply 66 with 2.54 = 167.64 cm.
- Sometimes you need to convert cm to meter (m)
- What we know: 1 m = 100 cm
- Therefore 168 cm $\times$ 0.01 = 1.68 m

TABLE 1.1:
Factors for conversion from non-metric to metric units
(Adapted from Anderson et al 2002, pp. 1857–1864)

Measure-ments	Non-metric units (units to convert from)	Metric units (units to convert to)	Multiply the non-metric unit by the factor (value) below to obtain the metric unit
Energy	kilocalories (kcal)	kilojoules (kJ)	4.184 ≈ 4.2
Length	feet (ft)	centimetres (cm)	30.48
	feet (ft)	metres (m)	0.3084
	inches (in)	centimetres (cm)	2.54
	inches (in)	meters (m)	0.0254
	meters (m)	centimetres (cm)	100
	millimetres (mm)	centimetres (cm)	0.1
	millimetres (mm)	meters (m)	0.001
	centimetres (cm)	metres (m)	0.01
Mass	grams (g)	kilograms (kg)	0.001
	kilograms (kg)	grams (g)	1000
	ounces (oz)	grams (g)	28.35 ≈ 28 or 30
	pounds (lb)	kilograms (kg)	0.4536 ≈ 0.454
	pounds (lb)	grams (g)	454
Volumes	litres (L)	millilitres (mL)	1000
	millilitres (mL)	litres (L)	0.001
	pint (pt)	litres (L)	0.4732 ≈ 0.47
	gallons (gal)	litres (L)	3.7854≈ 3.8
	fluid ounce (oz)	millilitres (mL)	29.6 ≈ 30
	fluid ounce (oz)	litres (L)	0.0296

Let us now apply what we have learnt about the conversion of non-metric units into the correct SI units.

Activity 1.3

When you choose the chicken wrap and double chocolate mousse from the Café Funda menu, the nutrition composition is as follows:

Item	Energy	Protein	Fat	Carbo-hydrates
Chicken wrap	382 kcal	1.35 oz	0.3 oz	1.33 oz
Double chocolate mousse	244 kcal	0.14 oz	0.5 oz	0.88 oz

Convert the non-metric units of each item into the correct SI units.

Reflection on activity 1.3

The chicken wrap provides 382 kcal of energy.

- *kcal is a non-metric unit and should be converted to kJ.*
- *What we know: 1 kcal = 4.2 kJ*
- *Therefore: 382 kcal × 4.2 = 1604.4 kJ ≈* ***1604 kJ***

There are 1.35 oz of protein in the chicken wrap.

- *Ounce (oz) is a non-metric unit and should be converted to grams (g).*
- *What we know: 1 oz = 28.35 g (This amount can be rounded off to 28 g or 30 g – all of these values are correct. We used 28.35 g, because it is the most accurate value for the conversion of oz to gram.)*
- *Therefore 1.35 oz × 28.35 = 38.2725 g ≈* ***38.3 g***

There is 0.3 oz fat in the chicken wrap.

- *Ounce (oz) is a non-metric unit and should be converted to grams (g).*
- *What we know: 1 oz = 28.35 g*
- *Therefore 0.3 oz × 28.35 = 8.505 g ≈* ***8.5 g***

There are 1.33 oz of carbohydrates in the chicken wrap.

- *Ounce (oz) is a non-metric unit and should be converted to grams (g).*
- *What we know: 1 oz = 28.35 g*
- *Therefore 1.33 oz × 28.35 = 37.7055 g ≈* ***37.7 g***

Compare your answer for the conversion of the non-metric units of the double chocolate mousse to metric units with the answer below:

Item	*Energy*	*Protein*	*Fat*	*Carbo-hydrates*
Double chocolate mousse	*1025 kJ*	*4 g*	*14.2 g*	*24.9 g*

(b) Energy from foods and in the body

The main fuel for the body is provided by the three macronutrients, protein, carbohydrates and fat. When you consume any of these three nutrients, energy is released. That is why they are collectively referred to as energy-yielding nutrients. Digestive enzymes[a] in the gut break these energy-yielding nutrients down into smaller particles through the process of digestion. These small particles are then taken up by the body (absorbed) and transported in the blood and lymphatic system[b] to all the body cells where they provide energy and perform specific functions. Alcohol also provides energy and water, but is not considered a nutrient, because it provides no other nutrients.

The energy that is released is in the form of glucose. Carbohydrates are the main source of energy and provide immediate glucose energy to the body. Protein and fat, on the other hand, have to go through more metabolic processes before they can be converted into glucose energy. Each one of these nutrients provides a certain amount of energy:

- 1 gram of **carbohydrate** yields 17 kilojoules (**17 kJ**)
- 1 gram of **protein** yields 17 kilojoules (**17 kJ**)
- 1 gram of **fat** yields 38 kilojoules (**38 kJ**)
- 1 gram of **alcohol** yields 29 kilojoules (**29 kJ**)

You should know the above values by heart, because many calculations will be based on them. By knowing these values, you will be able to calculate the amount of energy present in the food consumed by people. Table 1.2 (page 9) in the textbook gives the energy values in kilocalories. To convert these values to kilojoules, multiply the kcal value by 4.2 (see table 1.1) (eg 4 kcal/g of protein $\times$ 4.2 $\approx$ 17 kJ/g).

It is important to remember that apart from providing energy, the energy-yielding nutrients also have other essential functions in the body, which will be discussed in detail in the following study units.

STUDY

Study the sections "Energy from foods", "How to calculate the energy available from food", "Energy in the body", "Other roles of energy-yielding nutrients" and figure 1.2 on pages 9 to 10 in your prescribed textbook.

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a **Enzymes**: An enzyme is a protein that assists in chemical reactions without being changed in the process. For instance, enzymes assist in breaking down proteins, carbohydrates and fats into smaller particles, so that these can be absorbed from the gut. Examples of enzymes are amylase (which breaks down carbohydrates), lipase (which breaks down fat) and protease (which breaks down protein) (Rolfes, Pinna & Whitney 2012 & Anderson et al 2002 p. 609)

b **Lymphatic system**: The lymphatic system consists of lymphatic vessels, ducts and organs (eg the lymph nodes, spleen and tonsils) that help to protect and maintain the fluid environment of the body by producing, filtering and carrying lymphatic fluid and various blood cells (white blood cells) to the blood. Lymph (lymphatic fluid) also transports fat from the gut to the blood. The lymph is similar to blood, but does not contain any red blood cells or platelets (Rolfes, Pinna & Whitney 2012 & Anderson at al 2002, pp. 1030–10)

Activity 1.4

Appendix A shows the nutrient composition tables for Café Funda. Examine the nutrient composition of the different foods from Café Funda. Use these tables for this activity.

1.4.1 Write down the carbohydrate, protein and fat content of the food you ordered from the menu in activity 1.1.
1.4.2 Calculate the energy (kilojoules) provided by each of the energy-yielding nutrients in your meal.
1.4.3 Calculate the percentage of energy each of the energy nutrients contribute to the total energy of the meal.
1.4.4 High-energy-density foods provide more kilojoules than low-energy-density foods. Calculate the energy density based on the weight (in grams) of the meal.
1.4.5 Compare your answer in 1.4.4 to the energy density of a meal that consists of a chicken breast, a mealie and a salad and comment on your choice of meal from the menu.

Reflection on activity 1.4

1.4.1 If, for example, you chose the roasted chicken breast (with skin) and creamy mashed potato, the nutrient composition would be as follows (find the nutrient composition of the meal in Appendix A):

Nutrients	***Creamy mashed potato***	***Roasted chicken breast (with skin)***	***Total***
Total energy (kJ)	*816 kJ*	*1002 kJ*	*1818 kJ*
Protein (g)	*4.5 g*	*38.9 g*	*43.4 g*
Fat (g)	*7.2 g*	*8.9 g*	*16.1 g*
Carbohydrates (g)	*27.7 g*	*0.8 g*	*28.5 g*

1.4.2 The energy provided by each of the energy-yielding nutrients is calculated as follows:

Nutrients	***Total***	***Calculation***	***Total energy provided***
Protein (g)	*43.4 g*	*43.4 g protein × 17 kJ/g*	*737.8 kJ*
Fat (g)	*16.1 g*	*16.1 g fat × 38 kJ/g*	*611.8 kJ*
Carbohydrates (CHO) (g)	*28.5 g*	*28.5 g CHO × 17 kJ/g*	*484.5 kJ*
		Total energy provided by meals	*1834.1 kJ*

1.4.3 The percentage of energy each of the energy-yielding nutrients contributes to the total energy of the meal is calculated as follows:

- *The total energy according to the calculations is 1834.1 kJ.*

- *The total energy according to Café Funda's nutrient evaluation is 1818 kJ.*
- *The calculated value will always be slightly higher or lower than the actual total energy. The reason for this is that the amounts of energy (in kJ) per one gram of carbohydrate, protein, and fat are approximate (rounded-off) values*
- *You can choose the calculated energy or the actual total energy content for the calculation of the percentage of kilojoules each nutrient contributes to the total energy of the meal.*

Nutrients	***Total energy provided***	***Calculations***	***Percentage of total energy***
Protein (g)	*737.8 kJ*	*737.8kJ ÷ 1834.1 kJ = 0.4023 × 100 = 40.23%*	*40%*
Fat (g)	*611.8 kJ*	*611.8kJ ÷ 1834.1 kJ = 0.3336 × 100 = 33.36%*	*33%*
Carbohydrates (CHO) (g)	*484.5 kJ*	*484.5kJ ÷ 1834.1 kJ = 0.2642 × 100 = 26.42%*	*26%*
		Total percentage	*99%*

If the percentages add up to 99% and not 100%, you should not be concerned, because the final percentages calculated for each energy nutrient were rounded off. If your percentages more or less add up to two values higher or lower than 100% (ie 98–102%) they won't be marked as incorrect.

1.4.4 The energy density based on the weight of the meal (in grams) is calculated as follows:

	Creamy mashed potato	***Roasted chicken breast (with skin)***	***Total***
Size of serving (g)	*159 g*	*199 g*	*358 g*
Total energy (kJ)	*816 kJ*	*1002 kJ*	*1818 kJ*

Energy density of the meal = 1818 kJ ÷ 358 g = 5.087 kJ/g ≈ 5 kJ/g

1.4.5 Comparison between the energy density of the roasted chicken breast and creamy mashed potato and a meal that consists of the grilled chicken breast, a mealie and a salad:

- *Energy density if the grilled chicken breast, mealie and salad = 1426 kJ ÷ 569 g = 2.506 kJ/g ≈ 2.5 kJ/g*

A meal that consists of a grilled chicken breast, a mealie and a salad provides half the amount of energy (2.5 kJ/g) that the roast chicken and creamy mashed potatoes (5 kJ/g) meal do. It has a lower energy density and is a better and healthier choice than the roast chicken and creamy mashed potato, because

of the lower kilojoule content. It will therefore be beneficial for an overweight person who wishes to lose weight.

Activity 1.5

Mrs van der Merwe is 42 years old. She is overweight and wants to lose weight.

According to her diet history, she drinks about two glasses of wine at night and eats the Café Funda's chicken, cheese and pine burger and regular chips topped with cheese sauce twice a week. Answer the following questions on this case study.

1.5.1 Explain the term "energy density" to Mrs van der Merwe.
1.5.2 Which of the three energy-yielding nutrients is the most energy dense? Give a reason for your answer.
1.5.3 Considering that Mrs van der Merwe wants to lose weight, which type of food (the collective term) would you advise her to consume?
1.5.4 Give Mrs van der Merwe four examples of food with a high energy density and four examples of food with a low energy density. Give your answer in table format.
1.5.5 Explain to Mrs van der Merwe how alcohol can contribute to weight gain.
1.5.6 Write down the carbohydrate, protein and fat content of the meal she regularly orders from the Café Funda menu (use the Café Funda nutrient composition tables in Appendix A).
1.5.7 Calculate the amount of energy provided by each of the energy-yielding nutrients in Mrs van der Merwe's Café Funda meal.
1.5.8 Calculate the percentage of energy each of the energy-yielding nutrients in the Café Funda meal contributes to the total energy.
1.5.9 Calculate the energy density based on the weight (in grams) of the meal.
1.5.10 What advice would you give Mrs van der Merwe with regard to her choice of food from Café Funda?
1.5.11 Which alternative meal on the menu would you advise her to have instead? Substantiate your answer by calculating the energy density of the meal.
1.5.12 Explain to Mrs van der Merwe how the energy-yielding nutrients fuel the activities in the body.
1.5.13 Explain to Mrs van der Merwe what happens in the body if excess energy nutrients are consumed.
1.5.14 Based on the answer in question 1.5.13, what should Mrs van der Merwe do to lose weight?

Reflection on activity 1.5

1.5.1 When answering this type of question, it is important that you don't merely write down the definition of energy density, because Mrs van der Merwe has no knowledge of nutrition and won't necessarily understand the terminology. You need to explain energy density to her in easy, understandable, or lay terms, for example: "Energy density is the total amount of energy provided by a certain amount of food."

1.5.2 Fat is more energy dense than carbohydrates and protein because 1 gram of fat provides 38 kJ in comparison with the 17 kJ/g that carbohydrates and protein supply.

1.5.3 Low-energy-density foods will help Mrs van der Merwe to lose weight.

1.5.4 Examples of high- and low-energy-density foods:

High-energy-density foods	***Low-energy-density foods***
Chips *Crisps eg Simba chips* *Chocolate* *All fried food* *All oil* *All margarine and butter* *Full-cream milk* *Cream* *Cremora* *All nuts** *Peanut butter** *Avocado** *Muesli** *Wholewheat bread/seed loaf** *Dried fruit** *100% fruit juice** *All foods high in sugar or refined carbohydrates such as sugar, sweets, cookies, cake, pita bread, wraps, white bread, buns, doughnuts etc.* *Alcohol* *Most fast foods and take-aways*	*Fruits* *Vegetables* *Lean meat, chicken (without skin), fish* *Eggs (not fried)* *High-fibre carbohydrates eg all-bran flakes, and oats* *Legumes* *Low-fat/fat-free milk products*

* Certain healthy foods which are high in vitamins, minerals and good fats (essential fatty acids) have a high energy density, eg nuts, muesli, wholewheat bread, seed loaves, peanut butter, dried fruit, avocado and 100% fruit juice. Although these foods have a high energy density, they are nutrient dense as well. An excess or uncontrolled consumption of these foods will contribute to weight gain or make it difficult to lose weight, so their intake should be controlled in a weight-loss diet. This is one of the reasons why portion sizes are important role in weight-loss diets. This will be discussed in more detail in Study Unit 2.

Remember: Foods with a low energy density have some or all of following properties:

- *They are low in fat.*
- *They are high in fibre.*
- *They are rich in vitamins and minerals.*
- *They may have a high water content, for example tomato, lettuce and cucumber.*

1.5.5 Alcohol is not an essential nutrient and provides 29 kJ/g energy. It is more energy dense than protein and carbohydrates and therefore increases the total energy intake per day, which contributes to weight gain. Alcohol also interferes with certain essential functions and may have detrimental long-term effects on the body (eg an increased risk of cancer and raised blood pressure).

1.5.6 The nutrient composition of Mrs van der Merwe's meal from Café Funda (find the nutrient composition of the meal in Appendix A):

Nutrients	***Chicken, cheese & pine burger***	***Regular chips***	***Cheese sauce***	***Total***
Total energy (kJ)	*2019 kJ*	*1351 kJ*	*676 kJ*	*4046 kJ*
Protein (g)	*38.8 g*	*5.1 g*	*0.2 g*	*44.1 g*
Fat (g)	*11.8 g*	*13.4 g*	*12.5 g*	*37.7 g*
Carbohydrates (g)	*54.3 g*	*45.3 g*	*13.2 g*	*112.8 g*

1.5.7 The amount of energy provided by each of the energy-yielding nutrients in Mrs van der Merwe's Café Funda meal:

Nutrients	***Total***	***Calculation***	***Total energy provided***
Protein (g)	*44.1 g*	*44.1 g protein × 17 kJ/g*	*749.7 kJ*
Fat (g)	*37.7 g*	*37. 7 g fat × 38 kJ/g*	*1432.6 kJ*
Carbohydrates (CHO) (g)	*112.8 g*	*112.8 g CHO × 17 kJ/g*	*1917.6 kJ*
Total energy provided by meals			*4099.9 kJ*

1.5.8 The percentage of energy each of the energy nutrients in the Café Funda meal contributes to the total energy:

Nutrients	Total energy provided	Calculations	Percentage of total energy
Protein (g)	749.7	749.7 kJ ÷ 4046 kJ = 0.1852 × 100 = 18.529%	18%
Fat (g)	1432.6	1432.6 kJ ÷ 4046 kJ = 0.3540 × 100 = 35.407%	35%
Carbohydrates (CHO) (g)	1917.6	1917.6 kJ ÷ 4046 kJ = 0.4739 × 100 = 47.394%	47%
		Total percentage	100%

1.5.9 The energy density based on the weight (in grams) of the meal:

Nutrients	Chicken, cheese & pine burger	Regular chips	Cheese sauce	Total
Size of serving (g)	294 g	122 g	70 g	486 g
Total energy (kJ)	2019 kJ	1351 kJ	676 kJ	4046 kJ

Energy density of the meal = 4118 kJ ÷ 486 g = 8.473 kJ/g ≈ 8.5 kJ/g

1.5.10 Mrs van der Merwe has chosen a meal Café Funda with a high energy density, which is likely to contribute to her weight gain. She should rather choose a meal that has a lower energy density.

1.5.11 We already know that the grilled chicken breast meal, mealie and salad has a lower energy density (refer back to activity 1.4) than the roasted chicken breast and creamy mashed potato, and one can safely assume that it will be lower than the chicken, cheese and pine burger and regular chips with cheese sauce . Another meal option that has a lower energy density than the chicken cheese and pine burger and regular chips with cheese burgers is the grilled chicken salad. The energy density of the chicken salad = 575 kJ ÷ 304 g = 1.8914 kJ/g ≈ 1.89 kJ/g.

Yet another meal option is the roasted chicken breast without the skin and a salad. The energy density of this meal = (825 kJ + 225 kJ) ÷ (190 g + 257 g) = (1050 kJ) ÷ (447 g) = 2.34 kJ/g ≈ 2.3 kJ/g. Both these meals have a lower energy density than the vitality meal.

1.5.12 The answer to this question can be found on page 9 of the prescribed textbook, under the heading "Energy in the body".

1.5.13 The answer to this question can be found on page 10 of the prescribed textbook, under the heading "Energy in the body".

1.5.14 She should consume less energy and use more energy though physical activity. This will lead to less food being stored as fat and, consequently, weight loss.

1.3.2 Vitamins, minerals and water

Good nutrition does not only involve protein, carbohydrates and fats, but also vitamins, minerals and water. Figure 1.2 illustrates that vitamins and minerals are micronutrients which are required for various physiological functions in the body. Each specific vitamin and mineral performs important functions in the body. Water is another essential nutrient which facilitates, maintains and regulates body functions.

STUDY

Vitamins, minerals and water will be discussed extensively in the module NUT1602. For the purpose of this module, you only need to study the section "Vitamins, minerals and water" and the summary on pages 10 and 11 in your prescribed textbook.

Activity 1.6

Mrs van der Merwe's diet history shows that she rarely eats fruit and vegetables and she doesn't drink enough water during the day.

1.6.1 Explain to Mrs van der Merwe why it is important to consume fruit and vegetables every day.
1.6.2 Explain in layman's terms to Mrs van der Merwe what a vitamin is, and give two examples of vitamins.
1.6.3 Explain in layman's terms to Mrs van der Merwe what a mineral is, and give two examples of minerals.
1.6.4 What advice would you give her about the cooking of vegetables, to optimise her micronutrient intake?
1.6.5 Explain to Mrs van der Merwe the importance of drinking enough water.

Reflection on activity 1.6

1.6.1 Fruits and vegetables contain vitamins and minerals which have essential functions in the body. Both fruit and vegetables have a low energy density and will assist with weight loss.

1.6.2 A vitamin, according to the textbook, is an "organic, essential nutrient required in small amounts by the body for health". However, if you've given this as the answer to the question, it would have been marked as incorrect. It is expected of you to explain in simple terms what a vitamin is, for example: "A vitamin is a component found in small amounts in food and it has important functions in the body. Our body needs vitamins for it to function normally and most vitamins are not made in sufficient amounts by the body to support these functions. Therefore

we need to get them from food sources. If one's intake of vitamins is low, or if the body it is not able to use vitamins properly, this can lead to deficiencies."

1.6.2 The answer is on page 11 of the prescribed textbook.

1.6.3 The answer can be found under the section "Water" on page 11 of the prescribed textbook.

1.4 DIETARY REFERENCE INTAKES

Dietary reference intakes (DRIs) are a **dietary standard**. A dietary standard is a set of nutrient recommendations which is used to determine the "goal for good nutrition" for both groups of people and individuals. These standards ensure that people consume the correct amounts of energy, carbohydrates, fats, proteins, vitamins and minerals to meet their daily needs and to improve and maintain their health (NICUS 2003, p. 7).

The DRIs were researched and developed by the Food and Nutrition Board of the Institute of Medicine of the United States. In South Africa we don't have our own set of dietary standards so we use the American DRIs. The main goal for developing the DRIs was to "*maximise health and improve quality of life*". It is an indicator of the optimal nutrient intake which assists in **reducing** the **risk of chronic diseases** and **prevents deficiencies** and **adverse effects associated** with the **over- or under-consumption of nutrients** (NICUS 2003, pp. 4, 7).

The DRIs are used to evaluate and plan a healthy diet for **healthy people only** and **not for people with specific disease conditions**. Certain disease conditions increase or decrease one's macro- or micronutrient needs. Remember that the DRIs are only **reference values** for nutrient intake. This means that if a child or adult's intake is less than the recommended intake, it cannot be assumed that such a low intake is indicative of an individual who is inadequately nourished.

The term DRIs collectively refers to **four reference** values, namely

- Estimated Average Requirement **(EAR)**
- Recommended Dietary Allowance **(RDA)**
- Adequate Intake **(AI)**
- Tolerable Upper Intake Level **(UL)**

The RDA is used to assess and plan the adequacy of nutrient intakes from the diet and food supplements. It is aimed at individuals, and is not used to assess the nutrient intakes of groups. The EAR is used for groups. On the other hand, the AI and UL can be used as dietary standards for both individuals and groups. It is necessary to be able to distinguish which of the four values can be used to assess and plan the diets of groups and/or individuals.

When evaluating and planning a diet, the macro- and micronutrient intake or contribution from both the diet and food supplements must be taken into account. One often forgets to take nutrition supplements into account when evaluating a diet. This can lead to an excess intake of nutrients, or a sufficient intake of nutrients in those suspected of having a possible deficient intake from the diet alone.

STUDY

Study the sections "Dietary reference intakes" (pp. 17–19), "Using nutrient recommendations" (p. 20) and "Comparing nutrient recommendations" (p. 20) in your prescribed textbook.

Before we continue, do the following activity.

Activity 1.7

1.7.1 Write down the RDA, AI and UL of the following nutrients, for your age and gender: thiamine, niacin, riboflavin, folic acid, vitamins C and A, sodium, calcium, magnesium and iron.

1.7.2 You are using a multivitamin supplement every day. The micronutrient composition is indicated on the bottle and reference is made to the RDA values. You can't remember exactly what RDA means and you remember there are three other reference values as well. Study and then define each of the four reference values of the DRIs.

1.7.3. Now that you have the knowledge of the four reference values of the DRIs, compare the micronutrient composition of the multivitamin given below with the DRIs for your age and gender.

SUPPLEMENT INGREDIENTS	
NUTRIENT	**AMOUNT IN CAPSULE PER DAY**
Magnesium	100 mg
Vitamin A (beta carotene)	500 RE
Thiamine	24 mg
Riboflavin	24 mg
Vitamin B 6	24 mg
Vitamin B12	24 µg
Folic acid	400 µg
Niacin	36 mg
Calcium	24 mg
Biotin	30 µg
Vitamin C	300 mg
Vitamin D	5 µg
Vitamin E	15 mg
Zinc	15 mg
Iron	5 mg
Selenium	10 µg

1.7.4 Comment on the comparison between the supplement and the DRIs for your age and gender and indicate whether additional supplementation is required or not.

1.7.5 Summarise what you have learned about micronutrient recommendations in this section and activity. Use the format of the mind map (figure 1.3) below as a framework for your summary. The core concepts which you have to elaborate on are given in the mind map. The concept of dietary standards is used as an example of the type of questions you could ask yourself when summarising the topic.

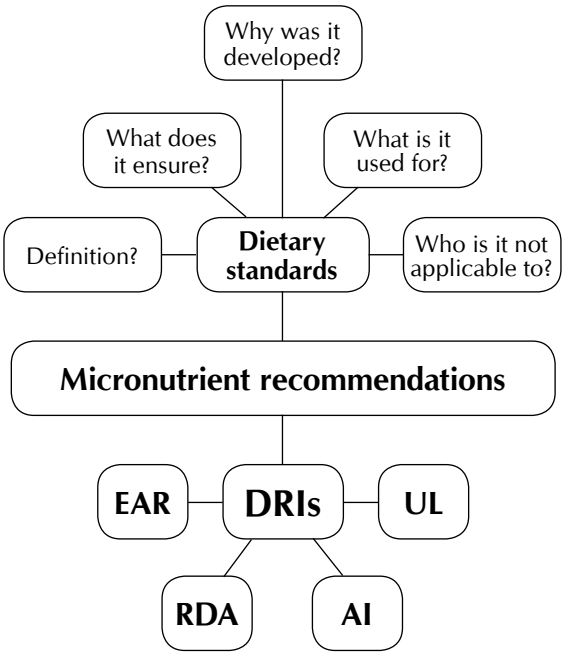

FIGURE 1.3
Framework for summary

Reflection on activity 1.7

1.7.1 The RDA and AI values are given on the inside cover (page A–C) of your textbook. The table below gives the DRIs of a 32 year-old, pregnant woman. Compare it to the DRIs on the inside cover of your textbook and see if you find the values to be similar. Remember the units of measurement when answering a question like this.

DRI	Thiamin (mg/d)	Riboflavin (mg/d)	Niacin (mg/d)	Folic acid (µg/d)**	Vitamin C (mg/d)	Vitamin A (µg/d)*	Sodium (mg/d)	Calcium (mg/d)	Magne-sium (mg/d)	Iron (mg/d)
RDA	1.4	1.4	18	600	85	770	–	1000	360	27
AI	–	–	–	–	–	–	1500	–	–	–
UL	–	–	35	1000	2000	3000	2300	2500	350	45

* *Vitamin A is teratogenic to the foetus, which means that is can cause congenital defects and should rather not be included in a supplement for pregnant women, even though the RDA and UL have been established.*

** *Folic acid is essential for the prevention of neural-tube defects in the foetus.*

It is not expected of you to know the DRI values by heart. If a question concerning the DRI values is given in the assignment, you should refer to the DRI values on the inside cover of your textbook. In the examination, the values needed to answer the question will be given.

1.7.2 The answer to this question can be found on pages 18–19 of your prescribed textbook.

1.7.3 Example of a 32-year-old non-pregnant female:

SUPPLEMENT INGREDIENTS		***DRIs***		***COMMENTS***
NUTRIENT	***AMOUNT IN CAPSULE PER DAY***	***RDA or AI for a 32-year-old female (according to front cover of prescribed textbook)***	***UL for a 32 year old female (according to front cover of prescribed textbook)***	
Magnesium	*100 mg*	*320 mg*	*350 mg*	*The supplement provides less magnesium than the DRI. The diet should provide sufficient amounts of magnesium.*
Vitamin A (beta carotene)	*500 RE*	*700 RE*	*3000 RE*	*The supplement provides less vitamin A than the RDA/AI. The diet should provide sufficient amounts of vitamin A.*
Thiamine	*24 mg*	*1.1 mg*	*No UL established*	*The supplement provides more thiamine than required.*
Riboflavin	*24 mg*	*1.1 mg*	*No UL established*	*The supplement provides more riboflavin than required.*
Vitamin B6	*24 mg*	*1.3 mg*	*100 mg*	*The supplement provides more vitamin B6 than required, but less than the UL.*
Vitamin B12	*24 µg*	*2.4 µg*	*No UL established*	*The supplement provides more vitamin B12 than required, but less than the UL.*
Folic acid	*400 µg*	*400 µg*	*1000 µg*	*The supplement provides the required amount of folic acid.*
Niacin	*35 mg*	*14 mg*	*35 mg*	*The supplement provides more niacin than the RDA/AI, and the amount is equal to the UL.*
Calcium	*24 mg*	*1000 mg*	*2000 mg*	*The supplement provides less calcium than the RDA/AI. The diet should provide sufficient amounts of calcium – if not, a specific calcium supplement should be taken.*
Biotin	*30 µg*	*30 µg*	*No UL established*	*The supplement provides the required amount of biotin.*
Vitamin C	*300 mg*	*75 mg*	*2000 mg*	*The supplement provides more vitamin C than the RDA/AI, but less than the UL.*
Vitamin D	*5 µg*	*15 µg*	*100 µg*	*The supplement provides less vitamin D than the RDA/AI. Sunshine is the best source of vitamin D and will provide the remainder of the DRI.*

Vitamin E	*15 mg*	*15 mg*	*1000 mg*	*The supplement provides the required amount of vitamin E.*
Zinc	*15 mg*	*8 mg*	*40 mg*	*The supplement provides more zinc than the RDA/AI, but less than the UL.*
Iron	*5 mg*	*18 mg*	*45 mg*	*The supplement provides less iron than the RDA/AI. The diet should provide sufficient amounts of iron.*
Selenium	*10 µg*	*55 µg*	*400 µg*	*The supplement provides less selenium than the RDA/AI. The diet should provide sufficient amounts of selenium.*

It is important to always take into consideration the nutrients supplied by the diet, together with those provided by the multivitamin supplement, and to ascertain whether you or the person you are evaluating are/is not consuming too much or too little of a certain nutrient.

The multivitamin above provides more thiamine, riboflavin, vitamin B6, vitamin B12, niacin, vitamin C and zinc than the required amount (according to the RDA or AI), but these amounts are still within a healthy range (less than the UL).

The multivitamin does not provide sufficient amounts of magnesium, vitamin A, calcium, iron and selenium and one should ensure that the diet provides enough of these micronutrients.

Folic acid, biotin and Vitamin E are provided in sufficient amounts by the multivitamin. However, it is important to remember that the individual consuming these micronutrients will be obtaining these nutrients from his/her diet as well.

Vitamin and mineral supplementation is a controversial topic and whether to supplement the diet with micronutrients or not will be discussed in module NUT1602.

1.7.5 Do your own reflection and summary of this section.

1.5 ESTABLISHING ENERGY REQUIREMENTS

We now know that food supplies us with energy in the form of three energy-yielding nutrients, namely carbohydrates, protein and fat. But how much energy, protein, carbohydrates and fat should we eat in a day? How do we know when our intake of these nutrients is too much or too little? The **estimated energy requirement (EER)** and **acceptable macronutrient distribution range (AMDR)** were developed as guidelines of how much total energy, protein, carbohydrates and fat we should consume in a day. The **EER** is the estimated amount of energy that a person needs in a day to maintain his/her energy balance and good health. No two individuals are the same, and therefore our energy requirements are not the same. Consequently individual differences in weight, height, gender, age, physical activity, body composition and size should be taken into account when determining how much energy a healthy person should consume in a day. It is not possible to calculate the exact energy

requirement. That is why an **estimate** was determined. The use of the EER will be discussed in more detail in future modules.

The **AMDR** is a reference range to give us an idea of which percentage of the energy each of the three energy-yielding nutrients should contribute to the total energy intake in a healthy diet. It is used as a guideline to establish whether the energy distribution in a diet is adequate (falls within the reference range) or not (falls outside the reference range as well). If a person consumes above the mentioned ranges in table 1.2 below the risk of overweight or obesity and the development of chronic diseases such as hyperlipidaemia (increased cholesterol), hypertension, insulin resistance or diabetes mellitus increases. If a person's intake is below this reference range, the risk of undernutrition and certain nutrient deficiencies increases (NICUS 2003, p. 13; Lucas & Feucht 2008, p. 224).

STUDY

Study the section "Establishing energy recommendation" on page 19 of the prescribed textbook. To help you understand the AMDR and its use better, work through the following example.

Example: In activity 1.4 you had to calculate the percentage of energy (kilojoules) each of the energy-yielding nutrients contributed to the total energy intake in a certain meal. The answer is given in the table below.

Nutrients	***Percentage of total energy***	***AMDR for adults***
Protein (g)	*40%*	*10–35%*
Fat (g)	*33%*	*20–35%*
Carbohydrates (CHO) (g)	*26%*	*45–65%*

The next step is to establish whether the energy provided by each of the macronutrients in the meal is acceptable or not, in other words, within the normal AMDR or not. Start by comparing the calculated percentages in the table above with the AMDR values in table 1.2 below.

The AMDR of protein for an adult is 10–35% of the total energy (TE) intake. In the Café Funda meal of the roasted chicken breast (with skin) and creamy mashed potato, 40% of the TE is provided by protein, thus the amount (percentage) of protein in the meal is too high.

The AMDR of fat for an adult is 20–35% of the total energy intake. The meal provides 33% fat. The amount of fat in the meal is acceptable according to the AMDR.

The AMDR of carbohydrates is 45–65% and 26% of the meal consists of carbohydrates. The intake of carbohydrates in this meal is insufficient, according to the AMDR.

You need to take into consideration that this was only the macronutrient distribution in one meal and not across the total energy intake over a whole day. In practice, the AMDR is used to evaluate the macronutrient distribution over a whole day and not just in a single meal. The above example was chosen just to illustrate the concept of evaluating whether the energy provided by each of the macronutrients in food is acceptable or not, in other words, within the normal AMDR or not. In the activities in this module, the assignment and the examination, the evaluation of total energy intake would be **per day and not per meal**.

The AMDR, like the DRIs, is for healthy individuals and not for those who are ill, for example overweight people, and those who suffer from obesity, heart disease, diabetes, hypertension and cancer. It can therefore not be used to evaluate the intake of Mrs van der Merwe in activity 1.5, because she is overweight. Also note that the AMDR is different for different age groups, as pointed out in table 1.2 below.

TABLE 1.2:
Comparison between the AMDR for children and adults
(NICUS 2003, p. 13; Lucas & Feucht 2008, p. 224)

Energy-yielding nutrient	Children 1–3 years	Children 4–18 years	Adult > 18 years
Carbohydrates	45–65%	45–65%	45–65%
Protein	5–20%	10–30%	10–35%
Fat	30–40%	25–35%	20–35%

Note

You have to know the AMDR values in table 1.2 above by heart.

Activity 1.8

Mrs van der Merwe's husband is 45 years old and he has a healthy body weight and no health problems. Mrs van der Merwe is concerned that her husband is not eating healthily and that this might affect his weight in future. He consumes 157 g of carbohydrates, 107 g of fat and 238 g of protein per day.

1.8.1 Calculate the energy provided by each of the energy-yielding nutrients.
1.8.2 Calculate Mr van der Merwe's total energy intake for the day.
1.8.3 Calculate the percentage of energy each of the energy-yielding nutrients contributes to the total energy intake per day.
1.8.4 Compare Mr van der Merwe's intake with the AMDR and explain whether his macronutrient distribution is acceptable or not.

Reflection on activity 1.8

1.8.1 The energy provided by each of the energy-yielding nutrients is calculated as follows:

Nutrients	Total	Calculation	Total energy provided
Protein (g)	238 g	238 g protein × 17 kJ/g	4046 kJ
Fat (g)	107 g	107 g fat × 38 kJ/g	4066 kJ
Carbohydrates (CHO) (g)	157 g	157 g CHO × 17 kJ/g	2669 kJ

1.8.2 The total energy intake for the day = 4046 kJ + 4066 kJ + 2669 kJ = 10 781 kJ

1.8.3 The percentage of kilojoules each of the energy-yielding nutrients contributes to the total energy intake per day is calculated as follows:

Nutrients	Total energy provided	Calculations	Percentage of total energy
Protein (g)	4046 kJ	4046 kJ ÷ 10 781 kJ = 0.3753 × 100 = 37.53%	37.5%
Fat (g)	4066 kJ	4066 kJ ÷ 10781 kJ = 0.3771 × 100 = 37.71%	38%
Carbohydrates (CHO) (g)	2669 kJ	2669 kJ ÷ 10 781 kJ = 0.2476 x 100 = 24.76%	25%
		Total percentage	100.5%

1.8.4 Mr van der Merwe's protein and fat intake is higher than the AMDR and his carbohydrate intake is lower than the AMDR. His macronutrient distribution is therefore inadequate and dietary adjustment is necessary.

1.6 NUTRITIONAL ASSESSMENT

The nutritional assessment of individuals or populations is an essential part of the nutritional care process. It gives information and clues about health which assist in determining whether nutritional needs are being met and if there is any nutrient imbalance such as an excess or deficiency of nutrients, or a risk that these may develop (Rolfes, Pinna & Whiney 2012, p. 540). From this information, a diet can be planned and adjustments can be made. The nutritional assessment consists of 5 components. These components are summarised in figure 1.4.

STUDY

Study the section "Nutrition assessment" on pages 21 to 25 of the prescribed textbook.

PATIENT INFORMATION

- Name and surname
- Age
- Gender
- Contact details
- Home language

HISTORICAL INFORMATION

- Medical/health history
- Family history
- Economic circumstances
- Social history
- Drug/medication and supplement history
- Dietary history

ANTHROPOMETRIC MEASUREMENTS

- Height/length
- Weight
- Waist cicumference
- Hip circumference
- Mid-upperarm circumference
- Head circumference
- Skin-fold measurements

PHYSICAL EXAMINATION

- General impression
- Hair
- Eyes
- Tongue
- Fingernails
- Skin
- Abdomen

LABORATORY TESTS

- Blood: albumin; haemoglobin (Hb); reb blood cell count (RBC); white cell count (WCC); c-reactive protein (CRP); sodium; potassium, calcium; magnesium; phosphate; urea; creatinine; vitamin B12; folic acid; iron; ferritin; total iron-binding capacity; cholesterol; blood glucose
- Urine: glucose; ketones; protein; blood; pH

FIGURE 1.4

The five components of nutrition assessment and examples of each
(adapted from Rolfes, Pinna & Whitney 2012, pp. 21–22)

Activity 1.9

You are asked to do a nutritional assessment of one of your family members. Before you can start doing nutritional assessments, you need to understand the theory. Answer the following questions.

1.9.1 If you conduct a thorough nutritional assessment, what will you be able to detect?
1.9.2 Define malnutrition, undernutrition and overnutrition.
1.9.3 One of the components of the nutritional assessment is historical information. Explain why you would obtain the following information:

(a) medical/health history
(b) family history
(c) economic circumstances
(d) social factors
(e) drug/medication history
(f) dietary history

1.9.4 List three (3) methods you can use to obtain a dietary history.
1.9.5 Which two aspects/factors do you think are important to consider when taking a dietary history?
1.9.6 What would you do with the information obtained from the dietary history?
1.9.7 Explain why it is necessary to do (a) anthropometric measurements, (b) physical examinations and (c) laboratory tests.
1.9.8 Illustrate with the aid of a figure the stages of development of a nutrient deficiency by referring to what happens in the body and which assessment method would reveal the change. Use iron as an example.
1.9.9 Which methods are used in nutritional surveys?
1.9.10 What kind of information can these surveys provide?
1.9.11 Discuss how eating trends have changed over the past few decades.

Reflection on activity 1.9

1.9.1 A proper nutritional assessment can detect malnutrition.

1.9.2 The answer is on page 21 of the prescribed textbook. Malnutrition is often considered to be only a deficient intake of energy and nutrients. This is not true. Malnutrition encompasses both under- and overnutrition, as illustrated in figure 1.5. This means that someone who is obese is malnourished, just as someone who is anorexic is malnourished.

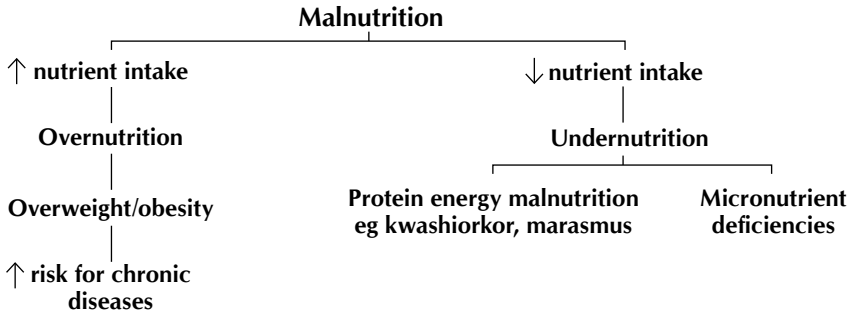

FIGURE 1.5

Summary of malnutrition

1.9.3 The answer is on page 21 of the prescribed textbook.

1.9.4 One could (i) record the food the person has eaten over a period of 24 hours – this is known as a 24 hour recall; (ii) record the food the person has eaten over a period of 3 days or a week – this is referred to as a food diary/ record; (iii) record the food the person typically eats and how much of each he/she eats – this is known as a food frequency questionnaire.

1.9.5 a) The days recorded should be typical of the person's diet; and b) the portion sizes must be recorded accurately (see page 20 of the prescribed textbook).

1.9.6 The answer is on page 22 of the prescribed textbook.

1.9.7 The answer is on pages 22 to 23 of the prescribed textbook.

1.9.8 Copy figure 1.8 on page 23 from the textbook and add the information about iron on page 23 to the figure as an example. It is important that you understand primary, secondary and subclinical deficiency.

1.9.9 The answer is on pages 23 and 24 of the prescribed textbook.

1.9.10 The answer is on pages 23 and 24 of the prescribed textbook.

1.9.11 The answer is on pages 24 and 25 of the prescribed textbook. The national trends in the textbook are those in America, but they are applicable to South Africa as well.

1.7 DIET AND HEALTH

A healthy diet is important for the maintenance of long-term health. Figure 1.5 in the previous section illustrates that an increased intake of nutrients leads to weight gain, which is a risk factor for the development of chronic diseases of lifestyle. These chronic diseases include conditions such as heart disease, high blood pressure (hypertension), diabetes mellitus, asthma, bronchitis, emphysema and chronic obstructive pulmonary disease. On the other hand, a too low food intake leads to undernutrition and consequently macro- and micronutrient deficiencies develop (figure 1.5). It can therefore be concluded that poor nutrient intake, whether in excess or deficit, affects one's health adversely. This is why correct food choices are essential for health, as are

making lifestyle changes such as doing physical activity, stopping smoking and decreasing one's use of alcohol.

The disease profile in South Africa differs from that of the United States. Table 1.3 illustrates that the leading cause of death in our country is tuberculosis (TB) with heart disease being the fourth leading cause of death. In our country we have a double burden of disease, because we have diseases which are associated with both undernutrition (a deficient intake of nutrients) and overnutrition (an excessive intake of nutrients). In both of these there is an energy imbalance (Maunder, Majti & Hlatswayo-Molea 2001, pp. S7 and S9). The focus of this section is not on undernutrition, but on overnutrition and the associated risk of developing chronic diseases.

TABLE 1.3:

The 10 leading natural causes of death in South Africa in 2008
(Statistics South Africa 2010)

Disease condition	Percentage of total deaths
1. Tuberculosis (TB)	12.6%
2. Influenza and pneumonia	7.7%
3. Intestinal infectious disease e.g. diarrhoea/gastroenteritis (viral, bacterial and parasitic intestinal infections)	6.6%
4. Heart disease e.g. heart failure, arrhythmias, heart attacks, valve disorders, endocarditis (infection of the heart valves)	4.4%
5. Cerebrovascular disease eg stroke*	4.1%
6. Diabetes mellitus	3.3%
7. Acquired immunodeficiency syndrome (AIDS)	2.5%
8. Certain disorders involving immune mechanisms eg immunodeficiency following from antibody defects, other immunodeficiencies, sarcoidosis	2.5%
9. Chronic lower respiratory tract infections eg asthma, bronchitis, emphysema, chronic obstructive pulmonary disease (COPD)	2.4%
10. Hypertension	2.4%

* A stroke is not a chronic disease, but rather a consequence of the chronic condition of hypertension.

Activity 1.10

You were introduced to Mrs van der Merwe in previous activities. Activity 1.5 states that she is 42 years old and overweight and consumes alcohol. According to her historical information, she doesn't exercise, smokes a pack of cigarettes a day and suffers from hypertension as well. Her father died of a heart attack.

1.10.1 List Mrs van der Merwe's risk factors for the development of chronic disease.
1.10.2 Discuss the relationship of the risk factors to the diseases.
1.10.3 Describe lifestyle changes Mrs van der Merwe can make to improve her chances of enjoying good health.

Reflection on activity 1.10

1.10.1 The answer to the question is on pages 25 and 26 of the prescribed textbook. Note that Mrs van der Merwe's father passed away because of a heart attack, which increases her risk for the development of heart disease.

1.10.2 The answer to this question is on page 25 of the prescribed textbook. Mrs van der Merwe already suffers from hypertension, which is a chronic disease.

1.10.3 The answer to this question is on pages 25 and 26 of the prescribed textbook.

1.8 INFORMATION AND MISINFORMATION ABOUT NUTRITION

How do we distinguish valid information on nutrition and health from misinformation? It is important to recognise false information and half-truths concerning nutrition, but this is not easy, and even individuals who are educated about the topic of nutrition are often misguided into believing false information. The aim of this section is to make you aware that not all information written and published about nutrition is true, and that such information is often misleading. False information on nutrition can have a detrimental effect on health. One should be attentive when reading information on nutrition, and try to establish if it is true or false. Highlight 1 (pp. 27-32) in the prescribed textbook points out what you should look out for when reading such information.

STUDY

Study the section "Highlight 1: Nutrition information and misinformation – on the net and the news" (pp. 27–32) in the prescribed textbook.

Activity 1.11

Read and evaluate the article 'Nutrient density and dairy' (http://www.rediscoverdairy.co.za → go to Health professionals → Nutrients in dairy) in

Appendix B using the information in 'Highlight 1: Nutrition information and misinformation' (pp. 27–32) and the theory discussed in this study unit. Discuss your opinion regarding the validity of the content of the article (ie is this nutritional misinformation or not).

Reflection on activity 1.11

Tips:

- *Look at the section "How to determine whether a website is reliable" on page 28 of the prescribed textbook.*
- *Visit the website: www.diary.co.za or www.rediscoverdairy.co.za/*
- *Does the content in this article correlate with what you have learnt about nutrient density in this study unit?*
- *What conclusion can you make if you look at the references?*
- *Who wrote the article? And who is responsible for the website?*
- *Does this article promote a specific brand of milk product?*

1.9 SUMMARY

We all have to make food choices on a daily basis – either to the advantage or disadvantage of our long-term health. The food we choose is divided into six classes of nutrients namely, protein, carbohydrates, fat, vitamins, minerals and water.

Standards have been developed to ensure that people consume the right amount of nutrients to meet their daily needs and maintain their health. These dietary standards are called the DRIs and comprise of four reference values: EAR, RDA, AI and UL. The DRIs are used to evaluate the diets of healthy people and to plan a healthy diet for healthy people. They are not meant for people with specific disease conditions.

Proteins, carbohydrates and fats are collectively known as the macronutrients or energy-yielding nutrients which mean that they supply the fuel for our body to function optimally. A gram of each of these three nutrients supplies a specific amount of energy. From this knowledge, the energy provided by each of the energy-yielding nutrients, the percentage of kilojoules each of the energy-yielding nutrients contributes to the total energy consumed daily, and the energy density can be calculated, interpreted and compared to the EER and AMDR.

Before a diet can be evaluated, it is necessary to conduct a nutritional assessment, so that important information and clues relating to an individual's health or the population's health can be obtained. This will assist in determining whether nutritional needs are being met and if there are any nutrient imbalances. From this information, an appropriate diet can be planned and adjustments can be made to improve health.

It can be concluded that poor nutrient intake, whether in excess or deficit, affects one's health adversely. This is why the correct food choices are so essential for long-term health.

Activity 1.12: Summary

1.12.1 Do the "Chapter review" questions on pages 833 and 834 of the prescribed textbook.

1.12.2 For additional study questions and activities go to www.cengagebrain.com and search for ISBN1111427143.

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STUDY UNIT 2

Planning a healthy diet

TIME ALLOCATION

You should spend at least 15 hours on this study unit.

Learning outcomes

On completion of this study unit, you should be able to

- apply the six diet-planning principles
- compare food based on nutrient density
- make dietary recommendations based on the South-African Food-based Dietary Guidelines (FBDGs) and the two food-plan guides (ie the exchange list and ChooseMyPlate.gov)
- classify food into main groups according to their kilojoule, carbohydrate, protein and fat content, along with the correctly stated portion and serving sizes for each exchange group
- make appropriate suggestions to improve the daily food intake of people from different age groups and circumstances
- evaluate food labels

2.1 INTRODUCTION

In the first study unit, the maze in figure 1.1 is likened to the daily food choices we make. Wrong choices lead to a dead end in the maze, but correct ones will lead to the exit of the maze. It is the same with food choices – incorrect food choices lead us astray, influencing our health adversely and increasing our risk for disease, whereas correct food choices will help path the way to good health. In this study unit, the correct food choices for our health will be discussed.

Were you able to find the solution to the maze (figure 1.1) in study unit 1? If not, figure 2.1 shows you where to go and which turns to take to exit the maze. Similarly, dietary guidelines advise us which specific food choices would benefit our health.

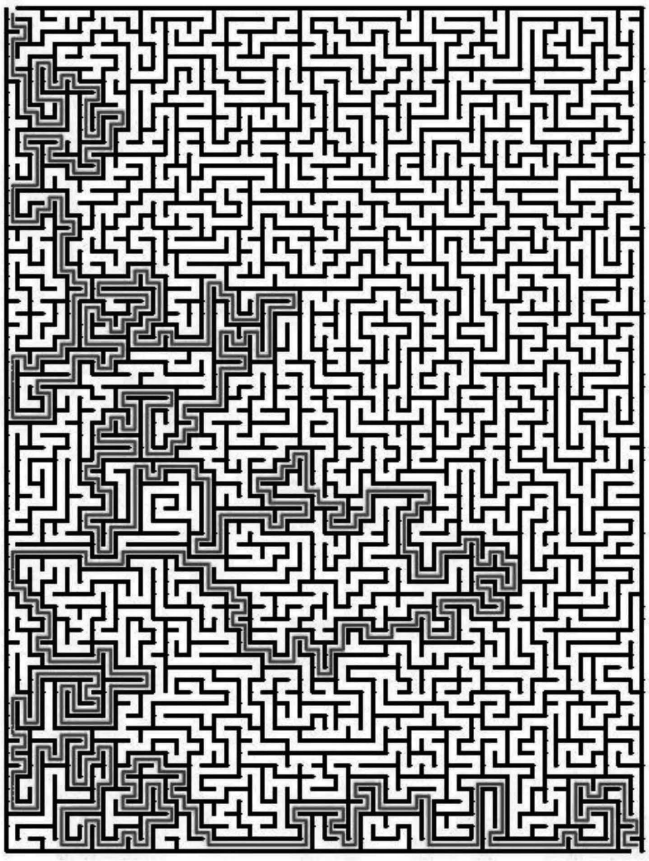

FIGURE 2.1
Solution to the maze puzzle

At this stage you might be asking yourself which types of food you should choose and what you should eat to remain healthy. The road to healthy eating is directed by different dietary recommendations. **Diet planning principles, dietary guidelines, diet planning guides** and **dietary standards (eg the dietary reference intakes or DRIs)** have been developed to use as ideals or standards for healthy eating. These are used as recommendations for healthy eating and assist us in making correct food choices and planning a healthy diet.

READ

Read through the introduction to chapter 2 on pages 34 and 35 in your prescribed book, as well as the first paragraph under the heading "Principles and guidelines".

2.2 DIET-PLANNING PRINCIPLES

In this section, the six diet-planning principles will be explained through different activities. In this section theory will be translated into practice, so that the concepts of the diet-planning principles and the practical application thereof are understood. Let us start with the first activity.

Activity 2.1

Mr Peter Hlongwane is 38 years old and overweight. He is a truck driver who is on the road the whole day, and therefore does not have any time to exercise. His food intake is more or less the same every day and is as follows:

Breakfast he eats at home at about 6 o' clock. It usually consists of a cup of Joko tea with three teaspoons of sugar and full-cream (whole) milk, and 2 cups of soft maize-meal porridge (mieliepap) with three teaspoons of sugar and 1 cup of full-cream milk. Sometimes he eats 4 slices of white bread and margarine instead of the maize-meal porridge.

His wife packs lunch for him, but by 10 o' clock he is usually so hungry that he eats the four slices of white bread spread with a thick layer of Rama hard brick margarine. He habitually buys a 500 ml Coke to drink with it.

Over lunch time he stops for a take-away meal consisting of ¼ hot peri-peri chicken, chips and a roll, with a tin of Coke.

Dinner his wife prepares and this usually consists of 2 cups of stiff maize-meal porridge with gravy and 150 g of fried chicken.

Before bed he drinks another cup of Joko tea with three teaspoons of sugar and full-cream milk

Do you think his daily food choices are healthy? Give reasons for your answer.

Reflection on activity 2.1

If your answer was that Mr Hlongwane's daily food choices are not healthy, you are correct. The reasons why his diet is unhealthy can be explained with the aid of the ***six diet-planning principles****. A healthy diet is described as one that is* ***adequate (1)*** *and* ***balanced (2)****, with* ***a controlled energy intake (3)****. It is* ***nutrient dense (4)*** *and provides a* ***variety (5)*** *of food from different food groups, and unhealthy, empty-kilojoule foods should be used in* ***moderation (6)****.*

STUDY

Study the section "Diet planning principles" on pages 35 to 37 of the prescribed textbook.

Activity 2.2

Based on the six diet-planning principles, re-evaluate Mr Hlongwane's diet as set out in activity 2.1.

2.2.1 Is Mr Hlongwane's diet adequate? Give reasons for your answer.
2.2.2 Is Mr Hlongwane's diet balanced? Give reasons for your answer.
2.2.3 Is his diet energy controlled? Give reasons for your answer.
2.2.4 Is his diet nutrient dense? Give reasons for your answer.
2.2.5 Is his intake of unhealthy, empty-kilojoule foods in moderation? Give reasons for your answer.
2.2.6 Does his diet consist of a variety of food? Give reasons for your answer.

Reflection on activity 2.2

2.2.1 Mr Hlongwane's diet is not adequate. He obtains some of the six classes of nutrients (ie protein, carbohydrates, fat, vitamins, minerals and water, as discussed in study unit 1) from his food choices, but not all the essential nutrients – especially not those provided by vegetables, fruit, whole grains, lean red meat, fish, eggs, legumes, and unsaturated ('good') fats. Apart from lacking vitamins and minerals, his diet is low in fibre as well.

*Mr Hlongwane's energy intake is not sufficient to maintain health. In his case 'not sufficient' means that his total energy intake is excessive. How do we know this? His **portion sizes** are big and his food choices consist of **empty-kilojoule foods** and food with a high **energy density**. The concept of portion sizes will be discussed later in this study unit and we explain empty-kilojoule food and energy density below. Based on the definition of adequacy given by the prescribed textbook, it can be concluded that Mr Hhlongwane's intake of "essential nutrients, fibre and energy is not sufficient to maintain health" (Rolfes, Pinna & Whitney 2012, p. 35).*

2.2.2 No, Mr Hlongwane's diet is not balanced. According to the prescribed textbook, "the art of balancing the diet involves consuming enough – but not too much – of each type of food" (Rolfes, Pinna & Whitney 2012, p. 36). Mr Hlongwane consumes the same types of carbohydrates, protein and fat daily or even twice a day, for example the maize-meal porridge, bread (white bread and a bread roll) and chicken. No nutrients are provided by whole grains, vegetables, fruits or other carbohydrates, proteins and fats.

2.2.3 It is safe to assume that Mr Hlongwane's diet is not energy controlled, because he is physically inactive and overweight (as indicated in his history in activity 2.1). Clearly, the amount of energy he consumes through food is not balanced by the amount of energy his body uses in a day (remember his sedentary work of driving trucks and his lack of physical activity). Some of the foods he is consuming are not low-fat and low-kilojoule (energy) choices and can contribute to his weight gain. These include the fried chicken, take-away peri-peri chicken (one can assume that the peri-peri chicken in high in fat, because usually

healthy cooking methods are not used when preparing take-away foods), chips, full-cream milk and Coke.

2.2.4 *No, his overall diet is not nutrient dense. Nutrient-dense foods are defined as "foods that deliver the most nutrients for the least food energy" (Rolfes, Pinna & Whitney 2012, p. 36). If you consider this definition, would you say the chicken (both the take-away peri-peri chicken and the fried chicken) is nutrient dense? See the example of cheddar cheese versus fat-free milk given in the prescribed textbook (page 36). Although the fried chicken and full-cream milk are nutrient dense, they provide much more energy (kilojoules) than their low-fat or fat-free equivalents, for example boiled chicken and fat-free milk. Both these foods contribute to a high energy intake and are therefore described as having a high* ***energy density****. The energy-density of food is defined as the amount of energy the food provides relative to the amount of the food. It doesn't take nutrients into account – only energy. If a certain food has a* ***low energy density****, it provides few kilojoules per gram of food. Foods with a* ***high energy density*** *provide more kilojoules for the same amount of food (Rolfes, Pinna & Whitney 2012, p. 34). The foods in Mr Hlongwane's diet that are not nutrient dense are the chips, Coke and sugar. These are referred to as* ***empty-kilocalorie or empty-kilojoule foods****.*

2.2.5 *No his food intake is not in moderation. Mr Hlongwane consumes food high in fat (take-away peri-peri chicken, fried chicken, full-cream milk and chips) and sugar (Coke and sugar in his tea and over his porridge in the morning) on a daily basis, and not just on occasions.*

2.2.6 *Mr Hlongwane consumes the same foods day after day and he even selects the same food from the same food group more than once a day, for example the take-away peri-peri chicken and the fried chicken, the soft and stiff maize-meal porridge, and the white bread and bread roll. His food choices don't include all the food groups. He chooses food from the starch, protein, milk and fat groups and rarely alternate food types within the groups. No fruit, vegetables and whole grains are included in his diet. From this it can be concluded that his diet doesn't consist of a variety of foods.*

Diet-planning principles can be used to evaluate a diet, as illustrated in activities 2.1 and 2.2. They can be used to make healthy food and dietary choices and to plan diets. In the following activity you will learn how to make suggestions based on the six diet-planning principles on how to improve daily food choices.

Activity 2.3

Read through the scenario in activity 2.1 once again.

Make suggestions on how Mr Hlongwane can improve his daily food intake. **Tip:** Use the definitions of each of the six diet-planning principles as a guide to answer this question.

Reflection on activity 2.3

*Mr Hlongwane needs to improve the **adequacy** of his diet by adding vegetables, fruit, whole grains, lean red meat, legumes and unsaturated fats to his diet. He should decrease his portion sizes and his intake of empty-kilojoule foods and high-energy-density foods. Some suggestions:*

- *Vegetables can be added to his lunch, for example raw carrots, cucumber and tomato.*
- *Two types of vegetables can be added to his supper, for example green beans, cooked carrots, salad, pumpkin, beetroot, spinach, cabbage or gem squash.*
- *A fruit, for example an apple, pear, peach, banana or orange, can be added as a healthy snack during the morning, say at 10h00, and during the afternoon, say at 15h00.*
- *He should alternate his breakfasts between soft maize-meal porridge and high-fibre options such as oats porridge or All Bran flakes.*
- *He should decrease his intake of sugar or rather use an artificial sweetener such as Canderel, Equal or Sweetex.*
- *He could stop drinking Coke and rather drink water, low-fat milk or sugar-free juice and cold drinks.*
- *It is better to choose wholewheat bread, low-GI bread or Provita, instead of white bread.*

He can balance his diet better by including lean red meat, chicken, eggs, fish, legumes, whole grains, fruit, vegetables, milk and other milk products and unsaturated fats in his diet, without consuming excessive amounts of one food group.

*He should control his energy intake by choosing foods that are **nutrient dense** with a **low energy density**. He could, for example, change from full-cream milk to low-fat milk or fat-free milk. He could also remove the skin of the chicken, boil the chicken or bake it in the oven without fat or oil, or choose a healthier, less energy-dense meal for lunch for example, substitute the chips and roll for a mealie or a salad without salad dressing or rather prepare a healthier lunch at home. Mr Hlongwane's energy intake can also be controlled by increasing his energy usage through physical activity, and by decreasing portion sizes.*

*Mr Hlongwane should consume foods which are high in fat and sugar in **moderation** and only on occasion – not regularly.*

*He should include a **variety** of food in his diet from all the different food groups and should also choose different foods from each food group.*

COMPARE FOOD BASED ON NUTRIENT DENSITY

In the previous section you were introduced to the concept of nutrient density. For the purpose of this module, you should be able to compare the nutrient density of different foods.

STUDY

Study the section on "How to compare foods based on nutrient density" on page 37 of the prescribed textbook.

Activity 2.4

Work through the example under "How to compare foods based on nutrient density" in your textbook (page 37) and do the "Try it" question at the bottom of the block.

2.3 DIETARY GUIDELINES

The dietary guidelines in the prescribed textbook are based on the "Dietary guidelines for Americans". In South Africa we have our own set of guidelines called the **South African Food Based Dietary Guidelines (FBDGs)**. In NUT2601 these guidelines will be dealt with comprehensively and only certain aspects of the FBDGs will be discussed in this module. For the purpose of this module, and to explain certain concepts, we will focus on both the South African and American guidelines. Remember that the road to healthy eating and food choices is directed by these dietary guidelines.

The South African FBDGs are a set of 11 scientifically based dietary guidelines. The FBDGs should be used as basis for education on nutrition, because they are the standard for healthy eating in South Africa. The goals of the guidelines are to promote good health, and prevent the development of undernutrition- and overnutrition-related chronic diseases in healthy South Africans over the age of 5 years. The guidelines exclude children younger than 5 years, the elderly, pregnant and lactating women, and people with specific disease conditions. The guidelines were developed by a working group of local nutritional experts, in accordance with the World Health Organization's (WHO) guidelines

for the development of FBDGs (Vorster, Love & Browne 2001, p. S3). The 11 FBDGs are:

(1) Enjoy a variety of foods
(2) Be active
(3) Drink lots of clean, safe water
(4) Make starchy foods the basis of most meals
(5) Eat plenty of fruits and vegetables every day
(6) Eat dry beans, peas, lentils and soya often
(7) Meat, fish, chicken, milk and eggs can be eaten every day
(8) Eat fats sparingly
(9) Use salt sparingly
(10) Use food and drinks containing sugar sparingly and not between meals
(11) If you drink alcohol, drink sensibly

These guidelines assist South Africans to consume an adequate, balanced, energy-controlled diet which is nutrient dense and includes a variety of food, while using unhealthy, empty-kilojoule food in moderation.

STUDY

Study "Dietary guidelines for Americans" (pp. 38–39) in the prescribed textbook.

2.4 DIET-PLANNING GUIDES

Read the first paragraph under the heading "Diet planning guides" on page 39 of the prescribed textbook. You will notice that reference is made to food-group plans. Food-group plans can also be referred to as food guides or food grouping systems. Examples of food-group guides include:

- the USDA food guide
- food pyramids such as 'MyPyramid: Steps to a healthier you' (outdated)
- the food-plate model, for example the USA Department of Agriculture's ChooseMyPlate (ChooseMyPlate.gov – Appendix C)
- the South African FBDGs
- exchange lists (Appendix D)

In South Africa we don't have a food-group plan like in America and we use the **FBDGs** and the **diabetic exchange list** as guides in planning a diet. The American food-plate model as it appears on ChooseMyPlate.gov is unofficially used in our country as a dietary education tool, but when it comes to planning meals, the food-plate model is used in collaboration with the exchange lists and FBDGs. Figure 2.2 illustrates this plate model. The MyPyramid concept of the food pyramid is flawed and has certain shortcomings and for this reason it was replaced by the food-plate model. The food pyramid should therefore only be used in conjunction with the food-plate model.

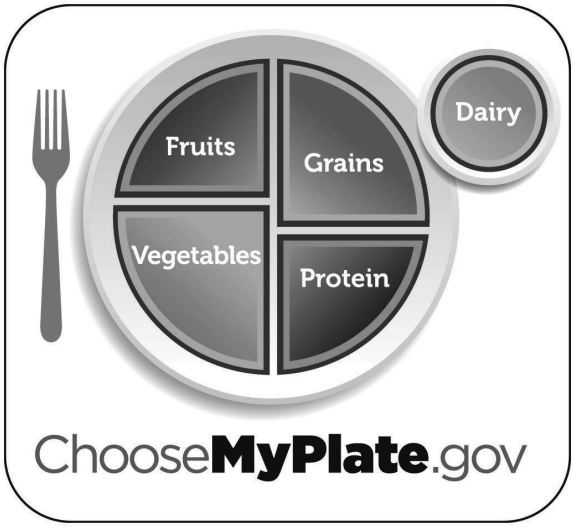

FIGURE 2.2

American food-plate model as it appears on ChooseMyPlate.gov

STUDY

1. Study Appendix C of this study guide (ChooseMyPlate.gov).

2. You can find additional information about the plate model on the website http://www.choosemyplate.gov/.

3. One of your study outcomes states that you must be able to make appropriate dietary suggestions to improve the daily food intake of people from different age groups and circumstances. You should therefore explore the following topics on the choosemyplate.gov website:

- 'Weight management and calories'
- 'Dieters'
- 'Pregnant and breastfeeding women'
- Children (6–11 years)
- Pre-schoolers (2–5 years)

The South African diabetic exchange list was adapted from the American diabetic exchange list (see Appendix G in the prescribed textbook). Note that the textbook mentions that the exchange list was originally developed for diabetics, but that it is also **useful for the planning of an adequate, balanced, varied diet which helps to achieve moderation and kilocalorie control** in healthy individuals (Rolfes Pinna & Whitney 2012, p. 47). See Appendix D of this study guide for the South African exchange list. This list is called an exchange list, because food in one specific group can be exchanged for another in the same group – in the quantities stated in Appendix D. The quantity or amount of food may be different, but each exchange contains the same amount of kilojoules, carbohydrates, protein or fat, for example, half a cup of all-bran flakes contains the same amount of macronutrients as a third cup of rice (see Appendix D).

STUDY

Study the sections "Exchange lists" (p. 47) and "Exchange list for diabetes" (pp. G–1 to G–3) in the prescribed textbook.

Study the following information in Appendix D of this study guide:

- The summarised South African exchange list – you need to know this table by heart.
- Following the heading of each food group, that is the starch list, fruit list, milk list, vegetable list etc., a description is given of the food group, as are the exchange serving sizes, nutrition tips, selection tips and meal-planning tips – these you have to know by heart.
- You have to know which foods fall into which food groups – for example, cheese and legumes count as meat or meat substitutes; legumes count as starch or meat/meat substitutes; sweet potatoes, potatoes, corn and mixed vegetables count as starches; olives, avocado and nuts count as fats; peanut butter counts as a meat/meat substitute or a fat – depending on the portion size.

The most important thing to remember is that there are different food guides available to use as tools when planning a diet. When it comes to diet planning, you should use the South African FBDGs and exchange lists where possible, and you are allowed to combine this information with that from other food guides.

Once you have studied the above-mentioned sections, complete the following activity. It is important that you do activity 2.5, because important theoretical concepts, which are not covered in the prescribed textbook, are explained in this activity.

Activity 2.5

2.5.1 Food-group plans are tools used for diet planning. Describe in your own words what a food-group plan is.

Reflection on 2.5.1: *According to your prescribed textbook, a food-group plan is a tool used to "build a diet from clusters of food that are similar in nutrient content" (Rolfes, Pinna & Whitney 2012, p. 39). Note that only some and not all food-group plans specify that people should eat certain amounts of food from each group. The USDA food guide is an example of a food-group plan.*

READ

Read the following sections in the prescribed textbook:

- "USDA food guide" (pp. 39–41)
- "Vegetarian food guide" (p. 45)
- "Mixtures of foods" (p. 45)
- "MyPyramid – steps to a healthier you" (pp. 45–46)
- "Recommendations versus actual intakes" (p. 46)
- "Pyramid shortcomings" (pp. 46–47)

- Appendix I: Canada's food guide
- Figure 15.8: Food guide pyramid for young children (p. 479)

The above should make you aware that there are different food-group plans, food guides or food grouping systems available, which can be used to plan a healthy diet.

2.5.2 List the featured selected messages used in ChooseMyPlate.gov to help consumers focus on key behaviours.

Reflection on 2.5.2: *The answers to the question are given in Appendix C of this study guide.*

2.5.3 Give two examples of food-group plans used in South Africa.
2.5.4 List the 11 South African FBDGs.

Reflection on 2.5.3 and 2.5.4: *The answers to the questions above are in this study guide.*

2.5.5 Describe in your own words what an exchange list is.
2.5.6 How do the exchange lists differ from the USDA food guide? Give examples.

Reflection on 2.5.5 and 2.5.6: *The answers to these questions are on page 47 of the prescribed textbook.*

2.5.7 List the food groups into which the South Africa exchange list is divided.
2.5.8 Use the South African exchange list (not the American one) in Appendix D in this study guide to make a summary of the carbohydrate, protein, fat and energy contents of the different exchange groups. *Remember to include the subgroups as well, for example: full cream, low fat, and skimmed; or very low fat, very lean, lean, medium fat, and high fat; or monounsaturated, polyunsaturated and saturated*. Use the table below as a guide.

Food	Exchange	CHO (g)	Protein (g)	Fat (g)	Energy (kJ)

Reflection on 2.5.7 and 2.5.8: *The answers to these questions are in Appendix D of this study guide. Among the South African exchange lists there is not*

a list for 'sweets, dessert and other carbohydrates', 'combination foods' and 'fast foods' as seen in the American exchanges (Appendix G in the prescribed textbook). Only some of these foods are found under the 'other carbohydrates list' and under the 'starch list'. In the 'starch list' in Appendix D of this study guide, these foods are referred to as 'starchy foods prepared with fat'. The South African exchange list has a 'free foods list' similar to the American one. There is no 'alcohol list' in the South African exchanges, so we use the American exchanges (Appendix G16 of the prescribed textbook) for alcohol. Remember that you have to convert the non-metric unit (fluid ounces – oz) in the serving size column to the metric unit (millilitres – ml).

2.5.9 Explain how the exchange list assists in controlling energy, fat and sodium intake. Note that your answer must relate to the South African exchange list (Appendix D) and not the American exchange list.

Reflection on activity 2.5.9: *The answer to this question appears in Appendix G (pp. G2–G3) of the prescribed textbook. Adapt the theory so that it is applicable to the South African exchanges.*

RECOMMENDED AMOUNTS

Some of the principles discussed in this section are not found in the South African food guides and can be applied in addition to the information in the South African food guides.

STUDY

Study the following sections in your prescribed textbook:

- "Recommended amounts" (pp. 39 and 42)
- "Noble nutrients" (pp. 42–43)
- "Nutrient dense choices" (p. 43)
- "Discretionary kCalorie allowance" (pp. 43–44)
- "Serving equivalents" (p. 44)
- "Ethnic food choices" (p. 44)
- Note that table 2.2 can be used in collaboration with the South African food guides.

The recommended intakes of the different food groups for different age groups as prescribed by the FBDGs are indicated in table 2.1 below. But a shortcoming of the South African food guides is that they only state the recommended daily intakes of different food groups for different age groups (see table 2.1) in general, and don't take the differences in daily energy needs for a specific gender and level of physical activity into account. In future modules you will be taught how to calculate the Estimated Energy Requirements (EER) of individuals. For the purpose of this module you can use tables 2.2, 2.3 and 2.4 (p. 42) in the prescribed textbook and table 2.1 in the study guide as guides to plan a diet.

TABLE 2.1:
Recommended daily amounts from each food group
(DOH 2004, pp. 12, 15, 17, 21)

Recommended number of servings per day	Children 7–13 years	Adolescents 14–25 years	Adults 25–60 years	Elderly people > 60 years
Starchy foods	6–8 servings	9–11 servings	6–8 servings	6–8 servings
Vegetables and fruit	5 servings (400 g)			
Meat and meat alternatives: chicken, lean meat, fish, eggs and/or dry beans, split peas, lentils and soya*	2–3 servings			
Milk and other dairy products**	500–750 ml (2–3 cups)	250–500 ml (1–2 cups)	250 ml (1 cup)	250 ml (1 cup)

* The recommended intake of legumes is 100–200 g/day and 25 g soy protein per day. It is recommended that meat be substituted with legumes at least once a week as they are a more cost-effective source of protein and a good source of protein and fibre.

** This table is not based on the exchange list – therefore the milk and dairy products include cheese, whereas the exchange list considers cheese to be part of the meat and meat alternatives.

Note

- You need to memorise table 2.1 above to be able to make appropriate suggestions to improve the daily food intake of different age groups.
- It is not expected of you to memorise tables 2.1, 2.2 and 2.3 in the prescribed textbook. If any of this information is required in the assignments or the examination, it will be given to you.
- Note that some of the values in tables 2.2, 2.3 and 2.4 in the textbook are in non-metric units. Remember to convert them to metric units (eg 5 oz protein foods = 150 g protein foods and 6 oz grains = 180 g grains).
- The section on recommended serving equivalents on page 44 of the prescribed textbook gives practical advice on how to explain certain portion sizes in simple terms. In South Africa we use the following examples:
  - 30 g protein portion = 1 small matchbox
  - 90 g protein portion = palm of a woman's hand
  - 120 g protein portion = ¾ of a woman's hand
  - 150 g protein portion = whole hand of a woman.
  - 1 cup of maize-meal porridge or other starches = 1 fist
  - 1 cup of fruit or vegetables = 1 tennis ball/1 fist

Activity 2.6

Lerato is 27 years old. She maintains a healthy body weight but she feels that she is not making healthy food choices for her long-term health. She comes to you for nutritional advice.

2.6.1 What are Lerato's recommended intakes of the different food groups according to table 2.1 in this study unit?

Reflection on 2.6.1:

- *Starchy foods: 6–8 servings*
- *Vegetable and fruit: 5 servings (400 g)*
- *Meat and meat alternatives: 2–3 servings*
- *Milk and other dairy products: 1 cup (250 ml)*

2.6.2 What are Lerato's recommended daily amounts from each food group if her energy requirement is 1600 kcal per day? Use table 2.2 (p. 42) in the prescribed textbook.

Reflection on 2.6.2:

- *Fruits: 1.5 cups*
- *Vegetables: 2 cups*
- *Grains (equal to starches): 5 oz = 150 g*
- *Protein foods: 5 oz = 150 g*
- *Milk: 3 cups*
- *Oils: 5 tsp*
- *Discretionary kilojoule allowance: 121 kcal × 4.2 = 508 kJ*

2.6.3 Explain how your answer in 2.6.2 differs from that in 2.6.1.

Reflection on 2.6.3: *The South African recommended daily amounts from each food group (table 2.1 in this study guide) are not as complete as the American ones in table 2.2 (p. 42) in the prescribed textbook. For example, the South African guidelines lack specific energy requirements. These guidelines can therefore only be used as a general or broad guideline for healthy eating for the general population and not as a specific guideline for individuals who are overweight or who suffer from disease conditions such as diabetes mellitus, cardiovascular disease, high blood pressure or cancer. The American recommended daily amounts from each food group make provision for oils (fats) and discretionary kilojoules in the diet. They also divide fruit and vegetables into separate daily amounts, whereas the FBDGs combine fruit and vegetables into a total of 5 servings (400 g) per day.*

How do we overcome these shortcomings when we only use the South African recommended amounts? When planning a meal, it is essential to incorporate all eleven of the FBDGs into the diet plan, as well as all the food groups in the exchange list (Appendix D). Never use table 2.1 on its own. For example: One of the FBDGs gives the instruction to "use fats sparingly" and the information in the exchange lists (page 11 of Appendix D) mentions that all fats are high in kilojoules and serving sizes should be limited, and that small amounts of mono- and polyunsaturated fats are associated with certain health benefits, whereas saturated fats are linked with disease. This information should be

taken into account when planning a diet and should be included as part of the nutritional recommendations or advice.

2.6.4 Explain the term 'phytochemicals' and give two examples of food containing them.
2.6.5 The USDA food guide encourages us to increase our consumption of certain foods groups to provide the nutrients most lacking in our diet. According to your prescribed textbook, what do most people need to eat?
2.6.6 Discuss why it is important for Lerato to include nutrient-dense food choices in her diet.
2.6.7 Explain the discretional kilocalorie/kilojoule allowance to Lerato in laymen's terms.
2.6.8 Give Lerato examples of types of food she can choose to use as discretional kilojoules.
2.6.9 What advice would you give Lerato concerning discretional kilojoules if she wanted to lose weight?

Reflection on 2.6.4–2.6.9: *The answers to these questions are on pages 42 and 43 of the prescribed textbook.*

2.5 PUTTING A PLAN INTO ACTION

It is necessary to translate nutrition recommendations into practical advice through the development of a diet and menu plan (sample menu). Dietary recommendations should always be accompanied by examples of foods that are allowed and not allowed in the diet.

This section integrates the theory discussed in sections 2.1 to 2.3 in this study unit. Your prescribed textbook starts this section by stating that the first step to diet planning is that you should familiarise yourself with each of the food group systems. Now familiarise yourself with each of the food groups in the exchange lists in Appendix D, as well as the theory in your prescribed textbook. Make sure that you understand how to go from dietary guidelines to buying groceries.

STUDY

Study the sections "Putting the plan into action" (pp. 47-49) and "From guidelines to groceries" (pp. 49–53) in the prescribed textbook. Make sure that you are able develop a diet plan and sample menu.

Activity 2.7

2.7.1 In activity 2.6 you have listed the recommended amounts from each food group for Lerato. Now combine the information in activity 2.6 and develop a diet plan for Lerato by assigning the different food groups to meals and snacks. Use the table below as guide.

Food	Total exchanges	Break-fast	Mid-morning snack	Lunch	Mid-after-noon snack	Supper	Snack (± 1 hour before bed time)
Milk**: Full-cream Low-fat Skimmed or very low-fat	2 (One portion of the milk group was moved to the meat and meat substitutes.)*						
Vegetables	5 eg 3 veggies plus 2 fruit						
Fruit							
Bread/starch	6–8 servings (choose between 6, 7 or 8 servings of bread/starch)						
Meat and meat substitutes**: Very lean Lean Medium-fat High-fat	2–3 meat portions + 1 portion from the milk group = 3–4 (One portion of the milk group was moved to the meat and meat substitutes.)*						
Fat: Monounsaturated Polyunsaturated Saturated	5						

* To be used as cheese or another protein

** Always choose the low-fat or very low-fat option with milk and very lean and lean meat and meat substitutes where possible.

2.7.2 Now fill in the diet plan with real foods and create a one-day sample menu (also known as a meal plan) for Lerato. Remember to include all the meals and snacks.

2.7.3 Give Lerato dietary recommendations or advice about each of her food choices based on the exchange list in Appendix D

Reflection on activity 2.7

2.7.1 The table below is just an example of how you can allocate the number of exchanges to the different meals and snacks.

Food	Total exchanges	Break-fast	Mid-morning snack	Lunch	Mid-afternoon snack	Supper	Snack (± 1 hour before bed time)
Milk**: Full-cream Low-fat Skimmed or very low-fat	2 (One portion of the milk group was moved to the meat and meat substitutes.)*	1			½		½
Vegetables	5 eg 3 veggies plus 2 fruit			1		2	
Fruit			1		1		
Bread/starch	6	2	1	2		1	
Meat and meat substitutes**: Very lean Lean Medium-fat High-fat	0 4 0 0		1	1		2	
Fat: Monounsaturated Polyunsaturated Saturated	3 2 0		2		1	2	

2.7.2 Use figure 2.5 on page 49 of the prescribed textbook as a guide to create a one-day menu for Lerato.

2.7.3 Use the information in Appendix D of this study guide and the section "From guidelines to groceries" in your textbook (pp. 48–53) to answer this question. You should provide advice on each of the food groups.

2.6 FOOD LABELS

In South Africa we use our own legislation when it comes to the labelling of food products, and not the American guidelines. In March 2010, South Africa published the first phase of its new food-labelling legislation. The legislation intends to increase health awareness and encourage improved lifestyle behaviour among South African consumers by assisting them to make healthier food choices (Kempen et al 2012, p. 15).

Activity 2.8

Visit your local supermarket and study four food labels of different products to familiarise yourself with the presentation of the information provided. Tabulate the information on each of the products according to the:

(a) Ingredient list
(b) Nutritional information
(c) Health claims made
(d) Expiry dates

STUDY

- Study the summary of food labelling in South Africa in appendix E written by Gabi Steenkamp, Registered Dietician. Available online: http://www.gabisteenkamp.co.za/food%20labelling.htm
- Study the section on "Food labels" (pp. 53–59) in the prescribed textbook.

In South Africa you will often see the "heart mark" on food products. The Heart and Stroke Foundation has developed this emblem (see figure 4.6 in study unit 4) to make it easy to identify healthy food products on the shelf. When a particular food features the heart mark, it means that it is low in cholesterol, fat (both saturated fat and trans fats), sodium (salt) and added sugar, and high in fibre (where applicable) (Heart and Stroke Foundation 2013). You will learn more about the heart mark in study unit 4.

Activity 2.9

2.9.1 Why was new legislation developed for food labelling in South Africa?
2.9.2 Evaluate the four food products you have chosen, based on the mandatory information on the label.
2.9.3 Which descriptive words may no longer appear on food labels? Do the four food products you have chosen have any of these descriptive words on them?

Reflection on activity 2.9

You'll find the answers to these questions in Appendix E. You can even examine some of the food products in your grocery cupboard to see if some of the mandatory information is on the labels and whether any 'illegal' descriptive words appear on them.

2.7 SUMMARY

In this study unit emphasis is placed on the importance of improving the daily food intake of individuals by applying knowledge of diet-planning principles, food-based dietary guidelines, food-group exchanges, the food-plate model,

portion sizes and the reading of food labels to daily food choices, and adapting these to individuals of different age groups and circumstances. This knowledge should be your road map to healthy eating. In the next three study units the characteristics, functions and recommended consumption of the three energy-yielding nutrients – carbohydrates, protein and fat – will be discussed.

Activity 2.10: Summary activity

Do the "Chapter review" questions on page 836 of the prescribed textbook. Answer questions 1 to 11.

For additional study questions and activities go to www.cengagebrain.com and search for ISBN1111427143.

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STUDY UNIT 3

Carbohydrates

Activity 3.1: Start-up activity and revision

It is 5 o' clock in the afternoon. You are very hungry and feel you don't have any energy. You realise that you have skipped both breakfast and lunch. It has been a while since you've been to Café Funda and you decide to visit them for an early dinner. Page to the Café Funda menu in activity 1.1 of study unit 1. Look at the menu and place a new order at the counter. Answer the following questions.

3.1.1 Identify the foods in the meal you ordered from Café Funda that contain carbohydrates.

3.1.2 If you consume one gram of carbohydrate it will provide you with _____ kJ of energy.

3.1.3 Examine, in Appendix A, the nutrient composition per serving of the meal you have ordered from Café Funda. Calculate the total energy and carbohydrate content of the meal you have ordered from the menu.

3.1.4 Calculate the energy provided by the carbohydrates in your meal.

3.1.5 Calculate the percentage of energy the carbohydrates contribute to the total energy of the meal.

Reflection on activity 3.1

3.1.1 If, for example, you chose the chicken, cheese and pine burger with regular chips and a Coke, the food in the meal that are carbohydrates would be the hamburger bun, pineapple, chips and the Coke.

*3.1.2 If you consume one gram of carbohydrate it will provide you with **17 kilojoules** of energy. Compare the amount of energy carbohydrate provides to that provided by protein and fat (refer back to study unit 1).*

3.1.3 If you chose the meal above, the nutrient composition would be as follows (find the nutrient composition of your meal in Appendix A):

Nutrients	***Chicken, cheese & pine burger***	***Regular chips***	***Coke****	***Total***
Total energy (kJ)	*2019 kJ*	*1351 kJ*	*613.2 kJ (146 kcal × 4.2 = 613.2 kJ)*	*3983 kJ*
Carbohydrates (g)	*54.3 g*	*45.2 g*	*40.5 g*	*140 g*

* *See Appendix H, page H50 of the prescribed textbook, for the nutrient composition of Coke. The total energy of the Coke is given in kilocalories (kcal). Remember to convert it to the metric unit kilojoules.*

3.1.4 The energy provided by the carbohydrates in the meal is:

Nutrients	***Total***	***Calculation***	***Total energy provided***
Carbohydrates (CHO) (g)	*140 g*	*140 g CHO × 17 kJ/g*	*2380 kJ*

3.1.5 The total energy provided by the chicken, cheese and pine burger with chips and Coke meal is 3983 kJ. The percentage of energy the carbohydrates contribute to the total energy of the meal is:

Nutrients	***Total energy provided***	***Calculations***	***Percentage of total energy***
Carbohydrates (CHO) (g)	*2380 kJ*	*2380 kJ ÷ 3983 kJ = 0.5975 × 100 = 59.75%*	*60%*

The percentage of energy the carbohydrates in the meal contribute to the total energy is 60%.

TIME ALLOCATION

You should spend at least 15 hours on this study unit.

Learning outcomes

On completion of this study unit you should be able to

- describe the chemical composition of carbohydrates and classify them, giving appropriate examples
- explain the concept of 'dietary fibre' and classify dietary fibres, giving appropriate examples
- explain the fundamentals of carbohydrate metabolism
- explain the role of glucose in the body and how a constant blood glucose level is maintained
- discuss the consequences of an abnormal blood glucose level (diabetes and hypoglycaemia)
- explain how the Glycaemic Index (GI) influences blood glucose control and how the GI rating is determined
- describe the factors that affect the GI of food and the concept of 'glycaemic load'
- rank foods based on their effect on the glycaemic response
- explain the health effects of sugars, starches and fibres and give the recommended intakes of these carbohydrates
- describe the way in which certain conditions (eg diabetes, heart disease, overweight, gastro-intestinal health and cancer) may affect the requirements of sugars, starches and fibres
- discuss alternative sweeteners
- calculate and interpret the energy provided by carbohydrates
- calculate and interpret the percentage of kilojoules carbohydrates contribute to the total energy intake
- give feasible dietary advice regarding sugars, starches and fibres and recommend appropriate foods as sources of carbohydrates for the following conditions: diabetes, heart disease, overweight, gastro-intestinal health and cancer
- provide suitable alternatives for unhealthy carbohydrate choices, given a particular diet history
- identify risk factors for a nutrition-related condition (eg heart disease, obesity, cancer or a gastro-intestinal condition) and make suitable recommendations

3.1 INTRODUCTION

In study unit 1 you have learned that just as a car runs on fuel, our bodies are 'powered' by the energy provided by protein, carbohydrates and fat. When we consume these three macronutrients, energy is released through metabolic processes in the body. This is why macronutrients are collectively called energy-yielding nutrients. The first of the three energy-yielding nutrients that we are going to deal with in this module is carbohydrates.

In the two previous study units you have learned that when we eat carbohydrates these are broken down by the body so that they can provide us with energy. If one gram of carbohydrate is consumed, it will provide us with 17 kJ of energy. According to the acceptable macronutrient distribution range (AMDR), **45** to **65%** of our total energy intake in a day should come from dietary carbohydrates (study unit 1). This makes carbohydrates our main energy source. Apart from energy, carbohydrate-rich foods may also provide dietary fibre, protein, vitamins and minerals.

Carbohydrates have many vital functions in our body which are necessary for the 'maintenance of health and prevention of disease' (Vorster & Nell 2001, p. S17). The four main functions of carbohydrates are as follows:

- Carbohydrates are **a source of energy** which is found in the form of glucose, fructose and galactose.
- They are responsible for the **storage of energy** in the liver and muscle of animals (glycogen) and in plants (starch).
- They are an important component of the **structure** of cell membranes, especially when they are linked to proteins and lipids (glycoproteins and glycolipids) (Dominiczak 2007, p. 54) and of the structure of DNA and RNA.
- They lead to **protein sparing**.

We get dietary carbohydrates mainly from starches, but legumes, fruits, vegetables, sugars and milk products are sources of carbohydrates as well (study unit 2) (Vorster & Nell 2001, p. S17). The three main types of dietary carbohydrates are starch, sugar and fibre. Many people regard starch and sugar as fattening and therefore to be avoided; refined sugar is commonly considered as a cause of attention deficit disorder (ADD) or hyperactivity in children; and fibre is known by consumers to prevent constipation. There is some scientific basis for each of these beliefs, although they are often exaggerated. Carbohydrates are an essential dietary component, but if consumed in excess they can cause weight gain. Only a small percentage of children with ADD are actually sensitive to sugar; and although a certain amount of fibre is a good thing, too much can cause problems.

Health authorities in most developed countries are encouraging people to increase their intake of carbohydrates, but to use sugar in moderation and to include adequate, but not excessive fibre in their diet. The kind and amount of carbohydrates in the diet play a role in the prevention and/or treatment of tooth decay, diabetes, hypoglycaemia, and various other health problems.

READ

Read the introduction to chapter 4 (pp. 92–93) of the prescribed textbook.

When you work through this topic, pay attention to the theory, figures, diagrams and definitions in the prescribed textbook, where these are presented in more detail. Use both the study guide and textbook as study aids.

3.2 THE CHEMIST'S VIEW OF CARBOHYDRATES

In this section we are going to examine the classification and chemical composition of carbohydrates. The classification is the main groups carbohydrates are divided into. Figure 3.1 is a summary of the classification of carbohydrates. The chemical composition, in short, is what the different carbohydrates look like and what their properties are. You will see in figure 3.1 that carbohydrates are divided into two main groups – **simple** and **complex carbohydrates**. These two main groups are in turn subdivided into **mono-** and **disaccharides** and **oligo-** and **polysaccharides** respectively (with examples of each and their constituents where applicable). We will examine each of these carbohydrates in more detail in the paragraphs that follow (3.2.1–3.2.3).

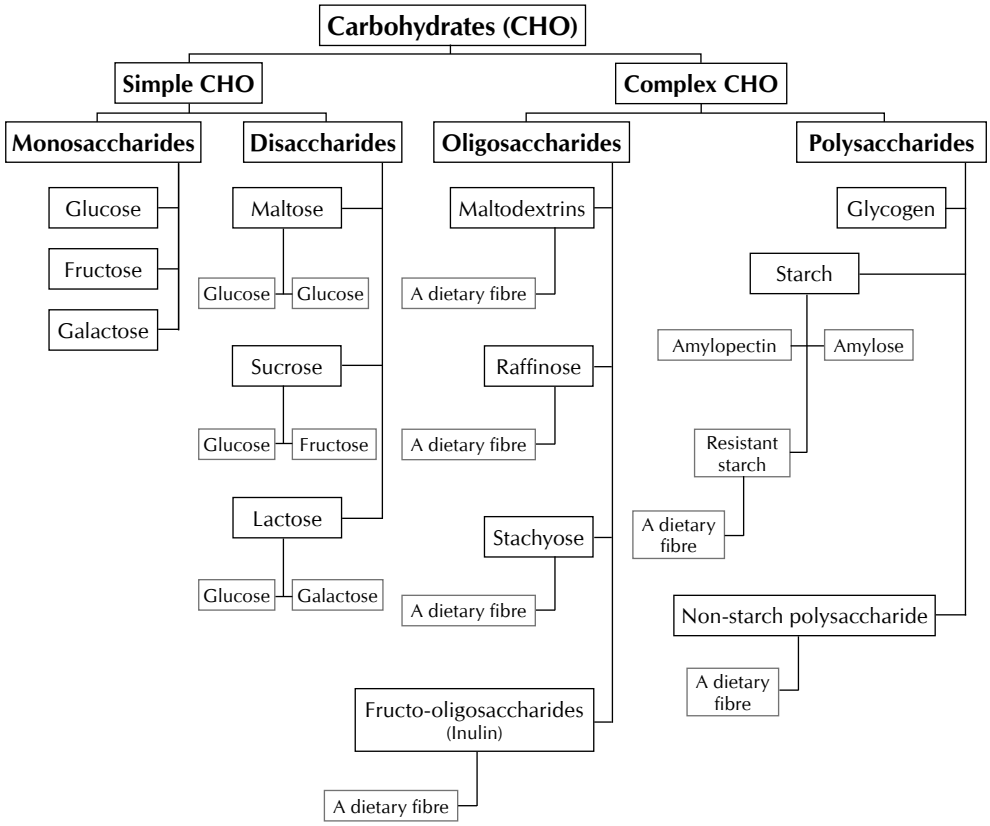

FIGURE 3.1

The classification of dietary carbohydrates

3.2.1 Simple carbohydrates (sugars)

In study unit 1 you were introduced to the concept of atoms and molecules. When **6 carbon**, **12 hydrogen** and **6 oxygen atoms** are combined in a certain pattern, it forms a molecule called a **monosaccharide**. A monosaccharide is the basic building unit of other carbohydrates such as **disaccharides** and **polysaccharides** and it cannot be **hydrolysed** (broken down) into smaller molecules.

The three important monosaccharides are **glucose**, **fructose** and **galactose** (as indicated in figure 3.1). These are the forms in which carbohydrates are absorbed (taken up) from the gastro-intestinal tract (GIT) into the blood stream. Glucose

is used immediately by the body cells for energy. Fructose and galactose first have to go to the liver, where they are converted into glucose molecules by metabolic processes (Rolfes, Pinna & Whitney 2012, pp. 93–95 and 101).

When **two monosaccharides** combine through a process called **condensation**, a larger molecule is formed, called a **disaccharide**. Disaccharides can be hydrolysed (broken down) into monosaccharides. This process of hydrolysis occurs in the GIT where digestive enzymes break the connections between the two monosaccharides. The three important disaccharides are: **maltose**, **sucrose** and **lactose** (figure 3.1). Mono- and disaccharides are collectively termed **simple carbohydrates** or **sugars** (figure 3.1) (Rolfes, Pinna & Whitney 2012, pp. 95–100).

STUDY

Study the sections "The chemist's view of carbohydrates", "Monosaccharides" and "Disaccharides" (pp. 93–96) and the chemical structures of mono- and disaccharides in Appendix C (p. C-1) of the prescribed textbook.

Activity 3.2

3.2.1 Summarise what you have learned about the chemical composition and properties of monosaccharides and disaccharides. Use figure 3.1 as a framework for your summary and add additional information to the figure.

3.2.2 Answer "Chapter review" questions 1, 2, 4 and 5 on 'The chemist's view of carbohydrates' on page 840 of the prescribed textbook.

Reflection on activity 3.2

Figure 3.2 below is an example of how to get started on this activity. The section on monosaccharides is summarised for you. Now do the same for the disaccharides.

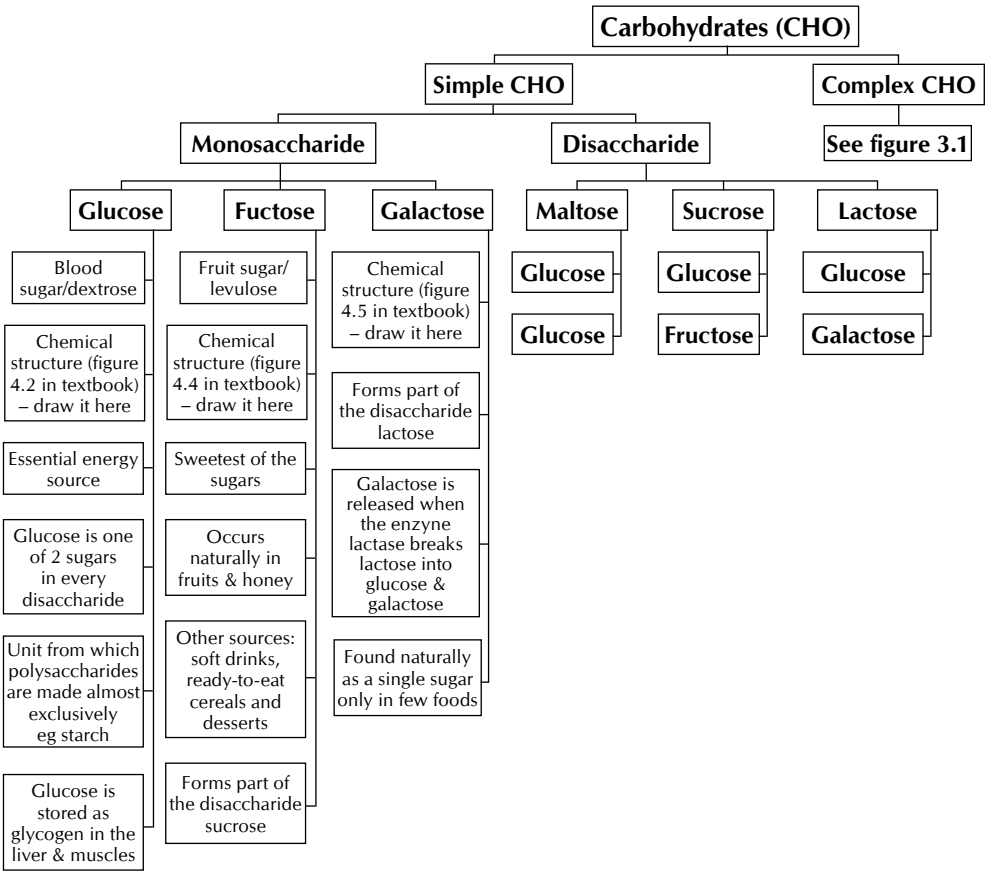

FIGURE 3.2

Reflection on activity 3.2

3.2.2 Complex carbohydrates

Complex carbohydrates can be divided into **oligosaccharides** and **polysaccharides** (figure 3.1). Oligosaccharides consist of **three** to **nine or ten monosaccharides** which are linked together. Some oligosaccharides are not hydrolysed or digested to monosaccharides and are classified as a 'dietary fibre' (see section 3.2.3) or an 'unavailable carbohydrate' (Vorster & Nell 2001, p. S18). Figure 3.1 gives four examples of oligosaccharides, namely maltodextrins, raffinose, stachyose and fructo-oligosaccharides (inulin).

Polysaccharides consist of **more than nine or ten monosaccharide units**. Our main dietary source of polysaccharides is **starch** from plants (figure 3.1). When starch polysaccharides are consumed, digestive enzymes hydrolyse them into smaller polysaccharides, oligosaccharides, disaccharides and eventually monosaccharides. The monosaccharides (mainly glucose) derived from starch are absorbed and the excess not used by the body for energy is stored in the liver and muscle as **glycogen**, for later use (figure 3.1). Note that glycogen indicated in figure 3.1 is not a dietary source of carbohydrates but just a type of polysac-

charide (Beyer 2004, p. 15; Rolfes, Pinna & Whitney 2012, p. 99). According to figure 3.1, the third type of polysaccharide is the non-starch polysaccharides. This will be discussed in the next section on dietary fibre.

STUDY

Study the sections "Polysaccharides", "Glycogen" and "Starches" (pp. 97–98) and the chemical structures of polysaccharides in Appendix C (pp. C–2 to C–3) of the prescribed textbook.

Note

It won't be expected of you to draw the chemical structures of carbohydrates, but you must be able to recognise them, know their properties, understand condensation and hydrolysis and recommend specific food sources of a particular carbohydrate.

Activity 3.3

3.3.1 Summarise what you have learned about the chemical composition and properties of polysaccharides, starch and glycogen. Use figure 3.1 as a framework for your summary and add additional information to the figure.

3.3.2 Answer questions 3 and 6 of the chapter review questions on "The chemist's view of carbohydrates" on page 840 of the prescribed textbook.

Reflection on activity 3.3

Use the example of monosaccharides in figure 3.2 of activity 3.2 as a guide to complete this activity.

3.2.3 Dietary fibre

It is difficult to define the term 'dietary fibre' and many definitions exist for it. This makes understanding the concept of dietary fibre complex.

STUDY

Study the sections "Fibres" and "In summary" on pages 98 and 99 of the prescribed textbook.

According to the textbook, dietary fibres include non-starch polysaccharides and non-polysaccharides. It is important to note that this is not entirely correct. Dietary fibre is **not just one individual thing** but it is a **collective term** for **different substances** with **different chemical** and **physical properties** which have **different physiological effects on the body** (Lunn & Buttriss 2007, p. 29).

The following aspects should be included when defining the broader term 'dietary fibre':

- Dietary fibre includes different edible structural parts of plants.
- It can't be broken down by the digestive enzymes or absorbed.
- Fibre does not contribute to the total energy intake.
- Fibres can be divided into soluble and insoluble fibres.
- Complete or partial fermentation of fibre occurs in large intestine.
- Fibre has properties that are beneficial to health (detail discussed later in this study unit).
- Dietary fibre includes **non-starch polysaccharides**. The latter are not digested by human digestive enzymes and make up the largest part of what is collectively referred to as 'dietary fibre'. Examples of non-starch polysaccharides include cellulose, hemicellulose, pectins, gums and mucilages (Lunn & Buttriss 2007, p. 30; Rolfes, Pinna & Whitney 2012, p. 98).
- Dietary fibre also includes non-polysaccharides such as lignins, cutins and tannins (Rolfes, Pinna & Whitney 2012, p. 98).
- **Resistant starch** is classified as dietary fibre as well. A resistant starch is a starch polysaccharide which is classified under the broader term 'dietary fibre', because the starch is physically inaccessible to the digestive enzymes. Examples are whole grains, legumes, pasta, seeds, unripe bananas, cooked and cooled potatoes (eg potato salad) and food containing commercial sources of modified starches such as bread, breakfast cereals and nutrition bars (Lunn & Buttriss 2007, p. 24).
- **Oligosaccharides** are not digested by enzymes in the gut but are broken down by enzymes from bacteria that naturally occur in the colon, making them part of dietary fibre. Examples are inulin (fructo-oligosaccharide), raffinose, stachyose and maltodextrins. These are also known as 'unavailable carbohydrates' (Lunn & Buttriss 2007, p. 22; Vorster & Nell 2001, p. S17).

Figure 3.3 provides a summary of how dietary fibre can be classified. Study this figure and make sure that you understand the concept of dietary fibre and its different components, and are able to give examples of each.

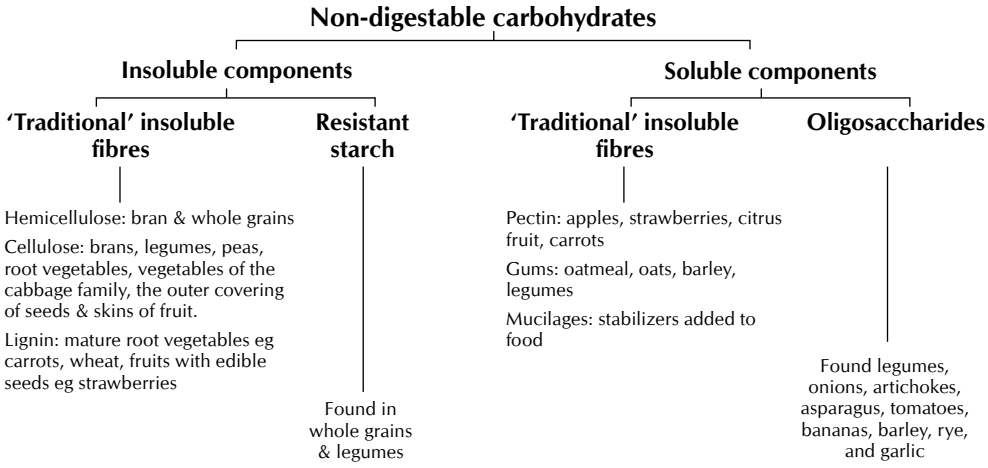

FIGURE 3.3

Classification of dietary fibre

(Groff & Gropper 2000, pp. 106–116; Rolfes, Pinna & Whitney 2012, p. 98; Vorster & Nell 2001, pp. S17–18; Lunn & Buttriss 2007, p. 29; Ettinger 2000, pp. 37–40)

Activity 3.4

Read the scenario in activity 3.1 and answer the following questions.

3.4.1 Calculate the total amount of fibre in the Café Funda meal you have ordered. Use the nutritional information in Appendix A to answer this question.
3.4.2 Explain the term 'dietary fibre'.
3.4.3 Dietary fibres are sorted into two groups according to their solubility. Explain the difference between soluble and insoluble fibre.
3.4.4 Give examples of foods containing soluble fibre.
3.4.5 Give examples of foods containing insoluble fibre.
3.4.6 Explain the difference between dietary fibres, functional fibres and total fibres.
3.4.7 If you had to give advice to someone concerning a high-fibre diet, which four Café Funda meals would you suggest they have, based on fibre content alone?

Reflection on activity 3.4

3.4.1 The total fibre in a Café Funda meal of chicken, cheese & pine burger with regular chips and Coke is:

Nutrients	***Chicken, cheese & pine burger***	***Regular chips***	***Coke****	***Total***
Fibre (g)	*3.0 g*	*3.6 g*	*0 g*	*6.6 g*

3.4.2 Consult page 98 of the prescribed textbook and the information in this study guide to answer this question.

3.4.3 Consult page 98 of the prescribed textbook and the information in this study guide to answer this question. When explaining the difference between soluble and insoluble fibre, remember to include the traditional soluble fibre, resistant starch, traditional insoluble fibre and oligosaccharides.

3.4.4–3.4.6
Consult page 98 of the prescribed textbook and the information in this study guide to answer these questions.

3.4.7 You will find the answer to this question in Appendix A of this study guide.

3.3 DIGESTION AND ABSORPTION

For the purpose of this module you don't have to study the section in the textbook on the digestion and absorption of carbohydrates. This topic will be covered comprehensively in NUT2601.

3.4 GLUCOSE IN THE BODY

How many days do you think you can go without food? Some say 180 days (Dominiczak 2007, p. 5). Study the following section and see if you can find the answer to this question.

When one hears the word 'glucose' one thinks of energy. Apart from providing energy, glucose has other important functions in the body as well. The four main functions of glucose are the four S's:

- **S**upply of energy
- **S**torage of energy as glycogen in muscle and liver, and as starch in plants
- **S**tructural role in cell membranes as glycoproteins and glycolipids
- **S**paring of protein

STUDY

Study the introductory paragraph under the section "Glucose in the body" on page 103 of the prescribed textbook.

You will notice in the textbook that reference is made to glycoproteins and glycolipids. According to Anderson, Elliot, Keith and Novak (2002, pp. 751–752) a glycolipid consists of a lipid and a carbohydrate, and a glycoprotein consists of a protein and a carbohydrate. Be careful to note that the sugar attached to a protein or a lipid is not necessarily glucose, for example, in the nervous system the carbohydrate in the glycolipids is usually galactose. The structural properties of carbohydrates are therefore not exclusive to glucose alone.

3.4.1 A preview of carbohydrate metabolism

All the chemical reactions that take place in the body that involve carbohydrates are referred to as carbohydrate metabolism. We are going to explore carbohydrate metabolism in activity 3.5.

STUDY

Before you start with activity 3.5, study the section "A preview of carbohydrate metabolism" (pp. 103–104) in the prescribed textbook. You won't be able to answer the questions in activity 3.5 if you haven't worked through this section in the textbook.

Activity 3.5

In the scenario in activity 3.1 it was mentioned that you had skipped both breakfast and lunch and that you felt hungry and had no energy. Answer the following questions:

3.5.1 When you skip both breakfast and lunch there is not enough blood glucose available in your blood to supply energy to your brain and other essential tissues such as red blood cells. Explain where

your get energy from for your body and brain to function in these circumstances.

3.5.2 Briefly explain what happens to glucose in the blood and body cells after you have eaten a Café Funda meal.

3.5.3 What happens to the excess glucose from your Café Funda meal that is not used for energy? (**Tip:** There is a short-term and long-term way in which excess energy is stored.)

3.5.4 Explain where your body would get energy from if you went without food for more than a day? (**Tip:** Name and explain both processes.)

3.5.5 Explain what you understand under 'protein sparing'?

3.5.6 What would you add to your diet to 'spare protein'?

Reflection on activity 3.5

You will find the answers to these questions on pages 103 to 104 of the prescribed textbook. It is important that you understand the following principles:

- ***Glycogenesis:*** *the process during which glycogen is formed from excess glucose (Dominiczak 2007, p. 5) (glycogen + genesis = glycogen production/ formation).*
- ***Lipogenesis:*** *the production (formation) and accumulation of lipids (Anderson et al 2002, p. 1011; Dominiczak 2007, p. 6) (lipid + genesis = lipid production).*
- ***Glycogenolysis:*** *the breakdown of glycogen into glucose (Dominiczak 2007, p. 6) (glycogen + lysis = glycogen breakdown/splitting into smaller parts).*
- ***Lipolysis:*** *the breakdown of lipids (triglycerides) into glycerol and fatty acids (lipid + lysis = lipid breakdown/splitting into smaller parts).*
- ***Gluconeogenesis:*** *gluco = glucose; neo = new; genesis = production; therefore gluconeogenesis is the production of new glucose from non-carbohydrate sources. See the definition on page 104 of the prescribed textbook.*

Glycogen can be described as our short-term 'emergency' store for glucose when insufficient amounts of glucose are supplied by the food we take in. This occurs when there is a short-term lack in food supply, for example when you skip meals, or don't eat enough, or during exercise (Dominiczak 2007, pp. 2 and 5).

When there is a long-term lack in glucose supply from food, like during starvation, fasting, or prolonged exercise, or when there is an increased need for energy for example during illness, glycogenesis and lipogenesis stop and the following energy pathways are activated (Dominiczak 2007, pp. 2, 5 and 6):

- Glycogenolysis: immediate energy supply
- Lipolysis: long-term energy supply
- Gluconeogenesis: long-term energy supply

The next section explains how energy supplies remain constant, even when the food supply does not.

3.4.2 The constancy of blood glucose: how the body controls blood glucose levels

Do you agree that glucose is our main energy source? It is also called our main metabolic fuel. The brain and red blood cells only use glucose for energy. It is therefore essential that there is a constant and continuous supply of glucose, irrespective of whether there is a food supply or not (Dominiczak 2007, pp. 2, 5 and 6).

STUDY

Study the section "Constancy of blood glucose" (pp. 103–104) in the prescribed textbook.

Activity 3.6

In activity 3.5 you had to explain in short what happens to glucose in the blood and body cells after you have eaten a Café Funda meal. Illustrate this by drawing a simplified diagram of how blood glucose homeostasis is maintained in the body.

Reflection on activity 3.6

Draw a simplified diagram of figure 4.12 (page 105) and add the theory on pages 104 and 105 of the prescribed textbook.

Note

On page 104 of the prescribed textbook the normal range for fasting blood glucose is given as 70 to 100mg/dL. In South Africa, however, we use the unit mmol/L for blood glucose and we therefore have to convert the **mg/dL to mmol/L** by **multiplying by 0.0551. The normal fasting blood glucose** values are **3.9–5.5 mmol/L.** You will note that different sources indicate slightly different reference values, for example some sources indicate the normal fasting blood glucose level as 3.5–5.5 mmol/L.

Try to calculate the units for the following fasting blood glucose values in mmol/L:

- Prediabetes: 100–125 mg/dL → _____ mmol/L
- Diabetes: > 126 mg/dL → _____ mmol/L

In the next section we discuss what happens if this glucose homeostasis is not maintained.

3.4.3 Falling outside the normal range

In some individuals the ability to maintain a constant and continuous supply of glucose is impaired and the glucose levels cannot be maintained within the normal range. This happens in **prediabetes, type 1** and **type 2 diabetes mellitus** and **hypoglycaemia**. Blood glucose levels outside the normal range may have a detrimental effect on the health of these individuals.

Activity 3.7

Mr Khumalo is 52 years old and was diagnosed with type 2 diabetes mellitus four years ago. According to his diet history he only eats breakfast and supper, and in between a lot of foods and drinks which are high in sugar.

3.7.1 Explain to Mr Khumalo the difference between type 1 and type 2 diabetes mellitus.
3.7.2 Mr Khumalo is using insulin injections as treatment for his diabetes and often experiences hypoglycaemia. Explain to Mr Khumalo the concept of hypoglycaemia.
3.7.3 Explain to Mr Khumalo the symptoms of hypoglycaemia so that he will be able to recognise it the next time it occurs.
3.7.4 Explain to Mr Khumalo the causes of hypoglycaemia in a diabetic.
3.7.5 Which dietary adjustments should Mr Khumalo make in order to prevent a hypoglycaemic attack?

Reflection on activity 3.7

3.7.1 You will find the answer to this question on page 106 of the prescribed textbook. Figure 3.4 below will assist you in answering this question.

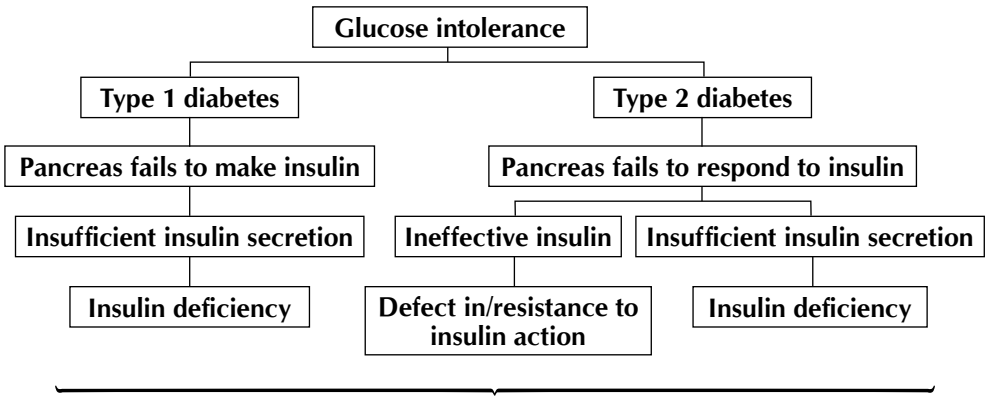

FIGURE 3.4
Difference between type 1 and type 2 diabetes

3.7.2 You will find the answer to this question on page 106 of the prescribed textbook. Note that type 1 and type 2 diabetes used to be referred to as insulin-dependent and non-insulin-dependent diabetes mellitus respectively. The latter classification was changed to types 1 and 2,

because type 2 diabetics often require insulin injections to control their blood glucose levels.

3.7.3–3.7.4

You will find the answer to these questions on page 106 of the prescribed textbook.

3.7.5 ***Tip:*** *When answering a question like this, it is important to consider the diet history given in the case study. This already provides you with some tips, for example: he only eats proper meals twice a day and snacks on foods high in sugar through the day. See page 106 in the prescribed textbook for the answer to this question.*

After working through the section "Glucose in the body", answer the question posed earlier in the study unit: How many days do you think one can go without food? There are not a specific number of days. How long you survive without food depends on your existing body stores of fat and protein, your individual health and nutrition status, as well as whether your glucose metabolism is normal or not. People who suffer from hypoglycaemia (low blood sugar) or diabetes can only go without food for short periods of time before they develop complications such as coma or death.

3.4.4 The glycaemic response and the glycaemic index (GI)

The two concepts of **glycaemic response** and **glycaemic index (GI)** are interrelated. The glycaemic response refers to the r**esponse of the body to glucose**, which may be slow, medium or fast. The GI is a **ranking of foods based on the effect they have on the glycaemic response** or, in simple terms, on the blood glucose level. The GI can be used as a tool in the dietary management of the glucose response in people with diabetes, hypoglycaemia, weight management difficulties and high blood cholesterol, and in active individuals.

STUDY

Study the section "The glycaemic response" (pp. 106–107) in the prescribed textbook.

Activity 3.8

What is the glycaemic index all about? Study the fact sheet in Appendix F of this study guide. This factsheet is also available online at: http://www.gabisteenkamp.co.za/GI.htm (accessed January 2013). It is important that you understand

- the concept of the glycaemic index (GI) and how it influences blood glucose control
- the health benefits of the GI
- how the GI is determined
- the factors influencing the GI (and how to describe them)
- how to make the GI work for you
- how to rank foods based on their effect on the glycaemic response

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Activity 3.9

You were introduced to Mr Khumalo in activity 3.7. He is 52 years old and a type 2 diabetic. You weigh him and find that he is obese. Mr Khumalo's diet history is as follows:

Breakfast
Cornflakes with full-cream milk and 3 teaspoons of brown sugar
Coffee with Cremora and 2 tsp. of brown sugar

Morning snack
Cream soda
White bread with jam and cheese

Lunch
Coffee with Cremora and 2 tsp. of brown sugar

Afternoon snack
Packet of Simba chips and a Coke

Supper
Stiff maize-meal porridge/mieliepap with mince and a bar one chocolate for dessert

Based on the information in the glycaemic index fact sheet, answer the following questions:

3.9.1 Explain to Mr Khumalo what the glycaemic index is and how it influences blood sugar control.
3.9.2 Based on Mr Khumalo's medical history, what health benefits would following a low-GI diet have for Mr Khumalo?
3.9.3 What are the other health benefits of following a low-GI diet?
3.9.4 Explain to Mr Khumalo what the difference between low, intermediate and high-GI foods is, and explain to him which of these GI groups he can consume and under what circumstances, for example to maintain his blood sugar level, after moderate exercise, or during a hypoglycaemic episode.
3.9.5 Visit the Glycaemic Index Foundation of South Africa's (GIFSA's) website at www.gifoundation.com (accessed January 2013) and access the GI food lists. Explore the different food lists. Then answer the next question.
3.9.6 Evaluate Mr Khumalo's diet history. State in each case whether the carbohydrate-containing food Mr Khumalo is consuming is high, low or intermediate GI.

Carbohydrate-containing food	Low, intermediate or high GI
Kellogg's Cornflakes	
Full-cream milk	
Brown sugar	
Cremora	

Cream soda	
White bread	
Jam	
Cheese	
Simba chips	
Coke	
Stiff maize-meal porridge/mieliepap	
Bar-one	

3.9.7 Some of the foods Mr Khumalo consumes do have a low GI, but is still high in fat and should be excluded from the diet, for example Cremora. Give other examples of such food.

3.9.8 Plan a healthy example menu for Mr Khumalo to illustrate to him which foods you would rather suggest he has. You don't have to give the portion sizes in your example menu.

Reflection on activity 3.9

3.9.1–4

You'll find the answers to these questions in the fact sheet referred to in activity 3.8.

3.9.5–7

All the GI and GL food lists appear on the GI Foundation's website. You can use these lists when planning a diet.

3.9.8 When planning a diet, it is important to remember to use the six diet-planning principles (study unit 2) and the South African Food Based Dietary Guidelines (FBDGs). An example menu should consist of breakfast, a healthy mid-morning snack, lunch, a healthy mid-afternoon snack, supper and a healthy night snack. Mr Khumalo only has tea for lunch. Do you think the tea is sufficient to maintain his blood glucose levels? The answer is no; therefore you need to add an example of lunch to his diet. According to Mr Khumalo's diet history he doesn't consume any fruit or vegetables. Remember to add all the food groups, including fruit and vegetables, to the diet.

Activity 3.10

What is the glycaemic load (GL) and how does it differ from the GI? Study the fact sheet on glycaemic load in Appendix G of this study guide. You will also find the factsheet on the following website: http://www.gifoundation.com/ (accessed January 2013). Click on the shortcut on the left

side of the home page that says 'GL concept'. After reading this, do the following tasks.

3.10.1 Explain to Mr Khumalo what the glycaemic load is.
3.10.2 Explain to Mr Khumalo what it means when a meal or food has a low glycaemic load.
3.10.3 Explain to Mr Khumalo what effects the following have on blood glucose levels:

a. a high GI food combined with high GL foods
b. a low GI food combined with high GL foods
c. a high GI food combined with low GL foods

Reflection on activity 3.10

You will find the answers to this activity on the GI Foundation website. It will not be expected of you in assignments and the examination to be able to calculate the GL per meal. For the purpose of this module you should just understand the concept of GL and its effect on blood glucose levels. You will find additional information regarding the GL on the following website: http://www.gabisteenkamp.co.za/

3.5 THE HEALTH EFFECTS AND RECOMMENDED INTAKE OF SUGARS

Did you know that there are 7 teaspoons of sugar in a 330 ml can of Coke? How many teaspoons of sugar do you think are there in a 61 g packet of Smarties and in a 90 g slab of chocolate?

A 61 g packet of Smarties contains 7.3 teaspoons of sugar and a 90 g slab of chocolate has about 10.6 teaspoons of sugar.

Often we don't consider how much sugar we consume in a day – especially the hidden sugars found in certain food products such as cereals, fruit juices and yoghurt. Remember that the sugars in our diet are mono- and disaccharides. In our diet we have two main sources of sugar, those that occur naturally in food and those that are added to food. Added sugars are the mono- and disaccharides that are added to foods and drinks during preparation and cooking (Steyn, Myburgh & Nel 2002, p. 599).

STUDY

Study the first paragraph under the heading "Health effects and recommended intakes of sugars" and the "Glossary of added sugars" on page 108 of the prescribed textbook.

Activity 3.11

3.11.1 If you e.g. ordered only a tin of coke from Café Funda and you know from that there is 7–8 teaspoons of sugar in tin of coke. How was this value calculated?
3.11.2 What is the difference between natural sugars and added sugars?
3.11.3 Visit your supermarket. Evaluate the food labels of three food products that contain sugar or added sugar. State what type of sugar or added sugar is used in the product, as well as the total amount of sugar per serving size.
3.11.4 Calculate how many teaspoons of sugar there are in the three products you have chosen.
3.11.5 Indicate whether these three food products are high in added sugars and give reasons for your answers.

Reflection on activity 3.11

3.11.1 The total sugar in tin of coke is 35–40 g and 1 teaspoon of sugar is equal to 5 ml or 5 g, therefore 35–45 g of sugar divided by 5 g is equal to 7–8 teaspoons of sugar.
3.11.2 Consult page 108 of the prescribed textbook and the information in this study guide to answer this question.
3.11.3 We will take a 61 g packet of Smarties as example:
Type of sugar = cane sugar
Total amount of carbohydrates (g) = 42.7 g
Of which sugar (g) = 36.4 g
3.11.4 1 teaspoon of sugar = 5 ml sugar = 5 g of sugar
Then 36.4 g sugar (in 61 g packet of Smarties) ÷ 5 g of sugar = 7.3 teaspoons of sugar
3.11.5 You will notice that the textbook mentions that a food product is usually high in added sugar if the ingredients list starts with any of the names of added sugars. On the Smarties packet the ingredients list starts with 'cane sugar' and it is therefore high in sugar.

3.5.1 The health effects of sugars

Sugars are found in white and brown sugar, jam, honey, syrup, sweets, and in foods made with sugar such as cakes, cookies, candy, some cereals and soft drinks. Sugar is energy dense but not nutrient dense, which means it provides us with energy but not with any nutrients. A high intake of sugar can affect our health adversely and it is therefore good practice to decrease your intake

of sugars. According to Steyn, Myburgh and Nel (2002, pp. 599–605) a high intake of sugar increases the risk for:

- obesity
- micronutrient deficiencies
- protein energy malnutrition
- dental caries

A diet high in sugar provides additional kilojoules which can contribute to weight gain and **obesity**. Research has shown that people in South Africa with a high sugar intake usually have a high intake of fat as well (Steyn, Myburgh & Nel 2002, p. 605). Sugar and fat increase the risk for the development of obesity, because both sugar and fat contribute an excess of energy to the diet.

A high intake of sugars can lead to the development of **micronutrient deficiencies**. Sugars 'dilute' vitamins and minerals in the diet and they displace nutrient-dense foods such as grains, milk, fruit and vegetables in the diet (Steyn, Myburgh & Nel 2002, pp. 604–605). This means that the intake of micronutrients decrease as the amount of sugar in the diet increases.

STUDY

Study the sections on the "Health effects of sugars" and "Nutrient deficiencies" (pp. 108–110) in your prescribed textbook.

In addition to micronutrient deficiencies, a high sugar intake can contribute to the development of **protein energy malnutrition (PEM)** in at-risk population groups such as the ill, children, elderly and those who are immune compromised. Research has shown that if a diet is high in sugar, the sugar replaces protein in the diet, thus reducing the total protein intake (Steyn, Myburgh & Nel 2002, pp. 602–604).

Together with the bacteria which are naturally present in the mouth, added sugars, as well as the sugar found naturally in foods like honey and fruit juices, contribute directly to the development of **dental caries**. Research has shown that fluoride protects against the development of caries. To reduce the risk of developing dental caries, it is recommended that the "sugar intake should be less than 40 g/day in areas in which water is not fluoridated and 55 g/day in fluoridated areas" (Steyn, Myburgh & Nel 2002, p. 201).

STUDY

Study the section "Dental caries" (p. 110) in the prescribed textbook.

A food that contributes to the development of dental caries is referred to as being **cariogenic**. Table 3.1 summarises the **cariogenicity** of foods.

TABLE 3.1

The cariogenicity of foods

FOOD GROUP	LOW CARIOGENICITY THESE FOODS ARE PROTECTIVE AGAINST DENTAL CARIES – USE WHEN TEETH CAN'T BE BRUSHED IMMEDIATELY	HIGH CARIOGENICITY THESE FOODS CONTRIBUTE TO THE DEVELOPMENT OF DENTAL CARIES – DON'T USE UNLESS FOLLOWED BY PROMPT AND THOROUGH DENTAL HYGIENE
Dairy	Milk, cheese, plain yoghurt	Chocolate milk, ice cream, milkshakes, fruit yoghurts
Meats or meat alternatives	Meat, fish, poultry, eggs, legumes	Peanut butter with added sugar, luncheon meats with added sugar, sugared glazed meats
Fruits	Fresh fruit	Dried fruit, fruit canned in syrup or juice, jam, jellies, marmalade, fruit juices and drinks eg smoothies
Vegetables	Most vegetables	Candied sweet potato or butternut, glazed carrots
Breads/cereals	Popcorn, toast, pretzels, corn chips, crackers, rolls	Biscuits & cookies, pastries eg 'koeksisters' & 'eclairs', pies, cakes, cereals
Other	Sugar-free gum & sweets, coffee & tea* without sugar, nuts	Cold drinks, fizzy dinks, energy drinks, sport drinks, squashes, candy, fudge, caramels, honey, sugar, syrups

*The tannins in tea can stain teeth

3.5.2 The recommended intake of sugars

The recommended intakes of sugar in the textbook are based on the American guidelines. In study unit 2 you have learned that in South Africa we use the Food Based Dietary Guidelines (FBDGs), which are the standard for healthy eating in our country. The FBDG states:

"Eat and drink food and drinks that contain sugar sparingly and not between meals."

STUDY

Study the section "Recommended intake of sugars" (pp. 110–111) in the prescribed textbook.

The following advice should accompany the FBDG on sugar in order to maximise protection against dental caries, prevent obesity, promote weight loss and prevent micronutrient deficiencies and protein energy malnutrition:

- Don't make a habit of consuming sweet food and drinks between meals, as this can damage your teeth.
- Reserve drinks and food that contain sugar as a treat for special occasions.
- Eat something sweet with meals and not in between.
- Read food labels to see if they contain any sugar or added sugars. Look for words such as sucrose, dextrose, corn syrup or molasses.
- Choose foods and drinks that are low in sugar or sugar free.
- Use little or no sugar when you prepare food or drinks or cook.
- Drink low-fat milk and fluoridated water instead of soft drinks, fruit juice and squashes. Try not to use sugar more than four times a day and preferably use it with meals.
- Try not to add sugar to vegetables; rather flavour with herbs.
- Use recipes that call for very little or no sugar at all.
- Use artificial sweetener in tea or coffee instead of sugar.
- Do not allow infants or small children to sleep with bottles of carbohydrate-rich liquids.
- Brush your teeth twice a day with fluoride tooth paste and floss your teeth regularly.
- Practise oral hygiene after eating or drinking anything sweet.
- Rinse your mouth with water after eating or drinking something sweet if you can't brush your teeth.
- Drink fluoridated water.
- Provide infants and children with fluoride supplements when fluoridated water is not available.
- Visit the dentist at least twice a year.
- Eat a variety of firm, fibrous food that will stimulate gum tissues, the jaw bone, and the salivary glands.

Some of the above-mentioned guidelines form part of the South African guidelines for healthy eating developed by the Department of Health (DOH 2004). Other sources used to obtain the above information were Rolfes, Pinna and Whitney (2012, pp. 108 and 110) and Steyn, Myburgh and Nel (2002, p. 602).

Activity 3.12

You were introduced to Mr Khumalo in activity 3.7 He is 52 years old and a type 2 diabetic. You weigh him and find that he is obese. According to his diet history he eats a lot of sugar and added sugars. You observe that he has a few teeth missing. Answer the following questions.

3.12.1 Was eating a large amount of sugar the cause of Mr Khumalo's diabetes? Give a reason/s for answer.
3.12.2 Explain to Mr Khumalo the health consequences of a high intake of sugar and added sugars in his diet.
3.12.3 Mr Khumalo explains to you that he has lost some of his teeth because he doesn't brush his teeth regularly. What practical advice would you give him to prevent dental caries?
3.12.4 What is the FBDG for sugar?

Reflection on activity 3.12

3.12.1 No, a high intake of sugar or carbohydrates does not cause diabetes directly, but a high intake of sugar and carbohydrates contributes to weight gain and obesity, which increase the risk of developing diabetes, as well as hypertension and heart disease.

3.12.2 Consult page 110 in the prescribed textbook and the information in this study guide to answer this question. You should note that the question refers to "the effect a high intake of sugar has on his health". Answer this question by taking Mr Khumalo's history into account. He is obese and therefore not at risk of developing protein energy malnutrition. On the other hand, he may have micronutrient deficiencies irrespective of his weight. He is obese and a high sugar intake may have contributed to his weight gain, especially if his diet is high in fat as well. He has already lost some of his teeth due to poor oral hygiene and the high sugar intake would have contributed to this.

3.12.3 Consult page 110 in the prescribed textbook and the information in this study guide to answer this question.

3.12.4 You will find the answer to this question is in this study unit and in study unit 2.

3.6 ALTERNATIVE SWEETENERS

Those with a sweet tooth or a high intake of sugar can substitute sugar (sucrose) with **alternative sweeteners**. Foods and beverages with a high sugar content add to the total carbohydrate intake in a day and some of them may be high in fat as well.

The benefit of alternative sweeteners is that they provide less or no kilojoules (energy) and don't increase blood glucose levels. This is why they are of benefit to those who want to lose weight or to people with diabetes. The safety of alternative sweeteners has been debated and there is a lot of controversy on this topic.

Make sure you understand the difference between **non-nutritive** (artificial and herbal sweeteners) and **nutritive sweeteners** (sugar alcohols) and that you are able to explain their benefits and give examples of each. You should also be able to identify alternative sweeteners on food labels and give advice on the use of alternative sweeteners.

STUDY

Study the section "Alternative sweeteners" (pp. 111–114) in the prescribed textbook.

A nutritive sweetener not discussed in the textbook is **fructose**. Fructose is found naturally in fruit and honey, but it is added to food and beverages as well. One gram of fructose provides the same amount of energy as one gram of carbohydrates, namely 17 kJ/g. The main difference between sucrose and fructose is that the latter has a lower glycaemic response than sugar and some of the other carbohydrates. The disadvantage of fructose is that it can increase cholesterol levels (Franz 2000, p. 754).

If you were asked to give advice about alternative sweeteners, remember the rule: too much sugar is harmful to your health and the same is true of artificial sweeteners. Moderation is the key.

Activity 3.13

3.13.1 Visit your nearest supermarket. Choose 10 products that contain alternative sweeteners. In each case, state the product name, the type of sweetener/s it contains, the sweetener group it falls under (ie artificial sweeteners, herbal products or sugar alcohols), the acceptable daily intake, as well as additional information provided on the packaging. Use the table below to answer this question. Canderel is used as an example.

Product name	Type of sweetener/s	Alternative sweetener group	Acceptable daily intake (ADI)	Additional information
eg Canderel	Lactose	Sugar (di-saccharide) – nutritive sweetener but not a sugar alcohol		1 tablet of Canderel provides 1.3 kJ and is equal to 1 teaspoon (5 g) of sugar, which provides 85 kJ
	Aspartame	Artificial sweetener	50 mg/kg body weight	
	Acesulfame-K	Artificial sweetener	15 mg/kg body weight	

3.13.2 Answer question 16 of the chapter review questions on "Alternative sweeteners" on page 840 of the prescribed textbook.

3.7 THE HEALTH EFFECTS AND RECOMMENDED INTAKES OF STARCH AND FIBRES

According to Vorster and Nell (2001, p. S17) a healthy and balanced diet should include "cereals and grains such as maize, wheat, sorghum, oats, breads, pasta, rice, rye, samp, maize rice, breakfast cereals and other starches". These starches are the main source of energy in the diet and provide micronutrients, dietary

fibre and a small amount of protein as well. The mentioned starches should be "consumed in an unrefined and minimally processed form and fortified cereals and grains should be used where necessary" (Vorster & Nell 2001, p. S17).

Carbohydrates are found in legumes, vegetables, fruits and milk products. Legumes, fruit and vegetables are also good sources of dietary fibres. Starches and dietary fibres have beneficial effects on health. Apart from the health benefits of starches, they are also an economic source of energy, especially in developing countries such as South Africa, and are seen as 'staple foods' (Vorster & Nell 2001, p. S23). It is therefore essential to included starches or fibres with every meal.

STUDY

Study the introductory paragraph under the heading "Health effects and recommended intakes of starch and fibres" (pp. 114–116) in the prescribed textbook.

3.7.1 The health effects of starch and fibres

Starches and dietary fibre have properties that are beneficial to health, especially if they are consumed in an unrefined and minimally processed form. Research has shown that starches and dietary fibres have a positive effect on certain diseases (Vorster & Nell 2001, p. S17) such as

- cardiovascular disease (heart disease)
- diabetes mellitus
- gastrointestinal (GI) disease (GI health)
- cancer
- overweight and obesity (weight management)

It is interesting that despite the positive effect on health, an excessive intake of fibre or a sudden increase in fibre intake can have certain negative effects. Make sure that you know the consequences of a high fibre intake and how these effects can be prevented.

STUDY

Study the section "Health effects of starch and fibres" (pp. 114–116) in the prescribed textbook.

Activity 3.14

You were introduced to Mr Khumalo in previous activities. You will remember that he is 52 years old, is a type 2 diabetic, and is obese. He explains to you that the doctor has recently told him that he has a high blood cholesterol level. Answer the questions.

3.14.1 Explain to Mr Khumalo the beneficial effects of starches and dietary fibres on his heart disease, diabetes and obesity.

3.14.2 Explain to Mr Khumalo what other benefits, apart from those mentioned in 3.14.1, a diet that includes starches and dietary fibre will have on his health.

3.14.3 Mr Khumalo is concerned that he might develop abdominal discomfort, gas and diarrhoea when he includes more fibre in this diet. Explain which precautions you would take to prevent such complications.

Reflection on activity 3.14

3.14.1 You will find the answer to this question on pages 114 and 115 in the prescribed textbook, under the headings "Heart disease", "Diabetes" and "Weight management".

3.14.2 In this question you should discuss the health effects of starches and fibres with regard to GI health and cancer. You will find the answer on page 115 of the prescribed textbook.

3.14.3 You will find the answer to this question on page 116 of the prescribed textbook.

Note

Table 4.3 (p. 116) in the prescribed textbook provides an important summary of dietary fibres, their characteristics, food sources and health benefits. You need to know this table.

3.7.2 The recommended intakes of starch and fibres

In the previous section, the beneficial effects of starch and fibre on health were discussed. Because of these advantages to one's health, the following South African FBDGs for carbohydrates, starch and dietary fibres were developed:

- **Make starchy foods the basis of most meals.**
- **Eat plenty of vegetables and fruit every day.**
- **Eat dried beans, split peas and soya regularly.**

The recommended daily intakes (number of servings per day) of starches, vegetables, fruit and legumes are summarised in table 2.1 in study unit 2. An intake of 20 to 35 grams of dietary fibre is recommended per day. One should therefore include foods which are rich in fibre with every meal. Table 3.2 below indicates the fibre content of different foods.

TABLE 3.2

Dietary fibre in foods

FOOD	FIBRE (GRAMS)	FOOD	FIBRE (GRAMS)	FOOD	FIBRE (GRAMS)
Apple, cooked (125 ml)	2,9	Cherries, fresh (10)	1,2	Orange, fresh (150 g)	3,0
Apple, fresh (150 g)	3,6	Crackers		Peach, fresh (100 g)	2,3
Asparagus, cooked (4 medium)	1,4	creamcrackers (3)	0,7	Peaches, dried (5 halves)	7,0
Avocado, fresh (100 g)	2,0	rye (3)	3,2	Pear, fresh (150 g)	3,6
Banana (100 g)	2,7	whole-wheat (3)	2,0	Peas	
Beans (125 ml)		Dates; dried (10)	4,4	dry, cooked (125 ml)	7,1
dry cooked		Figs, dried (5)	18,5	fresh, cooked (125 ml)	5,0
10,4 string, cooked	2,7	Flour (250 ml)		Plum, fresh (60 g)	1,3
Bean sprouts (60 ml)	0,5	cake	4,1	Popcorn, popped (250 ml)	1,2
Bread (per slice)		oatmeal	5,6	Prunes, dried (5)	4,8
brown	2,1	whole-wheat	11,5	Pumpkin, cooked (125 ml)	3,5
pumpernickel	1,0	Fruit salad (125 ml)	6,0	Radishes, raw (1)	0,2
white	1,1	Grapefruit, fresh (1)	2,2	Raisins (60 ml)	2,7
whole-wheat	3,6	Grapes, fresh (250 g)	2,3	Rice (125 ml)	
Broccoli (125 ml)	3,1	Lentils, cooked (125 ml)	5,2	brown, cooked	2,2
Cabbage, raw (125 ml)	2,7	Lettuce (1 leaf)	0,02	white, cooked	0,6
Carrots, raw (125 ml)	2,6	Mixed vegetables (125 ml)	5,1	Rusks (1 = 30 g)	
Cereals		Mushrooms, fresh (5 small)	1,8	white	0,6
100% bran (2 tablespoons)	3,6	Nuts (125 ml)		whole-wheat	1,2
All-bran (125 ml)	3,0	almonds	10,0	Spinach, cooked (125 ml)	5,0
Corn flakes (125 ml)	0,4	chestnuts	5,4	Strawberries (250 ml)	3,3
oats, porridge (250 ml)	2,0	peanuts	5,8	Sweet corn, canned (125 ml)	6,8
Rice crispies (125 ml)	0,1	walnuts	3,2	Tomato, raw (1 medium)	1,8
Weetbix (1)	3,2	Onion, raw (1 tablespoon)	0,1	Watermelon, 1 slice (150 mm diameter 635 mm)	4,0
wheat, puffed (125 ml)	0,3				
wheat, shredded	2,3				

NOTE: You need not study the amounts, however you need to know which foods are better sources of fibre.

STUDY

Study the section "Recommended intakes of starch and fibres" (pp. 116–117) in the prescribed textbook.

Activity 3.15

In the previous activity, you have explained to Mr Khumalo the importance of including fibre in his diet. Evaluate Mr Khumalo's diet history in activity 3.9 and then do the following tasks.

3.15.1 Give Mr Khumalo general tips on how to increase the fibre intake in his diet.

3.15.2 Adapt Mr Khumalo's usual food intake by giving him healthier alternatives for all the carbohydrates he normally consumes in a day.

3.15.3 Use table 3.2 and write down the fibre contents of the healthier alternatives you have suggested to Mr Khumalo. Use the portion sizes in table 3.2 as your portion sizes for Mr Khumalo.

3.15.4 An intake of 20 to 35 grams of dietary fibre is recommended per day. Calculate the total fibre content of the healthier alternatives. Are your alternative suggestions meeting Mr Khumalo's total daily dietary fibre requirement? If not, make adaptations to your suggestions so as to provide the required amount of fibre.

Reflection on activity 3.15

3.15.1 Consult pages 116 to 117 of the prescribed textbook and the information in this study guide to answer this question.

3.15.2–3

It is easier to answer these questions in table format. Refer to pages 116 and 117 in the prescribed textbook and the information in this study guide to answer these questions.

Carbohydrate-containing food	***Healthier carbohydrate alternative***	***Fibre content per serving***
Breakfast:	***Breakfast:***	
Cornflakes	*eg All Bran flakes*	*7 g*
Full-cream milk	*Low-fat/2% milk*	*0 g*
3 tsp. of brown sugar		
Cremora		
2 tsp. of brown sugar		
Morning snack		
Cream soda		
White bread		
Jam		
Cheese		
Lunch		
Cremora		
2 tsp. of brown sugar		
Afternoon snack		
Coke		
Simba Chips		
Supper		
Stiff maize-meal porridge/mieliepap		
Mince		
Bar-one		

3.15.4 Add the fibre contents together and compare the total with the recommendation of 20 to 35 grams of fibre per day. You are allowed

to add (for example) fruit, vegetables, legumes and high-fibre starches to Mr Khumalo's diet.

3.7.3 From guidelines to groceries

Now that we know how much carbohydrate we should eat in a day, we need to discuss which types of food we should eat and what to look for on food labels. It is important to translate the theory of the starch and fibre recommendations into practice.

How do we know whether a food product contains sugar, is high in carbohydrates or fibre, or is just a source of fibre? According to the regulations relating to the labelling and advertising of foodstuffs, Regulation R146, there are certain conditions that food products have to comply with before they can be called 'sugar free', 'virtually sugar free', 'high in carbohydrate', 'a source of dietary fibre' or 'high in dietary fibre'. Table 3.3 gives a summary of the conditions for claims regarding carbohydrates, sugars (mono- and disaccharides) and fibre on food products (DOH 2010, p. 35). This table will help you to evaluate the carbohydrate content of food.

TABLE 3.3

Conditions for carbohydrate, sugar and dietary fibre claims on food products (DOH 2010, pp. 35–36)

Mono – and disaccharides	**Virtually free or free**	**0.5 g per 100 g/ml**
Carbohydrate	High in	13 g per 100 g or 6,5 g per 100 ml
1. Dietary Fibre (as measured by the latest update of the Englyst method as stipulated in the tables in Guideline 1) ★	Source of	2.4 g per 100 g (solids)
	High in	4.8 g per 100 g (solids)
2. Dietary Fibre (as measured by the latest update of the specific general AOAC method used which are listed in the table in Guideline 1) ★	Source of	3 g per 100 g (solids)
	High in	6 g per 100 g (solids)
★ The food label is supposed to state which type of method was used to measure the total dietary fibre, the Englyst method or the AOAC method.		

STUDY

Study the section "From guidelines to groceries" (pp. 117–119) in the prescribed textbook.

Activity 3.16

On your next visit to the supermarket, write down all the nutritional information related to the carbohydrate, dietary fibre and sugar (including the type of sugar/s listed in the ingredient list) contents of the following four food products:

- Kellogg's All-Bran flakes
- Kellogg's Corn Flakes
- Bokomo Weetbix
- Tiger Oats

3.16.1 Write down the nutritional information for each of the products in the table below:

		Total CHO	Of which simple CHO/total sugar	Dietary fibre	Glycaemic index	Glycaemic load
Kellogg's All- Bran flakes	per serving					
	per 100 g					
Kellogg's Corn Flakes	per serving					
	per 100 g					
Bokomo Weetbix	per serving					
	per 100 g					
Tiger Oats	per serving					
	per 100 g					

3.16.2 Which of the products has the highest amount of sugar per serving?
3.16.3 Which of the products has the highest amount of fibre per serving?
3.16.4 Based on the parameters of 'high in carbohydrate' in table 3.3, state whether these four products are high in carbohydrate or not.
3.16.5 Calculate the grams of starch in each of the four products and indicate which one is the highest in starch per serving or per 100 grams of product. Use the serving size to calculate the grams of starch.

3.16.6 Visit the GIFSA website (www.gifoundation.com) and go to food list. Find the GI classification (low, intermediate or high) and GL for each of these four products. Remember to take note of how the GI and GL changes depending on whether the cereals are taken with or without milk.

3.16.7 Based on the GI and GL values, indicate which products Mr Khumalo will be allowed to have and which ones not? Give reasons for your answers.

Reflection on activity 3.16

3.16.1 To illustrate how an activity like this should be answered, ProNutro (whole wheat apple bake) is used as example:

Whole wheat apple bake ProNutro	***Total CHO***	***Of which simple CHO***	***Dietary fibre***	***GI***	***GL***
per 50 g serving	*30.4 g*	*6.3 g*	*13 g*	*Low*	*< 15*
per 100 g	*60.7 g*	*12.6 g*	*26 g*		

3.16.2 The amount of 'simple carbohydrate' per serving is 6.3 g. The types of sugar used in ProNutro (whole wheat apple bake) are sugar and fructo-oligosaccharides. Compare the amount of sugar per serving of the four products you had to investigate.

3.16.3 ProNutro (whole wheat apple bake) is a high-fibre product (26 g per 100 g) because it has more than 4.8-6 g of fibre per 100 g (see table 3.3).

3.16.4 According to table 3.3, a product can claim to be high in carbohydrates if it has more than 13 g of carbohydrates per 100 g. ProNutro (whole wheat apple bake) is therefore high in carbohydrates.

3.16.5 A gram of starch = total CHO – (dietary fibre + sugar)

The grams of starch in a serving of ProNutro (whole wheat apple bake) = 30.4 g – (13g + 6.3g) = 11.1 g

3.16.6 The answer is in the table in 3.16.1.

3.16.7 The whole wheat apple bake ProNutro has a low glycaemic index (GI) and the glycaemic load (GL) is less than 15. It is recommended that the GL be restricted to 20–25 for a meal and 10-15 for snacks. ProNutro is a breakfast cereal and the GL is below 20–25. This means Mr Khumalo is allowed to have ProNutro whole wheat apple bake for breakfast, because of its low GI and because it is within the recommended GL for a meal. The GL per portion is high though and it is therefore important that Mr Khumalo stick strictly to the portion size of ProNutro (whole wheat apple bake). You will find more information about the GL and GI on the website www.gifoundation.com.

3.8 CARBS, KILOCALORIES AND CONTROVERSIES

There are many controversies and misconceptions when it comes to the intake of carbohydrates. The question remains whether carbohydrate should be restricted in the diet or not.

STUDY

Study Highlight 4 entitled "Carbs, kcalories and controversies" (pp. 120–123) in the prescribed textbook to find the answer to the question whether carbohydrate should be restricted in the diet or not.

Activity 3.17

After studying Highlight 4, answer the following questions.

3.17.1 Mr Khumalo has read that a low-carbohydrate diet will help him lose weight. Do you agree with him? Explain your answer.
3.17.2 Explain to Mr Khumalo why a high intake of sugars can lead to weight gain.
3.17.3 Explain to Mr Khumalo why he is not allowed to have soft drinks and fruit juices.
3.17.4 Explain to Mr Khumalo what the most important factor in assisting with his weight loss is.
3.17.5 Explain to him how a low glycaemic meal promotes weight loss.

3.9 SUMMARY

The three major types of carbohydrates discussed in the study unit are starches, dietary fibre and sugar. Carbohydrates are essential as a source of energy and constitute the main fuel for our bodies. Providing energy is not the only function of carbohydrates. Carbohydrates are protein sparing, are the main roleplayers in energy metabolism, are important in glucose homeostasis, play a structural role in cell membranes, are responsible for the storage of energy for later use, and they also provide us with dietary fibre, protein, vitamins and minerals.

Our main food sources of dietary carbohydrates are starches, but legumes, fruits, vegetables, sugars and milk products provide us with carbohydrates as well. A healthy and balanced diet should include cereals and grains which should be consumed in an unrefined and minimally processed form, and fortified cereals and grains should be used where necessary.

Carbohydrates can be divided into simple and complex carbohydrates. Simple carbohydrates include mono- and disaccharides and complex carbohydrates

include oligo- and polysaccharides. Simple carbohydrates are also known as 'sugars'. A high intake of sugar can lead to weight gain, dental caries, and micronutrient and protein deficiencies. That is why, according to the FBDG, it is important to "eat and drink food and drinks that contain sugar sparingly and not between meals". As an alternative to artificial sweeteners, herbal products such as stevia or sugar alcohols can be added to the diet in moderation.

Complex carbohydrates like starches and dietary fibres have beneficial effects on health. Apart from the health benefits of starches, they are also an economic source of energy, especially in a developing country such as South Africa, and can be seen as our 'staple food'. They should therefore be incorporated in each meal and not be restricted unnecessarily (Vorster & Nell 2001, p. S23).

Dietary fibre, on the other hand, has no nutritive value, but plays an important role in the elimination of waste products through the formation of stools. They influence the character and quantity of bacterial flora in the colon (large intestine) and are important in the prevention and treatment of heart disease, diabetes, cancer, gastro-intestinal conditions and obesity. Dietary fibres should be introduced gradually into the diet and care should be taken to avoid excessive intake thereof.

The response of blood glucose to carbohydrates, that is the glycaemic response to carbohydrates, is measured with the glycaemic index (GI). The GI ranks foods based on their immediate effect on the blood glucose level. Foods are classified as having a low, intermediate or high GI. A low-GI diet is effective in the nutritional management of diabetes, hypoglycaemia, increased blood cholesterol levels and weight loss.

Like carbohydrates, lipids and proteins are classified as energy-yielding nutrients. These two macronutrients and their properties, physiological functions, health effects and recommended intakes will be discussed in the following two study units.

Activity 3.18: Summary activity

These problems will give you practise in doing simple nutrition-related calculations. Although the situations are hypothetical, the numbers are real, and calculating the answers provides a valuable lesson. Be sure to show your calculations for each problem.

Health recommendations suggest that 45 to 65 percent of the daily energy intake come from carbohydrates. Stating recommendations in terms of percentage of energy intake is meaningful only if energy intake is known. The following exercises illustrate this concept.

3.18.1 Calculate the carbohydrate intake (in grams) for a student who has a high carbohydrate intake (70 percent of energy intake) and a moderate energy intake (2000 kcalories a day).
How does this carbohydrate intake compare to the Daily Value of 300 grams? To the 45 to 65 percent recommendation?

3.18.2 Now consider a professor who eats half as much carbohydrate as the student (in grams) and has the same energy intake. What percentage does carbohydrate contribute to the daily intake?
How does carbohydrate intake compare to the Daily Value of 300 grams? To the 45 to 65 percent recommendation?

3.18.3 Now consider an athlete who eats twice as much carbohydrate (in grams) as the student and has a much higher energy intake (6000 kcalories a day). What percentage does carbohydrate contribute to this person's daily intake?
How does carbohydrate intake compare to the Daily Value of 300 grams? To the 45 to 65 percent recommendation?

3.18.4 One more example. In an attempt to lose weight, a person adopts a diet that provides 150 grams of carbohydrate per day and limits energy intake to 1000 kcalories. What percentage does carbohydrate contribute to this person's daily intake?
How does this carbohydrate intake compare to the Daiy Value of 300 grams? To the 45 to 65 percent recommendation?

These exercises should convince you of the importance of examining actual intake as well the percentage of energy intake.

For additional study questions and activities, go to www.cengagebrain.com and search for ISBN1111427143.

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STUDY UNIT 4

Lipids

Activity 4.1: Start-up activity and revision

In start-up activity 3.1 you ordered an early dinner from Café Funda. Use the same meal you chose and answer the following questions.

4.1.1 Identify the foods in the meal you have ordered from Café Funda that contain fat.

4.1.2 If you consume one gram of fat from the Café Funda meal, it will provide you with _____ kJ of energy.

4.1.3 Examine, in Appendix A, the nutrient composition per serving of the meal you have ordered from Café Funda. Calculate the total energy and fat content of the food you have ordered from the menu.

4.1.4 Calculate the energy provided only by the fat in your meal.

4.1.5 Calculate the percentage of energy that the fat contributes to the total energy provided by the meal.

Reflection on activity 4.1

4.1.1 If, for example, you chose the chicken, cheese and pine burger with regular chips and a Coke, the foods in the meal that contain fat would be the chicken, cheese and chips.

4.1.2 If you consume one gram of fat, it will provide you with 38 kJ of energy. Do you agree that fat provides more than twice the amount of energy per gram that carbohydrates and protein do, at 17 kJ per gram each?

4.1.3 If you chose the chicken, cheese and pine burger with regular chips and a Coke, the nutrient composition would be as follows (you will find the nutrient composition of your meal in Appendix A):

Nutrients	Chicken, cheese & pine burger	Regular chips	Coke*	Total
Total energy (kJ)	2019 kJ	1351 kJ	613.2 kJ (146 kcal × 4.2 = 613.2 kJ)	3983 kJ
Fat (g)	11.8 g	13.4 g	0 g	25.2 g

* See Appendix H, page H50 of the prescribed textbook, for the nutrient composition of Coke. The total energy of the Coke is given in kilocalories (kcal). Remember to convert it to the metric unit kilojoules.

4.1.4 The energy provided by the fat in the meal is:

Nutrients	Total	Calculation	Total energy provided
Fat (g)	25.2 g	25.2 g fat × 38 kJ/g	957.6 kJ

4.1.5 The total energy provided by the chicken, cheese and pine burger with chips and Coke meal is 3983kJ. The percentage of energy that the fat contributes to the total energy of the meal is:

Nutrients	Total energy provided	Calculations	Percentage of total energy
Fat (g)	957.6 kJ	957.6 kJ ÷ 3983 kJ = 0.2404 × 100 = 24%	24%

Therefore the percentage of energy the fat in the meal contributes to the total energy is 24%.

TIME ALLOCATION

You should spend at least 12 hours on this study unit.

Learning outcomes

On completion of this study unit you should be able to

- classify and describe the composition of lipids
- discuss the properties of lipids and their functions in the body
- explain the fundamentals of lipid metabolism in the body
- explain the effects of different lipids on health
- give and calculate the recommended intakes of fats
- recommend appropriate foods as sources of lipids

- calculate and interpret the energy provided by fat
- calculate and interpret the percentage of kilojoules fat contributes to the total energy intake
- identify risk factors for a nutrition-related condition (heart disease, cancer and obesity)
- give feasible suggestions/recommendations for the dietary management of heart disease, cancer and obesity
- provide suitable alternatives for unhealthy fat choices, given a particular diet history

4.1 INTRODUCTION

Did you know that a plate of sausages and chips, a meat pie and a slice of cake all provide about 12 teaspoons of oil (Medical Research Council 2013)? If one of these food items is consumed in a day it will provide you with an excess energy intake of 2280 kJ. If fat provides us with so much excess energy, should we avoid all fat, or are some fats good for us? You will find the answer to this question while you work through this study unit.



Lipids are the collective name given to **triglycerides** (fats and oils), **phospholipids** and **sterols** (cholesterol). Dietary lipids provide our body with a continuous supply of energy, especially when the carbohydrates stores are depleted (Wolmarans & Oosthuizen 2001, p. S48). In study unit 1 you have learnt that if you consume **one gram** of **fat**, it will provide you with **38 kJ** of energy. The acceptable macronutrient distribution range **(AMDR)** for fat in a day is between **20** and **35%** of our total energy intake (refer back to study unit 1).

Apart from providing energy, fat performs other vital functions in our body such as regulating temperature and protecting organs, and it is an important structural component in cell membranes. These are just some of the many functions of lipids in the body, which we will discuss.

Although fats have important functions in the body, a high intake can contribute to weight gain, increased cholesterol levels, heart (cardiovascular) disease, diabetes and cancer. Our main dietary sources of lipids are fats, oils, red meat, chicken, fish, nuts, legumes, milk and milk products.

READ

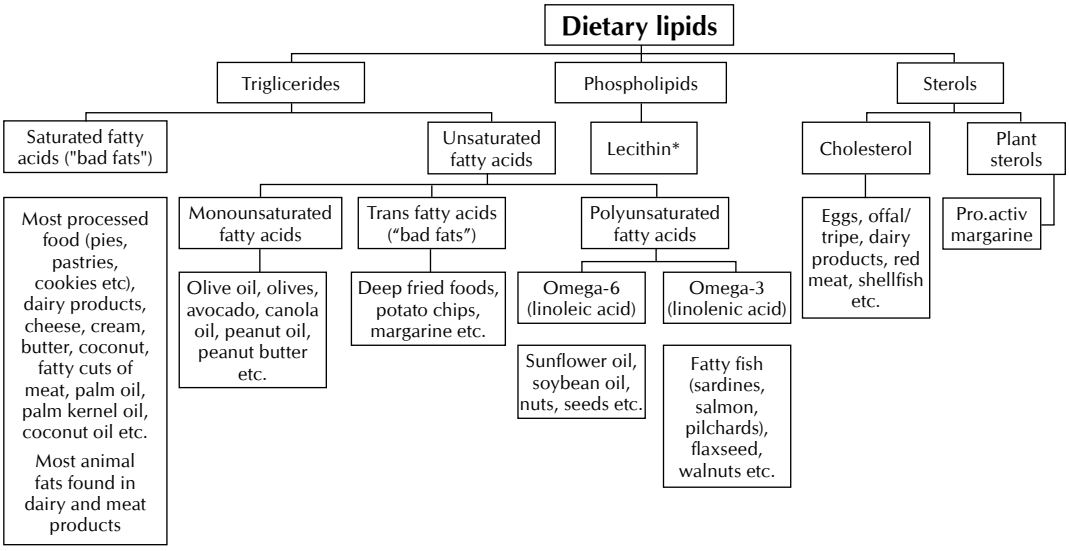
Read the introduction to chapter 5 (pp. 126–127) in the prescribed textbook.

In this study unit we are going to discuss the composition, classification, properties, role, health effects, recommended intakes and sources of dietary lipids. It

is important that you pay attention to the theory, figures, diagrams and definitions in the prescribed textbook, as these are presented in more detail there than in the study guide. Use both the study guide and textbook as study aids.

4.2 THE CHEMIST'S VIEW OF LIPIDS

This section focuses on the classification, chemical composition and properties of lipids. As indicated above, lipids are classified into three groups, namely **triglycerides, phospholipids** and **sterols**. These are the main types of lipids. Figure 4.1 below gives a summary of the classification of lipids, as well as examples of food sources containing these types of lipids. The chemical composition of lipids illustrated in figure 4.2 explains the basic structure of lipids or, in short, what they look like. The chemical composition also explains why lipids have certain properties, for example their **firmness** or **hardness** at room temperature, their **stability** when exposed to oxygen, and whether the lipid has gone through the process of hydrogenation.



* No examples of food that contain lecithin were added to the diagram, because the lecithin in food is not used by the body as a nutrient. The body produces its own lecithin in the liver.

FIGURE 4.1

Summary of the classification of dietary lipids
(Stanton, Phillips & Carapetis 2008, p. 34)

STUDY

Study the sections "The chemist's view of fatty acids and triglycerides" (pp. 127–133), "The chemist's view of phospholipids" (pp. 133–135) and "Lipids" in Appendix C (p. C-3) in the prescribed textbook.

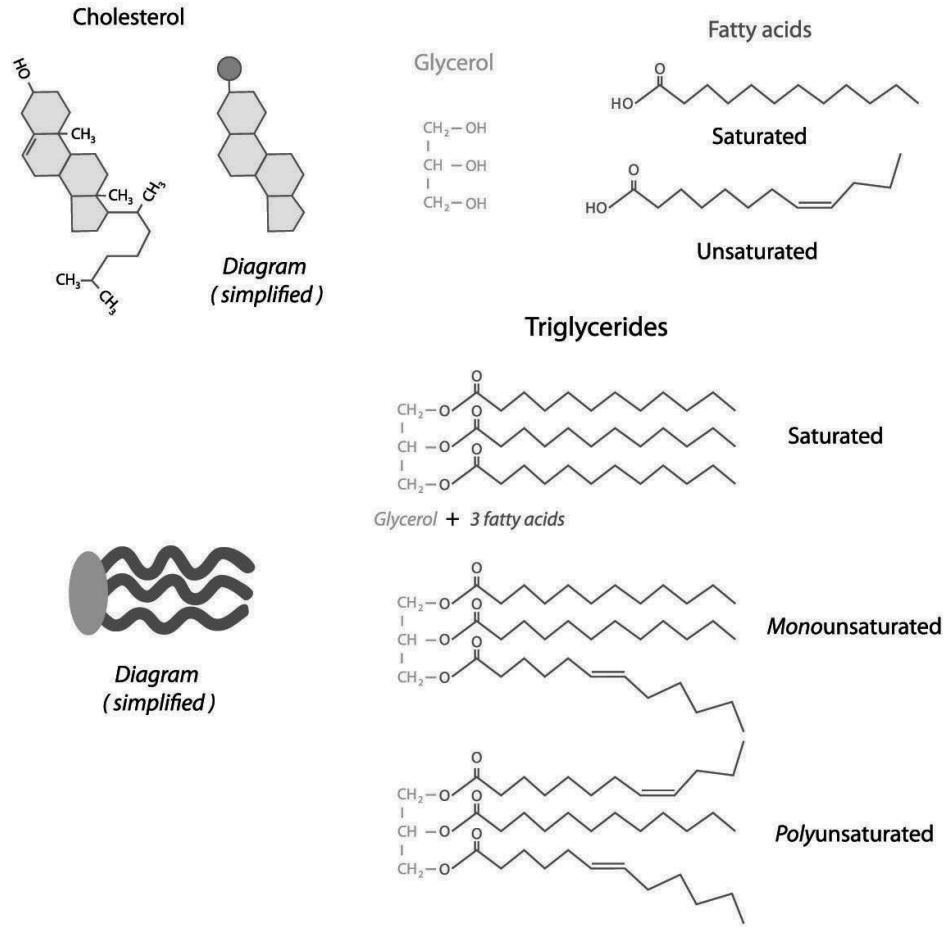


FIGURE 4.2

Summary of the chemical composition of different lipids

Note

The section in the textbook "Degree of unsaturation revisited" (pp. 131–133) gives a description of the properties of lipids.

Activity 4.2

4.2.1 Summarise what you have learned about the classification, composition and properties of lipids. Use figure 4.1 as a framework for your summary and add additional information from the textbook to the existing figure.

4.2.2 Answer the chapter review questions on "The chemist's view of fatty acids and triglycerides" on page 843 of the prescribed textbook.

4.2.3 Answer the chapter review questions on "The chemist's view of phospholipids and sterols" on page 843 of the prescribed textbook.

4.2.4 Your parents have recently started using lecithin supplements. Explain to your parents why you would not advise them to take the lecithin supplements.

4.2.5 A family member of yours was recently diagnosed with high cholesterol levels and is now on tablets to lower his cholesterol levels, but he doesn't understand why. Explain to him the harmful effects of having a high blood cholesterol level.

Reflection on activity 4.2

You will find the answers to these questions in the prescribed textbook (pp. 127–135).

4.3 DIGESTION, ABSORPTION AND TRANSPORTATION

For the purpose of this module, you don't have to study the section on the digestion, absorption and transportation of lipids. This topic will be covered comprehensively in NUT2601.

4.4 LIPIDS IN THE BODY

This section deals with the roles of lipids in the body. It is necessary that you understand the function of lipids in the body in order for you to realise that an excessive intake is unhealthy and to know why a small amount of the right type of fat remains essential in the diet.

4.4.1 The roles of triglycerides

Triglycerides, cholesterol and phospholipids individually have important functions in the body. **Triglycerides** are important as (Dominiczak 2007, pp. 44 and 56; DOH 2004, p. 22; Rolfes, Pinna & Whitney 2012, pp. 135 and 137):

- high-**energy storage** fuel
- long-term **energy reserves**
- sources of **heat** production
- **insulation** against heat loss
- **shock absorbers** for the protection of organs
- suppliers of **essential fatty acids**
- assistants in the **absorption** of the **fat-soluble vitamins A, D, E** and **K**
- components that add **flavour, tenderness** and **palatability** to food
- compounds that **increase satiety** by remaining in the stomach for longer, which means that hunger sensations are delayed

You will notice that the textbook explains that excessive amounts of fat in the diet are stored in the **adipose cells**. What the textbook doesn't mention is that this process is called **lipogenesis**. Remember that the adipose cells release various hormones called **adipokines**. Make sure that you understand what adipokines are and what their role in the body are, and that you are aware of the negative effects of adipokines on health.

STUDY

Study the sections "Lipids in the body" (p. 142) and "Roles of triglycerides" (pp. 142–143) in the prescribed textbook.

Students often get confused between the functions of triglycerides, cholesterol and phospholipids. For this reason we have summarised the roles of cholesterol and phospholipids for you.

Cholesterol is important (Wolmarans & Oosthuizen 2001, pp. 48–49; Dominiczak 2007, pp. 44 and 56):

- as **structural component** of cell membranes
- as component of **bile acid, sex hormones** (eg oestrogen, progesterone, testosterone), **steroid hormones** (eg cortisol) and **vitamin D**
- as important component of **brain** and **nerve cells**
- as **emulsifier** (during the digestive process bile assists in making fat soluble in the watery gastro-intestinal (GI) juices so that it can be broken down by enzymes into smaller fat molecules which can be absorbed from the gut)

Phospholipids are important (Wolmarans & Oosthuizen 2001, pp. 48–49; Dominiczak 2007, pp. 44 and 56):

- as **structural components** of cell membranes
- as **emulsifiers**
- in **cellular signalling**, that is, the transmission of information from one molecule to another so that certain activities can occur within the body cells

4.4.2 Essential fatty acids

Lipids which are important for our health, but not produced by the body are the **essential fatty acids** known as **linoleic acid (omega-6)** and **linolenic acid (omega-3)**. It is important that you know these fatty acids and understand the role each of them plays in the body.

Our overall dietary intake of omega-6 in the form of vegetable oils has increased in the last century and our intake of omega-3 has decreased. A concept in the textbook that is important to understand clearly is that omega-6 and omega-3 compete for the same enzymes and that a diet high in omega-6 will decrease the metabolism (use) of omega-3 and vice versa (Schwalfenberg 2006, p. 735). Figure 4.3 shows that omega-6 promotes inflammation (is pro-inflammatory) and omega-3 reduces inflammation (is anti-inflammatory). Apart from this benefit of omega-3, it has other important health benefits (see figure 4.3) which omega-6 does not have. The aim of the diet should therefore be to increase the intake of omega-3, which will then decrease the metabolism (use) of omega-6.

STUDY

Study the section "Essential fatty acids"' (pp. 142–144) in the prescribed textbook.

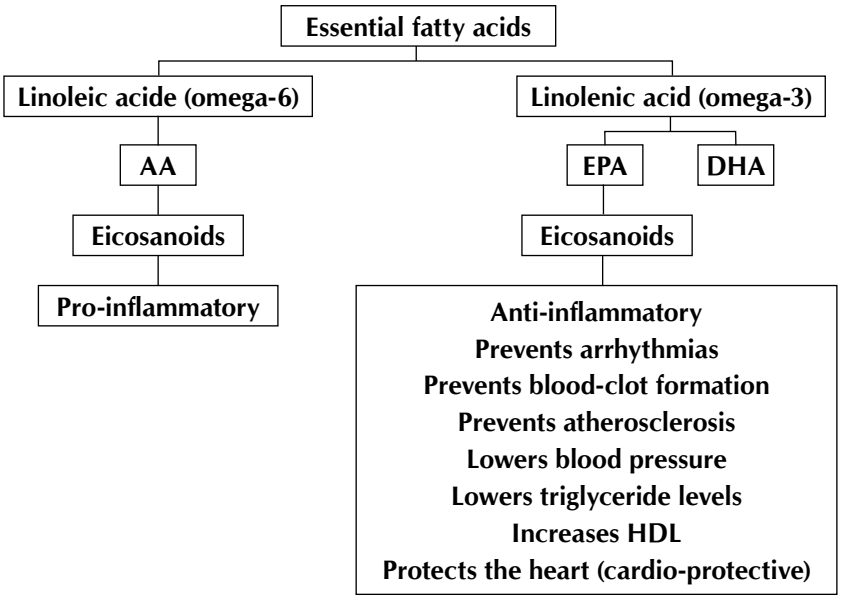
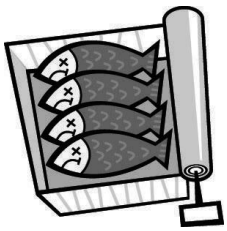


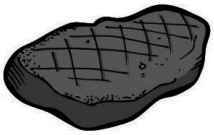
FIGURE 4.3

Metabolism and functions of essential fatty acids (AA = Arachidonic acid; EPA = Eicosapentanoic acid; DHA = Docosahexaenoic acid; HDL = high-density lipoproteins = 'good cholesterol') (Schwalfenberg 2006, p. 735)

Activity 4.3

Complete the following table by identifying the main type of essential fatty acid in the foods in the left-hand column. Then answer the question about the fatty acid in the right-hand column.

Essential fatty acids	Linoleic acid (omega-6)	Linolenic acid (omega-3)	Answer the question below
Sardines 			List all of the health benefits of this type of fatty acid.
Sunflower oil 			List one disadvantage of this fatty acid in the diet.

Sesame seeds  Pumkin seeds 			Into which 20-carbon poly-unsaturated fat is this fatty acid converted in the body?
Walnuts 			Into which 20- and 22-carbon polyunsaturated fats is this fatty acid converted in the body?
Meat contain small amounts of this type of essential fatty acid 			List some of the symptoms of a fatty-acid deficiency of this kind.

Reflection on activity 4.3

You will find the answers to these questions on pages 143, 146 and 147 of the prescribed textbook.

4.4.3 A preview of lipid metabolism

In study unit 3 you have learned that glycogen supplies us with our immediate energy needs when our food provides insufficient amounts of glucose, for example when we skip a meal or do exercise. Glycogen is therefore our 'emergency' energy source. When you fast for 12 hours or more the 'back-up' energy stores, namely protein and fat, are used for energy. Figure 4.4 illustrates that the 'back-up' energy during fasting and starvation is released through the metabolic processes of gluconeogenesis and lipolysis respectively. Lipolysis is the breakdown of triglycerides into glycerol and fatty acids. Both of these are eventually, through multiple steps, converted into the energy source glucose (Dominiczak 2007, pp. 2, 6, 86–89 and 134).

Time scale	Main energy fuel	
Minutes to 1 hour after a meal	Glycogenolysis: glycogen → glucose →	ENERGY
12 hour fast	Gluconeogenesis: protein & glycerol → glucose →	
Prolonged starvation	Lipolysis: triglycerides → fatty acids →	

FIGURE 4.4

Metabolic fuels used during fasting and starvation (Dominiczak 2007, p. 134)

The 'back-up' energy provided during exercise is slightly different, as you will see in figure 4.5. Glycogen supports the exercising muscles for about an hour. However, after 15 to 20 minutes fatty acids are released from the adipose tissue and used as the principal fuel or energy source. Soon after this gluconeogenesis starts, producing glucose (Dominiczak 2007, p. 124).

Time scale	Main energy fuel	
Minutes to 1 hour	Glycogenolysis: glycogen → glucose →	ENERGY
Prolonged exercise	Lipolysis: triglycerides → fatty acids →	
Prolonged starvation	Gluconeogenesis: protein & glycerol → glucose →	

FIGURE 4.5

Metabolic fuels used during exercise (Dominiczak 2007, p. 125)

STUDY

Study the section "A preview of lipid metabolism" (pp. 144–145) in the prescribed textbook.

Activity 4.4

Mrs Ramaphosa is 61 years old. She has high blood pressure, type 2 diabetes and high blood cholesterol levels. She is also severely overweight. She is using a nutritional supplement that contains both omega-3 and omega-6 fatty acids. Answer the following questions.

4.4.1 Mrs Ramaphosa has a large amount of adipose tissue and adipose tissue secretes hormones called adipokines. Explain how the adipokines could have contributed to her chronic diseases and obesity.

4.4.2 Explain to Mrs Ramaphosa why it is better for her to use a fatty acid supplement that only contains omega-3.

4.4.3 Explain to Mrs Ramaphosa the general health benefits of using an omega-3 supplement.

4.4.4 Explain to Mrs Ramaphosa how exercise will help her to lose some of her adipose tissue.

4.4.5 In study unit 3 the following question was asked: 'How many days can you go without food?' After studying this section, do you think a fatter or thinner person will survive longer in a famine? Give a reason/s for your answer.

Reflection on activity 4.4

4.4.1 To answer this question, you have to explain the link between adipokines, obesity and chronic diseases as discussed on page 142 of the prescribed textbook.

4.4.2 Consult page 142 of the prescribed textbook and the information in this study guide to answer this question.

4.4.3 Consult pages 143, 146 and 147 of the prescribed textbook and the information in this study guide to answer this question.

4.4.4 Consult page 144 of the prescribed textbook and the information in this study guide to answer this question.

4.4.5 The answer to this question is on page 144 of the prescribed textbook.

4.5 THE HEALTH EFFECTS AND RECOMMENDED INTAKES OF LIPIDS

In the next sections we are going to discuss the health effects and recommended intakes of lipids.

4.5.1 The health effects of lipids

By now you know that triglycerides, cholesterol and phospholipids have important functions in the body. However, a high intake of fat has certain health consequences, and a low-fat diet has certain health benefits. Different lipids have different effects on health. Some, such as polyunsaturated fatty acids (PUFAs) and monounsaturated fatty acids (MUFAs) are beneficial, while others such as saturated fats, trans fats and cholesterol may have some negative effects on health.

Before we start discussing the health effects of lipids, it is necessary to understand what **lipoproteins** are. Lipoproteins are molecules that consist of different combinations of lipids and proteins. Their main function is to transport lipids in the blood (Rolfes, Pinna & Whitney 2012, p. 141). There are 5 different lipoproteins and each one is different in size and its composition of lipids and proteins (Dominiczak 2007, p. 60). The different lipoproteins are:

- chylomicrons
- very-low-density lipoproteins (VLDL)
- intermediate-density lipoproteins (IDL)
- low-density lipoproteins (LDL)
- high-density lipoproteins (HDL)

The lipoproteins relevant in the diet and for health are **LDL** ('bad' cholesterol) and **HDL** ('good' cholesterol). The levels of these lipoproteins can be tested in the blood, together with **total cholesterol (TC)** and **triglycerides (TG)** levels.

STUDY

Study the section "Health implications" on page 141 of the prescribed textbook. Make sure that you can identify the factors that lower LDL and/or raise HDL.

Note

The textbook gives the normal blood values of these lipoproteins in **mg/dL**. To convert mg/dL to the **mmol/L** that we use, **multiply** the mg/dL value with the factor **0.02586** (Anderson et al, 2002:1857). **Example:** Total cholesterol (TC): < 200 mg/dL x 0.02586 = 5.2 mmol/L

See if you can calculate the mg/dL values (see page 145 in your textbook):

LDL cholesterol → _____ mmol/L
HDL cholesterol → _____ mmol/L
Triglycerides → _____ mmol/L

STUDY

Study the sections "Health effects of lipids" (pp. 145–148) and "Highlight 5: High fat foods – friend or foe" (pp. 156–159) in the prescribed textbook.

Activity 4.5

You were introduced to Mrs Ramaphosa in activity 4.4. She is 61 years old, has high blood pressure, type 2 diabetes and a high blood cholesterol level, and is obese. She is using a nutritional supplement that contains both omega-3 and omega-6 fatty acids. Answer the following questions. It is important that you integrate the information from the textbook and the study guide in order to answer these questions.

4.5.1 Explain to Mrs Ramaphosa the risk of having an increased blood cholesterol level.

4.5.2 Explain to Mrs Ramaphosa in laymen's terms the different types of lipids that we find in the diet and provide her with four examples of each type of lipid.

4.5.3 Explain the effect of the following lipids on blood cholesterol levels and heart disease:

(a) saturated fat
(b) trans fats
(c) cholesterol
(d) monounsaturated fats
(e) polyunsaturated fats
(f) omega-3

4.5.4 Which changes to her diet would you suggest to Mrs Ramaphosa to lower her intake of saturated fats?

4.5.5 Mrs Ramaphosa read in a magazine that fat can cause cancer and she is worried because her mother died of breast cancer. Discuss

with her the types of lipids she should exclude from her diet to decrease her risk of cancer.

4.5.6 Explain to Mrs Ramaphosa how a low-fat diet will help her to lose weight.

Reflection on activity 4.5

You should learn early on in your studies how to integrate a large amount of information. To be able to answer the questions in this activity, you will have to work through the theory and integrate what you have learned. Use the following table as a guide when summarising this section. As you attentively read through the pages in the prescribed textbook ("Health effects of lipids" on pp. 145-148 and "Highlight 5: High fat foods – friend or foe" on pp. 156–159), add the relevant information to the table. Once you have summarised this section, it will be easy to answer the questions above, and to study this section for the exam.

Type of dietary fat		***Health effects***	***Examples of food sources***
Saturated fatty acids			
Trans *fatty acids*			
Cholesterol			
Monounsaturated fatty acids (MUFAs)			
Polyunsaturated fatty acids (PUFAs)	***Omega-3***		
	Omega-6		

4.5.2 Recommended intakes of fats

Now that you know the health effects of different fats and that not all fats are bad, the question remains, how much is a healthy amount of fat to consume in a day? What amount and types of fat will reduce the risk for heart disease, and not cause excessive weight gain?

The AMDR for fat and the adequate intakes (AI) of linoleic and linolenic acid are given in the prescribed textbook. According to the textbook, cholesterol intake should be limited to less than 300 mg cholesterol per day in healthy individuals and less than 200 mg in those with high blood cholesterol levels (Rolfes, Pinna & Whitney 2012, pp. 146 and 148).

Although the AMDR for fat is between 20 and 35% of the total energy intake, research has shown that a diet that consists of 30% fat (a moderate fat diet), which is low in saturated fatty acids (<10% of the total daily energy intake from fats) and in which MUFAs and PUFAs are used as replacements for saturated fatty acids, has more health benefits than a diet that consists of 35% fat (Wolmarans & Oosthuizen 2001, p. S50).

STUDY

Study the sections "Recommended intakes of fats" (pp. 148–150), "How to make heart healthy choices" (p. 150) and "How to calculate a personal daily value of fat" (p. 153) in the prescribed textbook.

The South African guidelines differ slightly from those given in the textbook. You have to combine the guidelines in the textbook with the South African guidelines. The FBDGs applicable to fat are the as follows:

- **Eat dry beans, slit peas, lentils and soya regularly:** The majority of legumes are low in fat. The only exceptions are chickpeas and soybeans. However, these two still provide less fat and are better sources of saturated fat than, say, red meat and cheese. Also keep in mind that soybeans are a source of sterols. Legumes are mainly a source of linoleic acid (omega-6) but they also contain small amounts of omega-3 fatty acids (Venter & Van Eyssen 2001, p. S33–S34). Legumes should therefore be recommended as a source of 'good' fats and as a lower-fat alternative to meat and other protein-containing foods.
- **Chicken, fish, other meat, milk or eggs can be eaten daily (Scholtz et al 2001, p. S46):**
  - It is recommended that you choose low-fat, fat-free/skim milk and reduced-fat cheeses rather than the full-fat/full-cream options.
  - Fish should be eaten two to three times per week – especially darker fish such as pilchards or mackerel.
  - Four eggs can be eaten per week, preferably in the place of meat.
  - Choose lean cuts of meat and lower-fat options. It is recommended that you don't consume more than 560 g of red meat per week (that is approximately 80–90 g per day) and that you rather use low-fat cooking methods when preparing the meat.
- **Eat fats sparingly:** Aim for a low intake of saturated and trans fats in the form of fatty red meat, butter, hard block margarine, cream, ghee and lard and rather choose unsaturated fats from vegetable oils, soft tub margarine, nuts, seeds, peanut butter and avocados (Wolmarans & Oosthuizen 2001, p. S50).

Activity 4.6

Refer back to the scenario in activity 4.1. Take the Café Funda meal you've ordered into consideration and answer the following questions.

4.6.1 Calculate the total amount of saturated fat and cholesterol that the Café Funda meal you have ordered contains. Use the nutritional information in appendix A to answer this question.

4.6.2 Calculate the amount of energy provided by the saturated fat in the meal.

4.6.3 Calculate the percentage of energy that the saturated fat contributes to the total energy of the meal.

4.6.4 Based on the recommended intake for saturated fatty acids, comment on the percentage of energy that the saturated fats contribute to the total energy of the meal.

4.6.5 Based on the recommended intake of cholesterol for healthy individuals, comment on your intake of cholesterol from the Café Funda meal.

Reflection on activity 4.6

4.6.1 If you chose the chicken, cheese and pine burger with regular chips and a Coke, the nutrient composition would be as follows (you will find the nutrient composition of your meal in appendix A):

Nutrients	Chicken, cheese & pine burger	Regular chips	Coke*	Total
Total energy (kJ)	2019 kJ	1351 kJ	613.2 kJ	3983 kJ
Fat (g)	11.8 g	13.4 g	0 g	25.2 g
Saturated fat (g)	5.1 g	2.2 g	0 g	7.3 g
Cholesterol (mg)	92 mg	0 mg	0 mg	92 mg

4.6.2 The energy provided by the saturated fat in the meal:

Nutrients	Total	Calculation	Total energy provided
Fat (g)	7.3 g	7.3 g fat × 38 kJ/g	277.4 kJ

4.6.3 The percentage of energy that the saturated fat contributes to the total energy of the meal: The total energy of the chicken, cheese and pine burger with chips and Coke meal = 3983 kJ.

Nutrients	Total energy provided	Calculations	Percentage of total energy
Saturated fat (g)	277.4 kJ	277.4 kJ ÷ 3983 kJ = 0.07044 × 100 = 7%	7%

Therefore the percentage of energy the saturated fat in the meal contributes to the total energy is 7%.

4.6.4 The recommended intake of saturated fats in a day is less than 10% of the total energy intake and the percentage of energy from saturated fat in the meal is 7%. This means that the amount of saturated fat intake for this meal falls within the recommended amount. But the recommended amount is for a day, and not one meal only, which means that you should monitor your intake of saturated fat for the rest of the day.

4.6.5 The total cholesterol intake in a day should be limited to less than 300 mg cholesterol per day in healthy individuals and less than 200 mg in those with high cholesterol levels. The meal provides 92 mg cholesterol,

which is less than the recommended amount – but once again the recommended amount is for a whole day, which means that you will need to monitor your intake of cholesterol for the rest of the day.

4.5.3 From guidelines to groceries

The lipids we ingest are mainly in the form of triglycerides which come from fats, oils, nuts, avocado, red meat, chicken, fish and dairy. Only a small percentage of the total dietary fat consists of sterols and phospholipids.

The South African FBDGs recommend that we should **'eat fats sparingly'**. This guideline should be accompanied with dietary advice regarding

- the types of fats we should consume ('good' fats versus 'bad' fats) and their health effects
- food sources of 'good' and 'bad' fats
- other sources of fat, for example some breads, cereals, starches, milk and other dairy products, legumes and protein foods
- the reduction of fat intake
- healthy cooking methods
- the reading of food labels

The reading and interpretation of food labels will be discussed later in this study unit.

STUDY

Study the section "From guidelines to groceries" (pp. 150–151) in the prescribed textbook.

Activity 4.7

Mrs Ramaphosa (from activity 4.4 and 4.5) wrote down what she usually eats in a day:

Breakfast: Soft maize-meal porridge with full-cream milk and 2 tablespoons (tbs) of hard margarine mixed into the porridge, together with a cup of tea and 2 heaped teaspoons (tsp) of Cremora

Snack: 2 slices of brown bread with hard margarine spread thickly on the bread, an apple and a cup of tea with 2 heaped tsp of Cremora

Lunch: 2 sausages and chips with a Coke Light

Snack: 3 cookies

Supper: 'Vetkoek' and mince with a cup of tea and 2 heaped tsp of Cremora

According to her diet history, Mrs Ramaphosa consumes a total of 2500 kcal of energy, 123 g of protein, 247 g of carbohydrates and 110 g of fat, of which 39 g come from saturated fat in a day. Her cholesterol intake from food is 444 mg per day. Go back to activity 4.4 and 4.5 and read through Mrs Ramaphosa's medical history. Then answer the following questions.

4.7.1 Calculate the percentage of energy that fat, saturated fat and carbohydrates contribute to the total energy intake and discuss your results.
4.7.2 Comment on Mrs Ramaphosa's intake of cholesterol.
4.7.3 Given her particular diet history, provide suitable alternatives for her unhealthy fat choices.
4.7.4 What additional dietary advice would you give her to assist her in lowering her intake of fatty foods?

Reflection on activity 4.7

4.7.1 First convert the non-metric units to metric units before doing any calculations:

Total energy (TE) = 2500 ***kcal*** *x 4.2 = 10 500* ***kJ***

Mrs Ramaphosa takes in a total of 110 g of fat per day.

$$\text{\% kilojoules (energy) from fat} = \left[\frac{110\ g\ \text{fat} \times \frac{38\ kJ}{g}}{TE}\right] \times \frac{100}{1}$$

$$= \left[\frac{4180\ kJ}{10500\ kJ}\right] \times \frac{100}{1}$$

$$= 39.81\% \approx 40\%\ \text{of TE}$$

Discussion: The percentage of energy that fat in her diet contributes to Mrs Ramaphosa's total energy intake is 40%. According to the AMDR for fat, 20 to 35% of her total energy intake in a day should come from dietary fat. Considering that 40% of her diet consists of fat, her intake of fat is too high. This means that Mrs Ramaphosa should cut down on her total fat intake. Her high intake of energy-dense fatty foods contributed to the development of obesity and consequently hypertension, type 2 diabetes and high cholesterol levels. Her chronic disease conditions and obesity make it essential for her to reduce her fat intake to 30% or less of her total energy intake.

Mrs Ramaphosa takes in 39 g of saturated fat per day.

$$\text{\% kilojoules (energy) from saturated fat} = \left[\frac{39\ g\ \text{fat} \times \frac{38\ kJ}{g}}{TE}\right] \times \frac{100}{1}$$

$$= \left[\frac{1482\ kJ}{10500\ kJ}\right] \times \frac{100}{1}$$

$$= 14.11\% \approx 14\%\ \text{of TE}$$

Discussion: The percentage of energy that the saturated fat in her diet contributes to her total energy intake is 14%. According to the recommendations, her saturated fat intake should be less than 10% of her total energy intake. This high intake of saturated fats will inevitably contribute to her high cholesterol levels. Mrs Ramaphosa needs to decrease her intake of saturated fat and increase her intake of MUFAs and PUFAs.

Mrs Ramaphosa takes in 247 g of carbohydrates per day.

$$\text{\% kilojoules (energy) from carbohydrates (CHO)} = \left[\frac{247\ g\ CHO \times \frac{17\ kJ}{g}}{TE}\right] \times \frac{100}{1}$$

$$= \left[\frac{4199\ kJ}{10500\ kJ}\right] \times \frac{100}{1}$$

$$= 39.999\% \approx 40\%\ \text{of TE}$$

Discussion: The percentage of energy that carbohydrates contribute to her total energy intake is 40%. According to the AMDR, 45 to 65% of her total energy intake should come from carbohydrates. Mrs Ramaphosa's intake of carbohydrates is too low. She should therefore increase her intake of carbohydrates. She should include more cereals and whole grains in her diet, as well as other food sources which are high in both soluble and insoluble dietary fibre, because dietary fibre assists in managing blood glucose in type 2 diabetes, reduces cholesterol and assists with weight loss.

4.7.2 Mrs Ramaphosa's daily intake of cholesterol is too high and is more than the recommended 200 mg for individuals with high blood cholesterol levels. She will benefit from a diet that is low in foods that contain cholesterol, such as eggs, full-cream milk products, cheese, red meat, chicken and shellfish.

4.7.3 Start a question like this one by first highlighting the foods in Mrs Ramaphosa's diet that are high in saturated or trans fats. Then draw a table, similar to the one below and answer the question.

Food high in saturated and trans fats	***Healthier alternative***
Breakfast: *full-cream milk* *hard margarine* *Cremora*	***Breakfast:*** *eg fat-free/skimmed milk*

Snack *hard margarine spread thickly on the bread* *Cremora* ***Lunch*** *2 sausages and chips* ***Snack*** *3 cookies* ***Supper*** *'vetkoek'* *mince* *Cremora*	

4.7.4 You should provide Mrs Ramaphosa with additional dietary advice, for example:

- *Use low-fat cooking methods – for instance, use a non-stick spray or lightly coat the pan*
- *with vegetable oil; boil, bake, grill, poach, steam and microwave foods instead of frying them (DOH 2004, p. 24).*
- *Read the labels on food (see the next section).*
- *Eat less fried and deep-fried foods, such as take-away foods (DOH 2004, p. 24).*
- *Spread margarine thinly on bread (DOH 2004, p. 24).*
- *Increase your intake of fruits and vegetables.*
- *Don't add margarine or butter to vegetables.*
- *When buying meat, rather buy lean meat and cut visible fat from the meat.*
- *Use fish, lentils, split peas or dried beans instead of red meat, chicken and cheese (DOH 2004, p. 24).*

These are just a few examples of additional advice you can give Mrs Ramaphosa. Consult the section on "How to make heart healthy choices – by food group" on page 150 of the prescribed textbook.

(a) Fat replacers

In our country two types of fat replacers are available and they are referred to as **novel fats**. These two are **Salatrims** which contains 22 kJ/g and **Olestra®** which contains zero kJ/g (DOH 2010, p. 45).

STUDY

Study the section "Fat replacers" (pp. 152–153) in the prescribed textbook.

(b) Read food labels

How do we know if a food product is high or low in fat? According to Regulation R146 which governs the labelling and advertising of foodstuffs, there are certain conditions that food products have to com-

ply with before they can be called 'low in', 'virtually free from' or 'free from' fat, saturated fat or cholesterol. Table 4.1 below gives a summary of the conditions for fat claims on food products (DOH 2010, p. 35).

It is important to note that any wording on a label that states that a product is 'lean', 'trim', 'extra lean', 'reduced fat', 'light' or 'lite' does not mean that it is low in fat. Yet, even though it is not low in fat in terms of the definition of a low-fat product in table 4.1, it is likely to still be a better food choice than its full-fat counterpart.

TABLE 4.1

Conditions for fat claims on food products (DOH 2010, p. 35)

Total fat	Low	3 g per 100 g (solids*) 1.5 g per 100 ml (liquids*)
	Virtually free or free from	0.5 g per 100 g/ml
Saturated fat	Low	1.5 g per 100 g (solids*) 0.75 g per 100 ml (liquids*) and not more than 10% of energy
	Virtually free or free	0.1 g per 100 g (solids*) 0.1 g per 100 ml (liquids*)
Cholesterol	Low	20 mg per 100 g (solids*) 10 mg per 100 ml (liquids*)
	Virtually free or free	5 mg per 100 g (solids*) 5 mg per 100 ml (liquids*)
		and for both claims, low and free of, less than: 1.5 g saturated fat and trans fat combined per 100 g (solids) or 0.75 g saturated fat per 100 ml (liquids) and 10% ** of energy from saturated fat

You must be able to identify food products which are 'low in' or 'virtually free from' or 'free from' fat. As mentioned earlier in this study guide, it is important when educating others on how to "eat fats sparingly" that you should be able to explain to them how to read and interpret food labels so that they can make healthier food choices.

In study unit 1 you have learnt that the daily value is not given on food labels in South Africa. Instead, the nutrient reference value (NRV) which is based on the percentage recommended dietary allowance (RDA) per serving, is given. The textbook states that the '% daily value' and '% kilocalories from fat' are not the same (Rolfes, Pinna & Whitney 2012, p. 155). The same is true for the South African food labels. The percentage NRV or RDA is not equal to the 'percentage of kilojoules from fat'. See your textbook.

STUDY

Study the section "Read food labels" (pp. 153–155) in the prescribed textbook.

In South Africa the Heart and Stroke Foundation has developed the 'heart mark' (see figure 4.6) to make it possible to immediately identify healthy food products on the shelf. Food products that have the 'heart mark' on them are 'low in cholesterol, low in fat (both saturated fat and trans fats), low in sodium (salt) and added sugar, and high in fibre (where applicable) (Heart and Stroke Foundation 2013). Look out for the 'heart mark' on different food products on the shelves in the supermarket and become more aware of foods that are healthier, 'heart-friendly' options.

FIGURE 4.6
The 'heart mark' (Heart and Stroke Foundation, 2013)

For more information about the 'heart mark', heart-mark products and the Heart and Stroke Foundation, visit their website at www.heartfoundation.co.za.

Activity 4.8

Mrs Ramaphosa enjoys eating chicken livers. Chicken livers contain about 10 g fat per 100 g and 550 mg cholesterol per 550 mg per 100g. Remember to take Mrs Ramaphosa's medical conditions (see activity 4.4 and 4.5) into account when answering the questions below (refer back to previous activities).

4.8.1 Do you think chicken livers are a healthy choice, based on the cholesterol and total fat content per 100 g of chicken livers? Give reasons for your answer.

Reflection on activity 4.8

4.8.1 Let's take chicken giblets as an example, because it is high in cholesterol as well. Chicken giblets provide 6.5 g fat and 252 mg cholesterol per 100 g. A low-fat product is one that contains less than 3 g fat per 100 g. Chicken giblets contain more than 3 g fat per 100 g. The recommended cholesterol intake per day for someone like Mrs Ramaphosa who suffers from high cholesterol is 200 mg or less. Per 100 g, the chicken giblets

provide more than the recommended daily cholesterol. Now answer the question for 100 g of chicken livers.

Activity 4.9

4.9.1 Visit your nearest supermarket and complete the following table.

Type of food product to identify	Name of the product	Total fat content per 100 g or 100 ml
5 food products that are 'low fat' based on their nutrient composition	1. 2. 3. 4. 5.	1. 2. 3. 4. 5.
5 food products that claim to be 'lean', 'trim', 'extra lean', 'reduced fat', 'light' or 'lite'	1. 2. 3. 4. 5.	1. 2. 3. 4. 5.

4.9.2 What is the main difference between the 'low-fat' food products and those that claim to be 'lean', 'trim', 'extra lean', 'reduced fat', 'light' or 'lite'?

4.9.3 Visit your supermarket and complete the following table.

Food product high in cholesterol	Cholesterol content per 100 g or 100 ml
1. 2.	
Food product low in cholesterol	**Cholesterol content per 100 g or 100 ml**
1. 2.	
Food product high in saturated fat	**Saturated fat content per 100 g or 100 ml**
1. 2.	
Food product low in saturated fat	**Saturated fat content per 100 g or 100 ml**
1. 2.	

4.9.4 Visit your supermarket and write down the names of 10 food products that feature the 'heart mark'. Remember that the food products with the 'heart mark' on them are 'low in cholesterol, fat (both in saturated fat and trans fats), sodium (salt) and added sugar, and are high in fibre'.

Food products	Total fat content (g)	Saturated fat content (g)	Cholesterol content (mg)
1. 2. 3. 4. 5. 6. 7. 8. 9. 10.			

4.9.5 Explain to Mrs Ramaphosa why a food product that has a 'heart mark' on it is a good choice.

4.6 SUMMARY

The three main types of dietary lipids are triglycerides, phospholipids and sterols. We consume lipids mainly in the form of triglycerides from fats, oils, avocado, legumes, protein products and dairy. Lipids are energy dense and provide more than double the amount of energy that carbohydrates and proteins do. They should therefore be consumed in moderation, but at the same time not be excluded from the diet. Lipids are the only source of essential fatty acids in the diet and are carriers of the fat-soluble vitamins A, D, E and K. Lipids are important as a long-term energy reserve, they protect vital organs against mechanical shock, and they serve as insulation against the cold. Apart from these functions, lipids increase the palatability of the diet and increase satiety after a meal. It is therefore recommended that one should 'eat fats sparingly' by limiting the intake of 'bad' fats such as saturated fats, trans fats and cholesterol, and that one should increase the intake of 'good' food rich in mono- and polyunsaturated fatty acids. Now that you have learned more about dietary lipids, what changes do you need to make to your own diet to make it heart healthy and low in fat?

Activity 4.10: Summary activities

4.10.1 Compile a menu for one day (breakfast, lunch and supper, with snacks in-between) for an overweight friend who needs to reduce his intake of saturated fat, trans fats and cholesterol.

4.10.2 Answer questions 16 to 23 of the "Chapter review" questions on pages 843 of the prescribed textbook.

For additional study questions and activities go to www.cengagebrain.com and search for ISBN1111427143.

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STUDY UNIT 5

Proteins

Activity 5.1: Start-up activity and revision

In start-up activity 3.1 you ordered an early dinner from Café Funda. Use the same meal you chose then and answer the following questions.

5.1.1 Identify the foods in the meal you have ordered from Café Funda that contain protein.

5.1.2 If you consume one gram of protein from the Café Funda meal, it will provide you with _____ kJ of energy.

5.1.3 Examine, in Appendix A, the nutrient composition per serving of the meal you have ordered from Café Funda. Calculate the total energy and protein content of the food you have ordered from the menu.

5.1.4 Calculate the energy provided only by the protein in your meal.

5.1.5 Calculate the percentage of energy that the protein contributes to the total energy of the meal.

Reflection on activity 5.1

5.1.1 If, for example, you chose the chicken, cheese and pine burger with regular chips and a Coke, the foods in the meal that contain protein would be the chicken, the cheese and the chips. Remember that starches contribute an average of 2 g of protein per portion, in addition to the 15 g of carbohydrates (refer back to the exchanges in study unit 2).

*5.1.2 If you consume one gram of protein, it will provide you with **17 kJ** of energy. Do you agree that protein and carbohydrates provide the same amount of energy and that fat provide more than twice that amount of energy?*

5.1.3 If you chose the chicken, cheese and pine burger with regular chips and a Coke, the nutrient composition would be as follows (you will find the nutrient composition of your meal in Appendix A):

Nutrients	Chicken, cheese & pine burger	Regular chips	Coke*	Total
Total energy (kJ)	2019 kJ	1351 kJ	613.2 kJ (146 kcal × 4.2 = 613.2 kJ)	3983 kJ
Protein (g)	38.8 g	5.1 g	0 g	43.9 g

* See Appendix H, page H50 of the prescribed textbook, for the nutrient composition of Coke. The total energy of the Coke is given in kilocalories (kcal). Remember to convert it to the metric unit kilojoules.

5.1.4 The energy provided by the protein in the meal is:

Nutrients	Total	Calculation	Total energy provided
Protein (g)	43.9 g	43.9 g protein × 17 kJ/g	746.3 kJ

5.1.5 The total energy provided by the chicken, cheese and pine burger with chips and Coke meal is 3983 kJ. The percentage of energy that the protein contributes to the total energy of the meal is:

Nutrients	Total energy provided	Calculations	Percentage of total energy
Protein (g)	746.3 kJ	746.3 kJ ÷ 3983 kJ = 0.1874 × 100 = 18.74%	19%

Therefore the percentage of energy the protein in the meal contributes to the total energy is 19%.

TIME ALLOCATION

You should spend at least 12 hours on this study unit.

Learning outcomes

On completion of this study unit you should be able to

- classify and describe the chemical composition of proteins
- explain the process of protein denaturation
- describe the functions of protein in the body
- explain the fundamentals of protein metabolism in the body
- describe the protein quality of food and explain what is meant by complementary proteins
- discuss the health effects of protein deficiency and excess

- distinguish between kwashiorkor and marasmus
- give and calculate the recommended intakes of protein
- identify possible symptoms due to a deficient intake of protein
- recommend appropriate foods as sources of protein, including low- and high-biological-value foods
- calculate and interpret the energy provided by protein
- calculate and interpret the percentage of kilojoules protein contributes to the total energy intake
- identify excessive or deficient intake of protein and make suitable suggestions and provide alternatives, given a particular diet history

5.1 INTRODUCTION

In the previous two study units you have learned about carbohydrates and lipids. The third of the energy-yielding nutrients we are going to discuss is **proteins**. The three macronutrients work in synergy and a balanced intake of all three is necessary for the body to function optimally.

Proteins, like carbohydrates and lipids, provide us with energy. When insufficient amounts of glucose are provided by carbohydrate stores or when the glycogen stores are depleted, body protein is mobilised and converted to glucose through a process called gluconeogenesis. In study unit 1 you have learnt that if you consume **one gram** of **protein** it will provide you with **17 kJ** of energy. The acceptable macronutrient distribution range **(AMDR)** for protein in a day is between **10** and **35%** of our total energy intake (refer back to study unit 1).

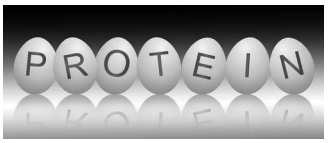
Apart from being a long-term energy reserve, protein is an important building block in the body and muscles, connective tissue, bones, blood, skin, hair, nails, hormones and enzymes have protein as part of their basic structural material. Protein is therefore needed for 'growth, maintenance and repair of body tissue' (DOH 2004, p. 19). The smallest building block of protein is an **amino acid**. Amino acids come together in different combinations to form different types of proteins that each has a different function in the body.

Protein in the diet is therefore essential and a deficient intake of protein can lead to protein-energy malnutrition (PEM). Conversely, an overconsumption of protein can cause certain chronic diseases such as heart disease, cancer, obesity, osteoporosis or kidney stones.

READ

Read the introduction to chapter 6 (pp. 164–165) in the prescribed textbook.

In this study unit we are going to discuss the chemical composition, classification, roles in the body, metabolism, and quality of protein in foods. We will also discuss protein-energy malnutrition and other health effects, recommended intakes and sources of dietary proteins and the vegetarian diet. It is important that you pay attention to the theory, figures, diagrams and definitions in the prescribed sections in the textbook as these are presented in more detail there than in the study guide. Use both the study guide and textbook as study aids.



5.2 THE CHEMIST'S VIEW OF PROTEINS

This section focuses on the classification and chemical composition (structure) of proteins. It is necessary to know this, so that you can better understand the role they play in the body. Proteins are classified as **primary, secondary, tertiary** or **quaternary** proteins. The chemical composition explains the basic structure of amino acids and proteins or, in short, what they look like. Figure 5.1 gives a summary of the classification and the chemical composition of proteins.

A protein molecule consists of various amino acids linked together in a specific pattern. In the same way that several different railway carriages are linked together to make a train, any number of different amino acids can be coupled or linked together to make a certain protein (see figure 5.1). Trains are uncoupled to make them shorter. Amino acids can be uncoupled in the same way to make smaller protein units. Unlike trains, which have only straight couplings, amino acids may be coupled together in different ways: they may form helices, sheet-like arrangements, or they may even be folded upon themselves to look like clusters or tangled balls of wool (see figure 5.1).

Protein molecules are therefore large, complex molecules consisting of combinations of different amino acids and they differ from one another in the follow three ways:

(a) the total **number** of amino acids in the chain
(b) the **amount** of each amino acid in the chain
(c) the **order/sequence** of amino acids in the chain

STUDY

Study the section "The chemist's view of proteins" (pp. 165–168) in the prescribed textbook.

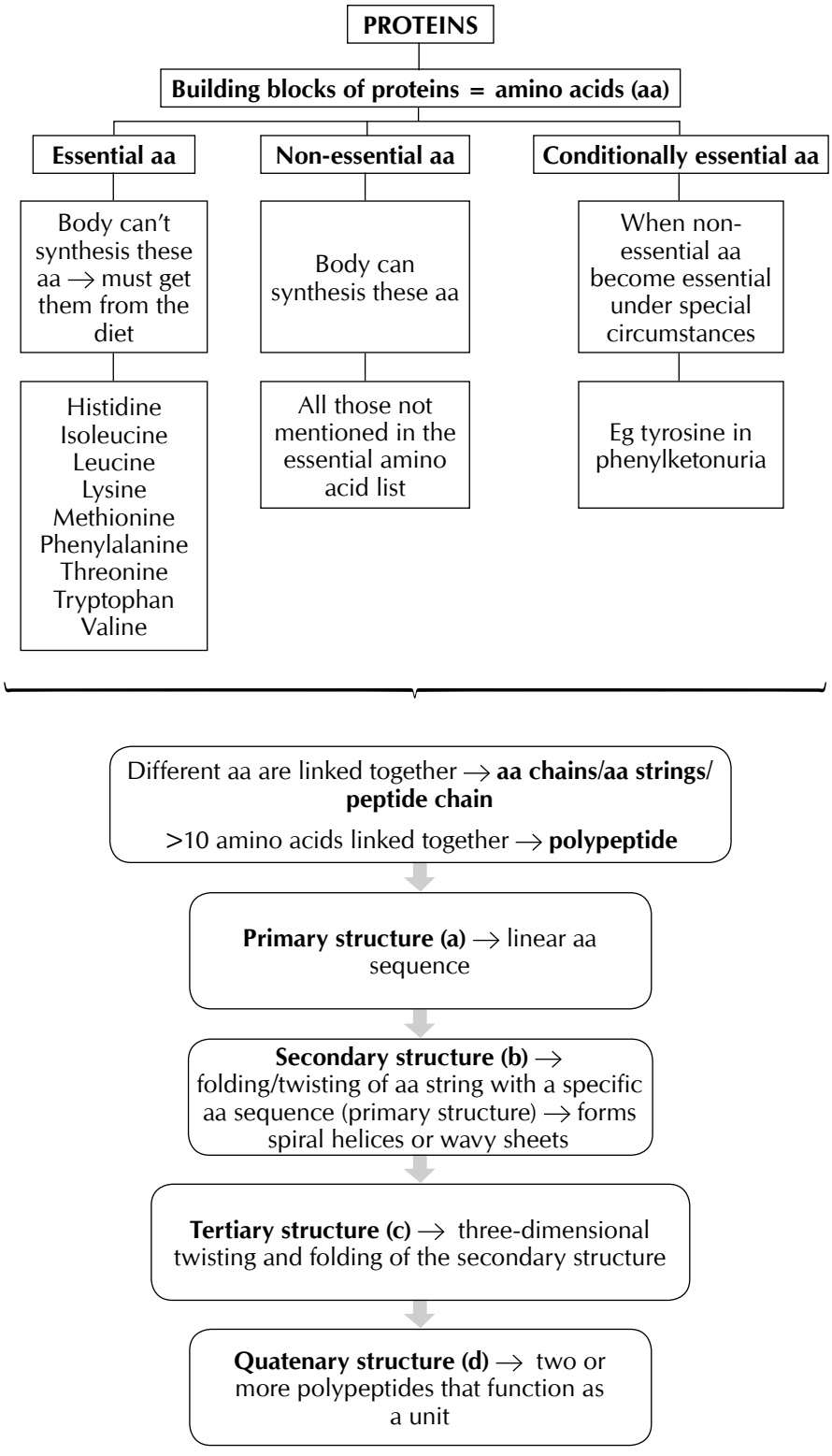


FIGURE 5.1

Classification and chemical composition of proteins (Dominiczak 2007, pp. 48 and 52)

Activity 5.2

5.2.1 Summarise what you have learned about the classification and composition of proteins. Use figure 5.1 as a framework for your summary and add additional information from the textbook to the existing figure.

5.2.2 You decide to make a poached egg for lunch, because a poached egg is a healthier option than frying the egg in oil. Explain what happens to the egg when it is exposed to heat. What is this process called?

Reflection on activity 5.2

5.2.1 You will find the necessary information in the prescribed textbook (pp. 165–168).

5.2.2 You have to state what the process is called (denaturation) and explain the process of protein denaturation (see p. 168 of the prescribed textbook).

5.3 THE DIGESTION AND ABSORPTION OF PROTEIN

For the purpose of this module you don't have to study the section in the textbook on the digestion and absorption of proteins. This topic will be covered comprehensively in NUT2601.

5.4 PROTEINS IN THE BODY

Now that you have some understanding of the classification and chemical composition of proteins, you can start to appreciate that proteins have important physiological functions in the body. For this reason it is necessary to include adequate amounts of proteins and essential amino acids in the diet.

5.4.1 Protein synthesis

For the purpose of this module you don't have to study the section on "Protein synthesis" (pp. 170–173) in the prescribed textbook.

5.4.2 The roles of proteins

In the introduction in the textbook it is mentioned that the word protein means 'of prime importance' (Rolfes, Pinna & Whitney 2009, p.164). In this section we are going to explore the reasons why proteins are of such importance by looking at the role of proteins in the body. Figure 5.2 gives a summary of some of the functions of protein in the body.

STUDY

Study the section "Roles of proteins" (pp. 173–176) in your prescribed textbook.

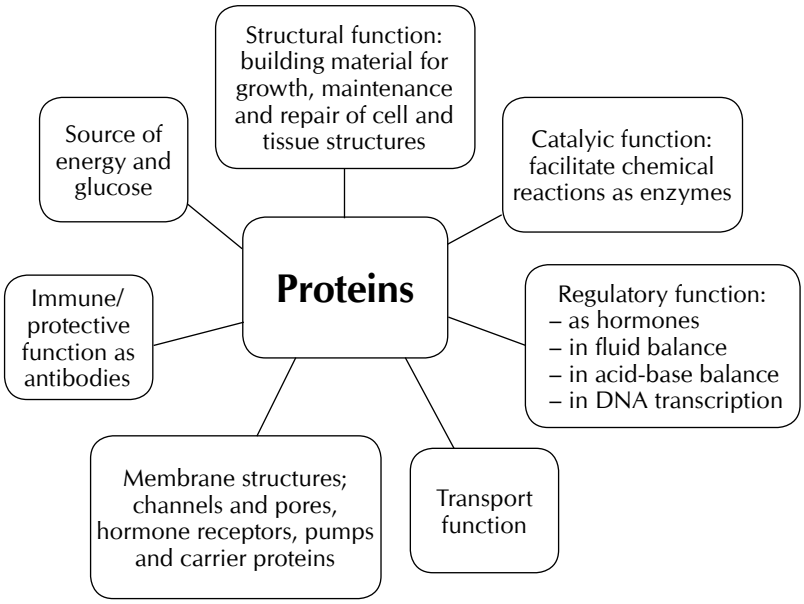


FIGURE 5.2
Functions of protein in the body

Activity 5.3

Summarise what you have learned about the roles of proteins. Use figure 5.2 as a framework for your summary and add additional information from the textbook to the existing figure.

Reflection on activity 5.3

You will find the answer to this question in the prescribed textbook (pp. 173–175).

5.4.3 A preview of protein metabolism

By now you know that proteins supply us with energy during times of starvation, critical illness and protein-energy malnutrition (PEM). This occurs at the expense of protein stores (muscle and other body protein). Glucose for energy is formed from amino acids through a process called **gluconeogenesis** (see study unit 3). When the body continues to use protein stores for energy, more nitrogen is used than is being supplied by the diet. This is known as a **negative nitrogen balance** and figure 5.3 illustrates of how the scale tips to the side of the negative nitrogen balance and protein loss during starvation, PEM and severe illness. Protein intake tips the scale toward a positive nitrogen balance. A positive nitrogen balance occurs in growing children, pregnant women and body builders. During a positive nitrogen balance protein stores are being 'filled' or 'replenished' and the growth and formation of new tissue takes place.

The main aim in nutritional intervention when there is a negative nitrogen balance is to increase the intake of carbohydrates and supply adequate amounts of fat, so that protein stores can be 'spared' (refer back to study unit 3). The

diet should also provide adequate amounts of protein so that the protein stores can be replenished. The aim is therefore to obtain a positive nitrogen balance after a period of starvation, protein-energy malnutrition or illness. When the protein stores are replenished, one should, however, be careful that the individual does not start to convert the excess protein into fat.

STUDY

Study the section "A preview of metabolism" (pp. 176–179) in your prescribed textbook.

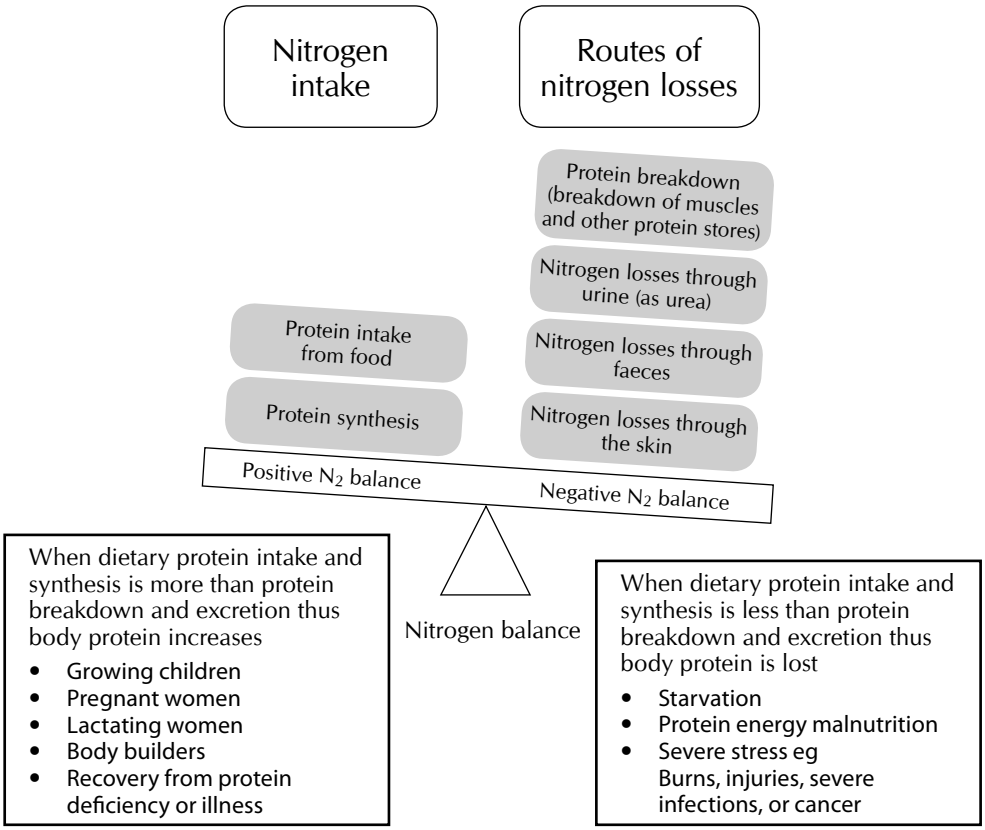


FIGURE 5.3

Illustration of nitrogen balance where the scale tips more towards the negative nitrogen balance

(Rolfes, Pinna & Whitney 2012, pp. 176–177)

Amino acids can't be stored or excreted as amino acids. The body first has to convert them into other compounds before storage and excretion can occur. The two processes through which amino acids are converted are called **deamination** and **transamination**. Figure 5.4 gives a summary of the fate of ingested amino acids in the body.

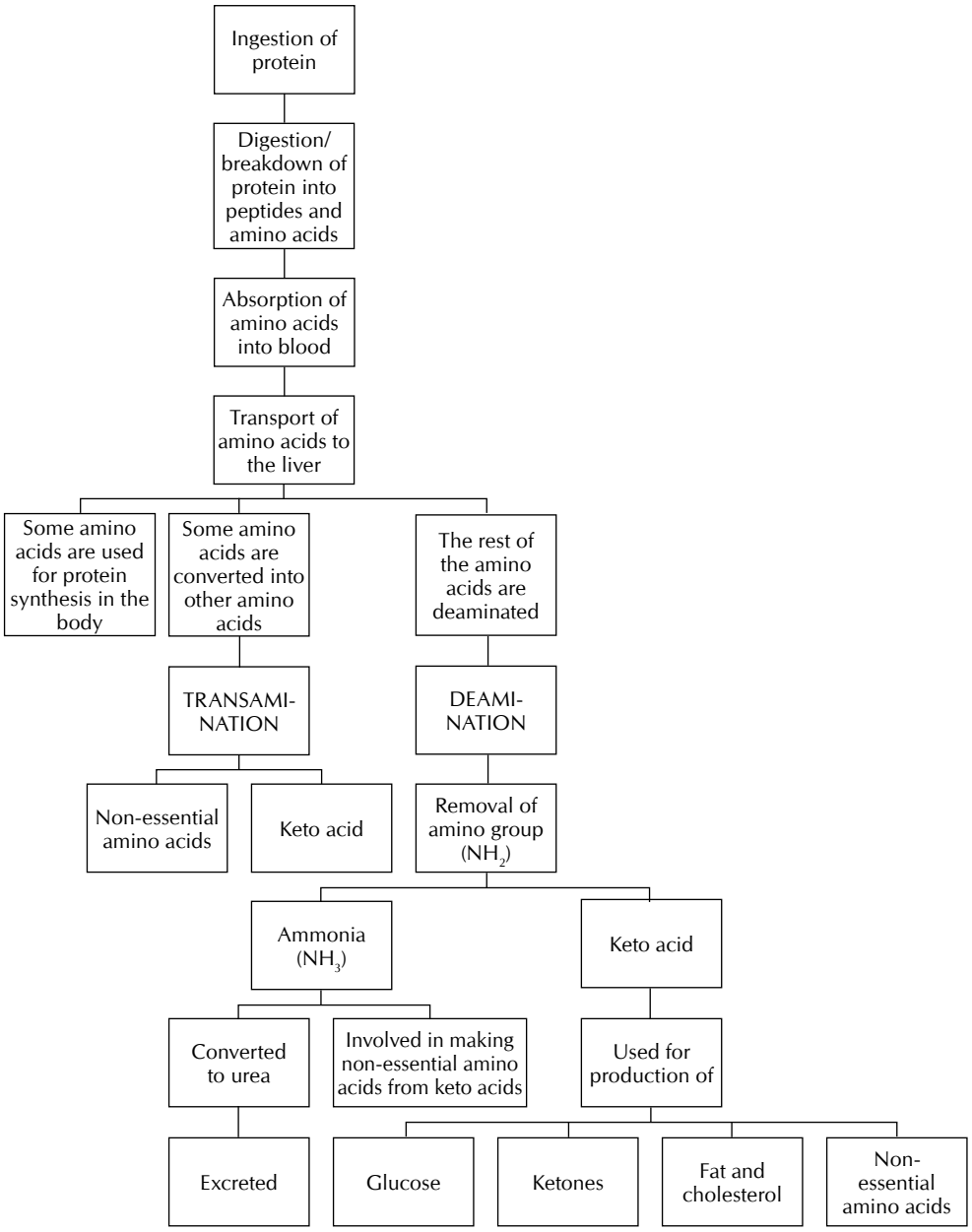


FIGURE 5.4

Metabolic fate of amino acids in the body

Activity 5.4

Mia is an 18-month-old girl who has been diagnosed with protein-energy malnutrition (PEM). Answer the following questions.

5.4.1 Describe how PEM affects Mia's nitrogen balance.
5.4.2 Explain how Mia's body uses protein as energy source during PEM.
5.4.3 Discuss the dietary strategies you will implement to correct her nitrogen balance.
5.4.4 What happens with the protein that Mia is ingesting? What happens to it in her body?

Reflection on activity 5.4

5.4.1 Protein-energy malnutrition causes a negative nitrogen balance, which means that the protein breakdown and excretion by Mia's body exceeds her dietary protein intake and protein synthesis.

5.4.2 You will find the answer to this question in this section of the study guide and on page 177 of the prescribed textbook.

5.4.3 You will find the answer to this question in this section of the study guide and on page 177 of the prescribed textbook.

5.4.4. The metabolic fate of amino acids is discussed in this section of the study unit, as well as on pages 177 to 179 of the prescribed textbook.

5.5 PROTEIN IN FOODS

The quality of different proteins is not equal. **Protein quality** depends on the capacity of the protein to be absorbed, in other words, its **digestibility**. A protein food that is poorly digested and/or absorbed (eg vegetables and starches) is inferior in quality to an equal amount of another protein food which is easily digested and properly absorbed. The more 'complete' a protein source (eg red meat, chicken, fish, eggs, soya and legumes), the better it will be absorbed, because it meets the body's needs (see the next paragraph on the value of proteins). The fibre content of vegetable or starch origin may decrease the absorption of the proteins. Absorption in these foods is also affected by preparation techniques and cooking. Overheating and overcooking of protein foods decrease their digestibility and consequently the protein absorption.

The value of protein in various protein sources in the diet is determined by the total amount of protein present in the food and the type of amino acid combination in the protein source. The **quality** of a protein in meeting the body's need for essential amino acids is sometimes expressed as its **biological value** (BV). A protein with a BV of 70 or more is capable of supporting the growth, maintenance and repair of body tissue, provided that sufficient kilojoules are also ingested with it. Examples of foods with a high biological value are meat, chicken, fish, eggs and legumes. Foods with a low biological value, for example vegetables and starch, have a low essential amino acid content. Figure 5.5 provides examples of the biological value of typical protein sources.

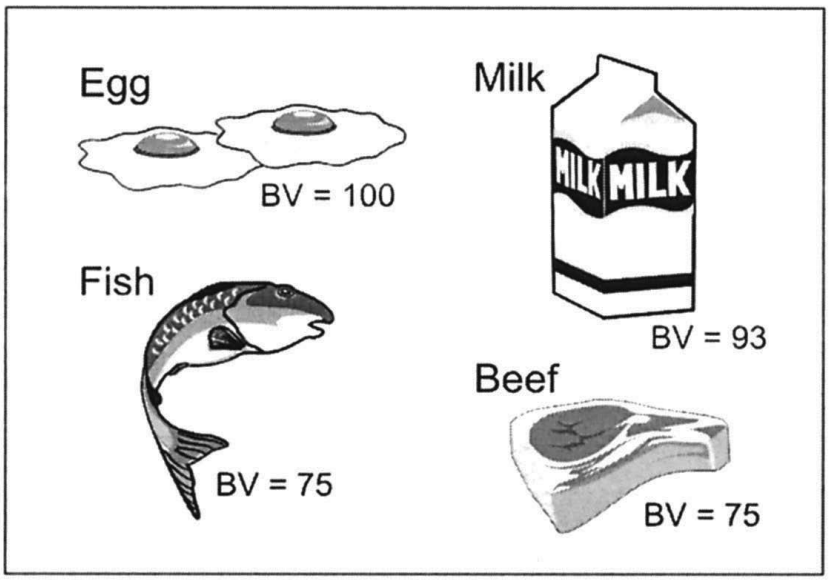


FIGURE 5.5

Biological value of different protein sources

The protein quality of food can be improved by including **complementary proteins** in the diet. Complementary proteins are two incomplete proteins that compensate for one another's amino-acid shortfalls. You will notice that examples of legumes and grains are mentioned in the prescribed textbook. Legumes can be combined with a small amount of animal protein such as milk, cheese, egg or meat. The animal protein will supply enough essential amino acids to make up for the deficient amino acids in legumes.

STUDY

Study the section "Protein in foods" (pp. 179–180) in your prescribed textbook.

Activity 5.5

5.5.1 Explain the difference between high- and low-quality proteins and give four examples of each.

5.5.2 Your friend is a vegetarian. Explain to her why it is important to use complementary proteins in her diet.

5.5.4 Give your friend five examples of good complementary protein combinations.

Reflection on activity 5.5

5.5.1–2

You will find the answer to these questions on pages 179 and 180 of the prescribed textbook.

5.5.4 Examples of good complementary protein combinations:

- *Macaroni and cheese*

- *Beans and cheese*
- *Cereal with milk*
- *Rice, wheat and peanuts*
- *Rice, wheat and soya beans*
- *Maize and legumes such as baked beans, kidney beans, dried peas, lentils and sugar beans*
- *Mealie rice and legumes*
- *Sesame seeds, peanuts and soya beans*
- *Sunflower seeds and peanuts*
- *Wheat and legumes*
- *Wheat, sesame seeds and soya beans*
- *Rice, egg and milk, for example in rice pudding*
- *Bread, egg and milk, for example in bread pudding*

5.6 THE HEALTH EFFECTS AND RECOMMENDED INTAKES OF PROTEIN

You have learnt that proteins have important functions in the body and should therefore not be excluded from the diet. A deficient intake of protein can lead to protein-energy malnutrition (PEM), but the overconsumption of protein can lead to the development of certain chronic diseases such as heart disease, cancer, obesity, osteoporosis and kidney stones. It is therefore important to include the correct amount and sources of protein in the diet. In the following sections we are going to discuss the health effects and recommended intakes of protein.

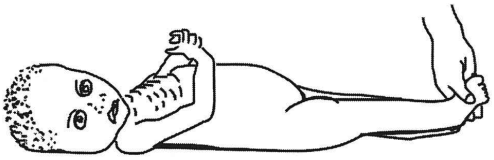
5.6.1 Protein energy malnutrition (PEM)

Before we start to discuss PEM and the other health effects of a lack or excess of protein, it is necessary that you understand the concept of malnutrition. **Malnutrition** is defined as an impairment of health which results from a **deficiency, excess or imbalance of nutrients**. Undernutrition, overnutrition, obesity and PEM are forms of malnutrition. **Undernutrition** is the deficient intake of energy or essential nutrients which can lead to underweight and protein-energy malnutrition (Rolfes, Pinna & Whitney 2012, p. GL–26). **Overnutrition** is an excess of energy and essential nutrients (Rolfes, Pinna & Whitney 2012, p. GL–20).

PEM is a condition often seen in developing countries such as South Africa. It mainly affects babies and toddlers between six months and three years of age. It would appear that poor socio-economic conditions, poverty and a lack of education about the correct feeding of babies and toddlers are largely responsible for the high incidence of PEM in our country. The types of PEM we are going to discuss are **kwashiorkor**, **marasmus** and a combination of the two called **marasmic kwashiorkor**. Figures 5.6 and 5.7 illustrate some of the clinical features of kwashiorkor and marasmus.

Oedema
Will not eat
Skin: patches of pigmentation and desquamation
Hair pale and thinned
Miserable and apathetic
Moon face
Liver usually palpable

Pitting oedema



KWASHIORKOR

FIGURE 5.6
Clinical signs and symptoms of a child suffering from kwashiorkor

Old man's face
No oedema
Normal hair
Grossly underweight
No fat
Gross muscle wasting

MARASMUS

FIGURE 5.7
Clinical signs and symptoms of a child suffering from marasmus

STUDY

Study the section "Protein energy malnutrition" (pp. 180–183) in the prescribed textbook.

Activity 5.6

In activity 5.4 you were introduced to Mia who is an 18-month old girl who was diagnosed with protein-energy malnutrition (PEM). She presented with the following symptoms: apathy, mild weight loss, oedema, loss of appetite, skin lesions, and colour changes in her hair. Answer the following questions.

5.6.1 According to Mia's symptoms, which type of protein-energy malnutrition does she have?
5.6.2 Tabulate the differences between marasmus and kwashiorkor.

5.6.3 Discuss why Mia is at risk of developing infections.
5.6.4 What is marasmic kwashiorkor?

Reflection on activity 5.6

You will find the answers to these questions on pages 180 to 183 of the prescribed textbook. When you tabulate the differences between marasmus and kwashiorkor, do not only write down the information in table 6.3 (p. 181) of the textbook. Work though the text on pages 181 and 182 of the textbook. Some differences between marasmus and kwashiorkor are mentioned in the text, but not in table 6.3.

5.6.2 The health effects of protein

In the previous section you have learnt the consequences of a deficient intake of protein. This section deals with the health effects of a high intake of protein.

STUDY

Study the section "Health effects of protein" (pp. 183–184) in the prescribed textbook.

Activity 5.7

Your friend is overweight and both her parents suffer from heart disease. She has read in a magazine that a high-protein, low-carbohydrate diet will help her to lose weight.

5.7.1 Discuss with your friend the health effects of consuming a high-protein diet.
5.7.2 Discuss the role of homocysteine as independent risk factor in heart disease.
5.7.3 Which type of diet would you recommend to your friend, which would better support weight loss and good health?

Reflection on activity 5.7

If both your friend's parents suffer from heart disease, she has an increased risk, genetically, of developing heart disease. She is overweight and this is an independent risk factor for the development of heart disease as well. You will find the answers to the above questions on pages 183 to 184 of the prescribed textbook.

5.6.3 Recommended intakes of protein

If a deficient intake of protein can lead to PEM and an overconsumption increases the risk for heart disease, cancer, osteoporosis and kidney disease, how much protein and which food sources of protein are we allowed to consume?

The South African FBDGs says we should **'eat dry beans, slit peas, lentils and soya regularly'** and **'meat, fish, chicken, milk and eggs can be eaten every day'**. Both these guidelines are applicable to protein intake. Red meat, fish, chicken, milk and eggs can be eaten every day because *"…these foods contribute valuable nutrients and high quality protein to the diet, preventing a deficient intake of especially calcium, iron, zinc, thiamine, riboflavin and omega-3 fatty acids"*. Conversely the overconsumption of these protein foods increases the risk for the development of heart disease and cancer, because of their cholesterol and saturated fat content (Scholtz et al 2001, pp. S39 and S46).

According to Scholtz et al (2001, pp. S39 and S46) *"it seems that 400–500 ml of milk or its equivalent per day, two to three servings of fish per week, about four eggs per week and alternatively not more than 560 g of meat per week, will improve nutritional status without increasing risk of chronic diseases. However, low-fat products should be chosen and fats should be used sparingly in the preparation, cooking and serving of these foods"*. But animal-derived proteins are expensive and dried beans and soya beans are both sources of good quality protein and can be used to substitute animal protein sources in the diet (Venter & Van Eyssen 2001, pp. S32 and S37; Scholtz et al 2001, p. S46).

STUDY

Study the sections "Recommended intake" and "Protein and amino acid supplements" (pp. 184–187) in the prescribed textbook. The block "How to calculate the recommended protein intakes" (p. 185) is important.

Activity 5.8

5.8.1 Calculate the RDA of protein for your weight.

5.8.2 Give two reasons why our bodies need dietary protein.

5.8.3 You are asked to give a talk on protein to a group of healthy men and women. Discuss the nutritional recommendation you would give to this group of people.

5.8.4 A 24-year-old male student consumes 2800 kcal energy in a day. He does mountain biking and he trains six times a week. He consumes 138 g protein, 93 g fat and 364 g carbohydrates in a day. He weighs 78 kg. Calculate the percentage that protein, fat and carbohydrates contribute to his total energy intake.

5.8.5 Compare your answers in question 5.8.4 with the AMDR for protein, carbohydrates and fat.

5.8.6 This student (see activity 5.8.4) wants to increase his protein intake with protein powders and amino-acid supplements. What advice will you give him regarding these supplements?

Reflection on activity 5.8

5.8.1 Use the block '"How to calculate the recommended protein intakes" on page 185 of the prescribed textbook to assist you in answering this question.

If, for example, you are a woman weighing 50 kg, the RDA of protein for your weight would be calculated as follows:

Multiply your body weight (50 kg) by 0.8 g/kg/day to get your RDA in grams per day:

50 kg x 0.8 g/kg/day = 40 g

If the RDA of protein for a 50 kg woman is 40 g, how much red meat, chicken, fish, eggs, milk and other dairy products, legumes, starches and vegetables can she consume in a day?

You will remember from study unit 2 that one exchange of meat contains 7 g of protein.

1 meat exchange = 7 g protein

1 portion of red meat, chicken, fish, eggs = 7 g protein

1 portion of milk = 8 g protein

1 portion of vegetables = 2 g protein

1 portion bread/ starch = 2 g protein

For 40 g protein a women weighing 50 kg can consume:

Meat (60 g)	*2 portions × 7 g = 14 g*
Milk (500 ml)	*2 portions × 8 g = 16 g*
Bread/starch	*3 portions × 2 g = 6 g*
Vegetables (125 ml raw; 250 ml cooked)	*2 portions × 2 g = 4 g*
Total protein	*40 g*

Now translate your RDA of protein into actual protein portions and see how many protein portions you are allowed to consume in a day.

5.8.2 You will find the answer to this question on page 184 of the prescribed textbook.

5.8.3 You will find the answer to this question in this section of the study guide.

5.8.4 This question is similar to activity 4.6 in study unit 4. Page back to this activity and use it as guide to answer this question.

5.8.5 Page back to table 1.2 in study unit 1 for the AMDR for protein, carbohydrates and fat and compare your answer to these values. Is this male student's intake of the three energy-yielding nutrients adequate, deficient or in excess?

5.8.6 You will find the answers to these questions on pages 186–187 of the prescribed textbook.

5.7 VEGETARIAN DIETS

This section on vegetarian diets is included in this study unit, because it is the exclusion of protein-rich animal-derived foods from the diet of vegetarians which increases their risk of developing certain micronutrient deficiencies. It is therefore important to substitute the animal protein with the correct protein sources and combinations (refer back to complementary proteins in section 5.4) to prevent protein and micronutrient deficiencies.

If the correct amounts and combinations of plant-derived protein are included in a vegetarian's diet, such a diet can provide certain benefits for weight control, blood pressure, heart disease, cancer and other diseases.

STUDY

Study "Highlight 2: Vegetarian diets" (pp. 60–65) in the prescribed textbook.

Activity 5.9

Sarah Wilken is 24 years old and has been a **vegan** for six years. Her mother, Mrs Wilken, is concerned that she is not getting the correct amount of nutrients and that she might develop deficiencies if she continues to follow a vegan diet.

5.9.1 Define the term 'vegan'.
5.9.2 Explain to Mrs Wilken the health benefits of a **vegan** diet.
5.9.3 Explain to Sarah which nutrient deficiencies she can develop if she doesn't follow a varied and balanced **vegan** diet.
5.9.4 Plan a one-day example menu for Sarah and include adequate **vegan** food sources that will provide her with all the key nutrients she requires to prevent her from developing nutrient deficiencies.

Reflection on activity 5.9

5.9.1 Before you start answering the questions related to the case study, it is important that you understand what a 'vegan' is and how the diet of a vegan differs from that of lacto-ovo-vegetarians, lacto-vegetarians and vegetarians, and how a vegan diets differs from the macrobiotic diet. You will find the answer in the glossary on page 60 of the prescribed textbook.

5.9.2–4
You will find the answer to these questions on pages 60 to 64 of the prescribed textbook.

5.8 SUMMARY

In this study unit emphasis is placed on the importance of protein in our diet. Proteins are nitrogen-containing compounds which the body needs to grow, maintain and repair tissues, provide energy, regulate fluid balance, form hormones, enzymes and antibodies, maintain the acid-base balance, and transport other nutrients. The body continuously breaks down and loses protein, and amino acids cannot be stored like glucose and fat. To replace these losses, the body needs adequate amounts of protein from the diet, because 'dietary protein is the only source of essential amino acids and it is the only source of nitrogen from which non-essential amino acids and other nitrogen containing compounds are made' (Rolfes, Pinna & Whitney 2012, p. 184).

The quality of protein in different foods needs to be taken into consideration, especially in a developing country like South Africa where people's diets may be deficient in amino acids and protein deficiencies may develop. The protein quality of food is especially of significance in growing children, in adults to maintain health, in vegetarian diets, and in those suffering from PEM.

In South Africa we have a double burden of disease. The one is related to a deficient intake of protein and the other to overconsumption. This is can be seen in the subsequent health effects. A deficient intake of protein can lead to PEM, while the overconsumption of protein can lead to the development of certain chronic diseases such as heart disease, cancer, obesity, osteoporosis and kidney stones. It is therefore important to include the correct amount and food sources of protein in the diet.

Once you have completed the summary activity questions on protein, you can start with revision for the exams. All the best!

Activity 5.10: Summary activity

5.9.1 Do the "Chapter review" questions on pages 846–847 of the prescribed textbook.

5.9.2 For additional study questions and activities go to www.cengagebrain.com and search for ISBN1111427143.

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The End

APPENDIX A

Café Funda nutrition information per serving

This nutritional information provides you with the estimated values and not the exact amounts. Please do not regard these values as accurate. The values should just be used for the purpose of the activities and the assignments. The information below was obtained and adapted from Appendix H in your prescribed textbook (Rolfes, Pinna & Whitney 2012) and from the Nando's nutritional information found on their website http://www.nandos.co.za

Sandwiches	Typical serving size (g)	Energy (kJ) per serving	Protein (g) per serving	Total fat (g) per serving	Saturated fat (g) per serving	Total carbs (g) per serving	Fibre (g) per serving	Cholesterol (mg) Per serving	Sodium (mg) per serving
Ham and Cheese	146	1478	21	15	6.44	33	2	58	771
Bacon and egg	127	1268	14	15	4.00	29	1	185	480
Roast chicken	234	1306	25	6	1.50	40	3	48	880
Steak and cheese	255	1730	23	18	6.00	42	4	44	1120

Burgers	Typical serving size (g)	Energy (kJ) per serving	Protein (g) per serving	Total fat (g) per serving	Saturated fat (g) per serving	Total carbs (g) per serving	Fibre (g)per serving	Cholesterol (mg) per serving	Sodium (mg) per serving
Hamburger	121	1302	17	13	5	31	2	40	580
Cheeseburger	133	1512	19	17	8	31	2	50	790
Double cheeseburger	189	2268	32	31	15	32	2	100	1050
Bacon cheeseburger	225	2772	31	30	12	64	3	85	1410
Chicken burger	220	1607	35.6	6.9	1.6	43.9	2.5	79	763
Chicken, cheese and pine burger	294	2019	38.8	11.8	5.1	54.3	3	92	946

Other	Typical serving size (g)	Energy (kJ) per serving	Protein (g) per serving	Total fat (g) per serving	Saturated fat (g) per serving	Total carbs (g) per serving	Fibre (g)per serving	Cholesterol (mg) per serving	Sodium (mg) per serving
Grilled chicken breast, salad and sweet chilli mealie	569	1426	34	6.3	1.4	36.2	6.5	75	562
Chicken wrap	242	1604	38.3	8.5	2.1	37.6	2.5	120	856
Chicken and pine wrap	302	1780	39	9	2.5	47	3	120	890
Veggie wrap	280	2380	15.9	17	2.8	85	9.5	2	910
Roasted chicken salad	304	575	16	3	0.50	12	3	36	730
Tuna salad	314	1000	13	16	4.00	11	3	42	880

Side orders & sauces	Typical serving size (g)	Energy (kJ) per serving	Protein (g) per serving	Total Fat (g) per serving	Saturated Fat (g) per serving	Total carbs (g) per serving	Fibre (g) Per Serving	Cholesterol (mg) Per Serving	Sodium (mg) Per Serving
Chips (small)	85	966	3	10	2.50	34	3	0	350
Chips (regular)	122	1351	5.1	13.4	2.2	45.2	0.7	0	210
Potato wedges	175	1735	7.1	14	3.2	6.5	5.3	0	825
Creamy mashed potato	159	816	4.5	7.2	11.7	27.7	2.5	0	90
Coleslaw	105	882	1	17	2.50	14	2	20	180
Salad	257	225	2.1	1.2	0.2	8.4	3	0	90
Corn on a cob (Mealie)	220	590	4.2	1.1	0.1	28	3.6	0	100
Roasted chicken breast (with skin)	199	1002	38.9	8.9	2.4	0.8	0	110	428

Roasted chicken breast (without skin)	190	825	36.5	5.6	1.6	0.4	0	105	295
Sticky chicken wings	273	1453	43.8	18.8	5.2	0.7	0	131	420
Cheese sauce	70	676	0.2	12.5	2.5	13.2	0	11	712
Creamy mushroom sauce	75	1070	0.5	23	5	14	0	21	399
Salad dressing	15	520	0.1	15	3.8	0.6	0	0	207

Desserts	**Typical serving size (g)**	**Energy (kJ) per serving**	**Protein (g) per serving**	**Total Fat (g) per serving**	**Saturated Fat (g) per serving**	**Total carbs (g) per serving**	**Fibre (g) Per Serving**	**Cholesterol (mg) Per Serving**	**Sodium (mg) Per Serving**
Chocolate Brownie	304	3108	10	27	16.00	112	0	50	350
Vanilla ice-cream (single serving)	94	588	3	5	3.00	22	0	15	70
Strawberry Cheesecake	98	960	9	6	9.6	30	1	4	53
Double chocolate mousse	83	1026	4	14.5	8.2	24.9	0	23	130

Drinks	**The nutritional values for the drinks could be obtained from appendix H in the back of the prescribed textbook (Rolfes, Pinna & Whitney 2012).**

APPENDIX B

Dairy Products Contain Many Nutrients

Dairy products contain many nutrients including protein and a variety of vitamins and minerals.

Nutrition labels and nutrition profiling systems provide an opportunity to demonstrate dairy's health benefits to consumers. Food-rating systems that attempt to measure the nutritional quality and healthfulness of foods are exploding in retail and regulating environments.

As one of the five core food groups, dairy products play a key role in a balanced diet. Dairy products are convenient, cost-effective, tasty, and contain essential nutrients, including calcium, vitamin A, B12, riboflavin, carbohydrate, protein, potassium, phosphorus, magnesium and zinc. Three servings of dairy every day (which can include 250 ml milk, 200 ml yoghurt and 40 g cheese) will provide most people with their daily calcium requirement, plus significant amounts of the other essential nutrients.

The Facts

- Nutrient density can be a valuable tool for nutrition education and dietary guidance.
- Both nutrient density and nutrient profiling are inter-dependent in determining food quality. Therefore, in order to determine nutrient density, nutrient profiling systems have to be in place.
- There are various types of nutrient profiling systems in use and yet, not any definite conclusion as to which is the best to use. The question is how to develop a science-based system for assessing the nutrient density of a food, which nutrients to include and which standard to measure nutrients against.

Terminology

- **Nutrient density** is defined as the ratio of nutrient content (in grams) to the total energy content (in kilojoules) of a specific food product or the ratio of food energy from carbohydrate, protein or fat content to the total food energy of the food product.
- The term **nutrient-rich** is commonly used as a synonym for nutrient-dense foods.
- **Nutrient profiling** of foods is defined as the science of ranking foods based on their nutrient composition.
- **Energy-dense/nutrient-poor** is a term commonly used to characterise foods perceived as unhealthy, also referred to as junk food or empty calories. Therefore foods high in energy and low in nutrients.

What About Dairy?

There is currently no single profiling system that can accurately reflect the contribution that a food, or food category, makes to the overall diet. A number of profiling systems have been proposed globally, yet none of these can be applied consistently to all foods, as they are not founded in science. Not one system reflects both the nutrient contribution of a food to the diet and the effect of its matrix on nutrient bioavailability. In addition, frequency of consumption is virtually impossible to account for when developing a profiling system.

Dairy products contain many nutrients and provide protein (8g protein / 250ml portion of milk) and a variety of vitamins and minerals to the diet. The nutritional benefits of dairy products are recognised by their inclusion in dietary guidelines worldwide. In South Africa the Food Based Dietary Guideline applicable reads: "Chicken, fish, meat, **milk** or eggs could be eaten daily".

The promotion of nutrient dense foods, consumed as part of a healthy balanced diet and lifestyle, is more likely to help consumers meet their nutrient needs while also addressing increased diet-related chronic diseases.

Nutrient	Unit	NRV for adults	% NRV* in 3 servings
Vitamin A	µg	900	31.7
Thiamin (B1)	mg	1.2	8
Riboflavin (B2)	mg	1.3	66
Niacin (B3)	mg	16	2.9
Vitamin B6	mg	1.7	13.2
Vitamin B12	mg	2.4	96
Calcium	mg	1300	69.5
Potassium**	mg	2000	42
Magnesium	mg	420	17
Zinc	mg	11	35.5

Phosphorus	mg	1250	52
Proteins	mg	56	45.6
Carbohydrates***	g	315	12.1

* NRV - Nutrient Reference Value for individuals 4 years and older

** RDA - Recommended Dietary Allowance

*** Prudent Dietary Guidelines for macro nutrients

(3 servings a day = 250 ml full-cream milk 200 ml low-fat yoghurt 40 g cheese)

Dairy is a source of calcium in the diet. Milk is transformed into a wide variety of dairy products, including cheese, yoghurt, cream, butter, ice-cream and various types of milk. Nutrient labels and nutrient-profiling systems need to characterize the role of nutrient-rich foods in a well-rounded, healthy diet.

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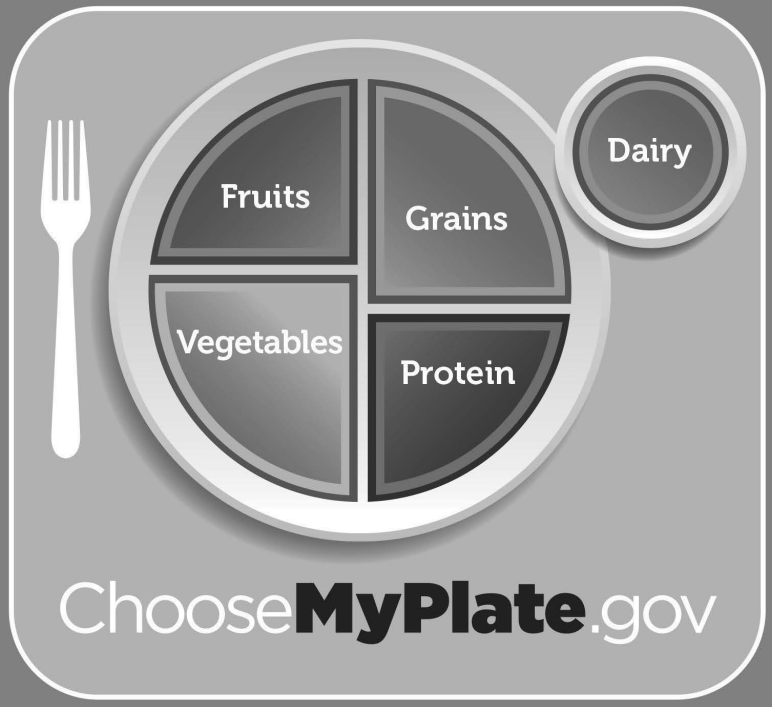
Recommended Downloads

- Athletes enhance muscle gain with milk
- Calcium from dairy is better than supplements
- Dairy a source of calcium
- Dairy protein
- Dairy an overemphasis on saturated fatty acids
- Debunking the mucus myths
- Obtaining calcium needs with milk
- Metabolic Syndrome

APPENDIX C

What's on your plate?



Before you eat, think about what and how much food goes on your plate or in your cup or bowl. Over the day, include foods from all food groups: vegetables, fruits, whole grains, low-fat dairy products, and lean protein foods.

Make half your plate fruits and vegetables.

Make at least half your grains whole.

Switch to skim or 1% milk.

Vary your protein food choices.

Vegetables	Fruits	Grains	Dairy	Protein Foods
Eat more red, orange, and dark-green veggies like tomatoes, sweet potatoes, and broccoli in main dishes. Add beans or peas to salads (kidney or chickpeas), soups (split peas or lentils), and side dishes (pinto or baked beans), or serve as a main dish. Fresh, frozen, and canned vegetables all count. Choose "reduced sodium" or "no-salt-added" canned veggies.	Use fruits as snacks, salads, and desserts. At breakfast, top your cereal with bananas or strawberries; add blueberries to pancakes. Buy fruits that are dried, frozen, and canned (in water or 100% juice), as well as fresh fruits. Select 100% fruit juice when choosing juices.	Substitute whole-grain choices for refined-grain breads, bagels, rolls, breakfast cereals, crackers, rice, and pasta. Check the ingredients list on product labels for the words "whole" or "whole grain" before the grain ingredient name. Choose products that name a whole grain first on the ingredients list.	Choose skim (fat-free) or 1% (low-fat) milk. They have the same amount of calcium and other essential nutrients as whole milk, but less fat and calories. Top fruit salads and baked potatoes with low-fat yogurt. If you are lactose intolerant, try lactose-free milk or fortified soymilk (soy beverage).	Eat a variety of foods from the protein food group each week, such as seafood, beans and peas, and nuts as well as lean meats, poultry, and eggs. Twice a week, make seafood the protein on your plate. Choose lean meats and ground beef that are at least 90% lean. Trim or drain fat from meat and remove skin from poultry to cut fat and calories.
For a 2,000-calorie daily food plan, you need the amounts below from each food group. To find amounts personalized for you, go to Choose**MyPlate**.gov.				
Eat 2½ cups every day **What counts as a cup?** 1 cup of raw or cooked vegetables or vegetable juice; 2 cups of leafy salad greens	**Eat 2 cups every day** **What counts as a cup?** 1 cup of raw or cooked fruit or 100% fruit juice; ½ cup dried fruit	**Eat 6 ounces every day** **What counts as an ounce?** 1 slice of bread; ½ cup of cooked rice, cereal, or pasta; 1 ounce of ready-to-eat cereal	**Get 3 cups every day** **What counts as a cup?** 1 cup of milk, yogurt, or fortified soymilk; 1½ ounces natural or 2 ounces processed cheese	**Eat 5½ ounces every day** **What counts as an ounce?** 1 ounce of lean meat, poultry, or fish; 1 egg; 1 Tbsp peanut butter; ½ ounce nuts or seeds; ¼ cup beans or peas

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Cut back on sodium and empty calories from solid fats and added sugars

Look out for salt (sodium) in foods you buy. Compare sodium in foods and choose those with a lower number.

Drink water instead of sugary drinks. Eat sugary desserts less often.

Make foods that are high in solid fats—such as cakes, cookies, ice cream, pizza, cheese, sausages, and hot dogs—occasional choices, not every day foods.

Limit empty calories to less than 260 per day, based on a 2,000 calorie diet.

Be physically active your way

Pick activities you like and do each for at least 10 minutes at a time. Every bit adds up, and health benefits increase as you spend more time being active.

Children and adolescents: get 60 minutes or more a day.

Adults: get 2 hours and 30 minutes or more a week of activity that requires moderate effort, such as brisk walking.

APPENDIX D

PRACTICAL GUIDELINES USED FOR COMPILING THE DIABETIC EXCHANGES

The Diabetic exchanges in this document are classified according to the composition of the Standard American Exchanges (Table 1) for the 5 main food groups and their respective categories. The small adjustments that have been made for practical reasons are as follows:

- 0 g fat per Starch-exchange
- 1 gram fat per fat free milk exchange
- The energy was calculated directly from the macronutrient content allocated to each exchange, namely 16.8kJ per gram carbohydrate and protein and 37.8kJ per gram fat.

The Protocol for determining portion sizes for standard Diabetic Exchanges:

1. The latest MRC tables available were used as the basis for the composition:
   1999: MILK, MEAT and EGGS
   1998: FRUIT and VEGETABLES
   1991: FAT and STARCHES
   The 1991 Food Quantity Tables were used to determine the most practical portion. A standard form was used to display all raw data, including the standard composition and portion size, as obtained from the MRC tables.

2. The amount of food required to provide the precise amount of the main determining factor were calculated and shown in grams. (Cooked products were used, except in the case of food items that can be eaten raw).

3. The practical household measure was calculated using the MRC Food Quantity Tables (Table2). This practical volume was converted to nearest 5 grams. The complete macronutrient composition of the exchange was then calculated.

Table 1: The American standard for Exchange list

Groups	Carbohydrate (g)	Protein (g)	Fat (g)	Energy (Kcal)
Carbohydrate group				
Starch	15	3	1 or less	80
Fruit	15	-	-	60
Milk				
Skim	12	8	0-3	90
Low-fat	12	8	5	120
Whole	12	8	8	150
Other carbohydrates	15	Varies	Varies	Varies
Vegetables	5	2	-	25
Meat and meat substitute group				
Very lean	-	7	0-1	35
Lean	-	7	3	55
Medium-fat	-	7	5	75
High-fat	-	7	8	100
Fat group	-	-	5	45

TABLE 2: PRACTICAL HOUSEHOLD MEASURES

Household measure	Volume
¼ cup	65 ml
1/3 cup	85 ml
½ cup	125 ml
2/3 cup	165 ml
¾ cup	190 ml
1 cup	250 ml
1¼ cup	315 ml
1 1/3 cup	335 ml
1 ½ cup	375 ml
1 2/3 cup	415 ml
1 ¾ cup	440 ml
2 cups	500 ml
TSP	5 ml
TBS	15 ml

Summary of Exchange list

Food	Exchange	CHO (g)	Protein (g)	Fat (g)	Energy (kJ)
Milk					
• Full Cream	1	12	8	8	640
• Low Fat	1	12	8	5	525
• Skimmed or very low fat	1	12	8	1	375
Vegetables	1	5	2	0	120
Fruit	1	15	0	0	250
Bread/Starch	1	15	2	0	280
Meat					
• Very lean	1	0	7	1	155
• Lean	1	0	7	3	230
• Medium fat	1	0	7	5	310
• High fat	1	0	7	8	420
Fat					
• Monounsaturated	1	0	0	5	190
• Polyunsaturated	1	0	0	5	190
• Saturated	1	0	0	5	190

EXCHANGE LIST FOR MEAL PLANNING

STARCH LIST

Cereals, grains, pasta, breads, crackers, snacks, starchy vegetables, and cooked dried beans, peas, and lentils are starches. In general one starch is:

- ½ cup of cereal, grain, pasta, or starchy vegetable,
- 30 g of a bread product, such as 1 slice of bread,
- 30 g of most snack foods.

Nutrition tips:

- Most starch choices are good sources of B vitamins.
- Cooled starch has a lower glycemic index
- Foods made from whole grains are good sources of fiber.
- Dried beans and peas are good sources of protein and fiber.

Selection tips:

- Choose starches made with little fat as often as you can.
- Dried beans, peas, and lentils are also found on the Meat and Meat Substitutes list.
- Regular potato chips and tortilla chips are found on the other carbohydrate list.
- Most of the serving sizes are measured after cooking.
- Check nutrition information on the label.

One exchange equals 15 grams of carbohydrate, 3 grams of protein, 0 grams of fat and 300 kJ.

Low GI (0-55)

	Mass	household measure
CEREALS AND GRAINS		
Pronutro, Whole-wheat (original and apple bake)	40g	¼ cup
Bran cereals, Hi fiber Bran	25g	½ cup
Cooled soft Maize porridge	100g	½ cup
Oats, Bokomo	100g	½ cup
Maltabella	100g	½ cup
Muesli, Fine form	25g	¼ cup
Samp (cold)	75g	1/3 cup
Wheat	50g	1/3 cup
Pasta, cooked	100g	½ cup
Maize meal porridge, stiff (cold)	60g	1/3 cup
Maize meal porridge, crumbly (cold)	45g	¼ cup
BREAD		
Bread, pumpernickel, seed loaf	30g	1 slice
Bread, whole-wheat with whole kernels, crushed wheat, rolled oats, low GI fruit		
CRACKERS AND SNACKS		
Provita	20g	3
DRIED BEANS, PEAS AND LENTILS		
(Count as 1 starch exchange, plus 1 very lean meat exchange)		
Beans, lentils and peas	100g	½ cup

	Mass	household measure
STARCHY VEGETABLES		
Sweet potato	100g	½ cup
Corn, whole kernel	95g	½ cup
Corn on cob, medium	140g	1
Mixed vegetables with corn, peas, pasta or potato	200g	1 cup
STARCHY FOODS PREPARED WITH FAT		
Popcorn	750ml	3 cups
Baked beans	90g	1/3 cup

Intermediate GI (56-69)

	Mass	household measure
CEREALS AND GRAINS		
Cereals e.g. Corn Flakes, Rice Crispies	20g	½ cup
Bran cereals e.g. All Bran, Raisin Bran	25g	½ cup
Rice, Basmati	50g	1/3 cup
Rice brown, with lentils	50g	1/3 cup
Couscous	50g	1/3 cup
Muesli, low fat	25g	¼ cup
BREAD		
Bread, rye	30g	1 slice
Pita, 15cm	90g	½
CRACKERS AND SNACKS		
Ryvita	20g	2
STARCHY VEGETABLES		
Corn, sweet & creamed	80g	1/3 cup
Baby potatoes, baked or boiled with skin	100g	2 small

High GI (70+)

	Mass	household measure
BREAD		
Bagel	30g	½
Bread, reduced energy e.g. slim slice	45g	2 slices
Bread, white, brown, regular whole-wheat	30g	1 slice
Bread roll	30g	½
English Muffin	35g	½
Raisin bread	30g	1 slice
Tortilla, 15 cm	35g	1
CEREALS AND GRAINS		
Mageu	250g	1 cup
Maltabella porridge	100g	½ cup
Maize meal porridge, stiff	60g	1/3 cup
Maize meal porridge, crumbly	45g	¼ cup
Mealie rice	65g	½ cup
Pressed cereals e.g. Weetbix, Nutrifix, Oatbix	19g	1
Pronutro, original, banana, strawberry, honeymelt chocolate	40g	¼ cup
Rice, white	50g	1/3 cup
Sago	100g	½ cup
Samp	75g	1/3 cup

	Mass	household measure
STARCHY VEGETABLES		
Peas, green	100g	½ cup
Potato, mashed, boiled, baked	100g	½ cup/1small
Squash, winter (butternut)	150g	1 cup
CRACKERS AND SNACKS		
Melba toast	30g	4 slices
Cream cracker, Cracker mate	20g	3
Snack-bread	20g	3
Bran S	20g	1
Rice cakes, 10 cm	20g	2
Pretzels	20 g	
Matzos	20g	½
STARCHY FOODS PREPARED WITH FAT		
(Count as 1 starch exchange, plus 1 fat exchange)		
Cookies	30g	2
Chow main noodles eg. 2 min noodles		½ cup
Crackers, savory	24g	6
French fried potatoes	45g	1
Pancake, 20 cm	70g	1
Crumpets	75g	2
Taco shell, 15 cm		2
Waffle, 20 cm		½
Roti, small, no oil	35g	1

FRUIT LIST

Fresh, frozen, canned, and dried fruits and fruit juices are on this list. In general one fruit exchange is:

- 1 small to medium fruit,
- ½ cup of canned or fresh fruit or fruit juice,
- ¼ cup of dried fruit.

Nutrition tips:

- Fresh, frozen, and dried fruits have about 2 grams of fiber and is therefore a better choice
  Fruit juices contain very little fiber.
- Citrus fruits, berries, and melons are good sources of vitamin C.
- Fruit should be eaten on a daily basis preferably with meals.

Selection tips:

- Portion sizes for canned fruits are for the fruit and small amounts of juice.
- Whole fruit is more filling than fruit juice and may be a better choice.

One exchange equals 15 grams carbohydrate and 250 kJ. The weight includes skin, core, seeds, and rind.

↓ **Low GI (0-55)**
• **Intermediate GI (56-69)**
↑ **High GI (>70)**

Please note only known South African GI values included

	Mass	household measure
FRUIT, FRESH		
↓Apple, unpeeled, small	115 g	1
↓Apricots, whole	155 g	4
•Banana, small	75g	1
↓Cherries, sweet	85 g	12
Figs, medium	90 g	2
Fruit salad	140g	2/3 cup
Gooseberry	255g	1½ cup
↓Grapefruit, large	310 g	½
↓Grapes, small	85 g	17
Granadilla, medium	120g	4
Guava, medium	190g	2
↓Kiwi	110 g	2
•Litchi	90g	11
•Mango, small	155 g	1
↓Minneola	185 g	1
↓Naartjie	230 g	2
↓Nectarine, small	140 g	1
↓Orange, small	180 g	1
•Pawpaw	230 g	2 slices/1 cup cubes/ ½ Papino
↓ Peach, medium	170 g	1
↓Pear, large	115 g	½
•Pineapple	125g	¾ cup
↓Plums, small	140 g	2
Pricklypear	180g	2
↑Spanspek	310 g	1-cup cubes
Strawberries	300g	1 ¼ whole berries
↑Watermelon	220 g	1 slice
FRUIT, DRIED		
Apples	20g	4 rings
Apricots	30g	8 halves
•Dates	20g	3
Figs	25g	2
Peach	25g	2 halves
Prunes	25g	3
•Raisins	20g	2 tbsp
FRUIT, CANNED		
Applesauce, unsweetened	145g	½ cup
Apricots	140g	½ cup
Blueberries	100g	¾ cup
Cherries	100g	½ cup
Fruit salad	140g	½ cup
Grapefruit sections	200g	¾ cup
Mandarin oranges	200g	¾ cup
Peaches	125g	½ cup
Pear	125g	½ cup/2 halves
Pineapple	100g	½ cup
Plums	100g	½ cup

FRUIT JUICE *(All juice made of low GI fruit has a low GI)*

	Mass	household measure
Apple	125ml	½ cup
Apricot	125ml	½ cup
Fruit juice blends, 100 % juice	85ml	1/3 cup
Grape	85ml	1/3 cup
Granadilla	125ml	½ cup
Grapefruit	125ml	½ cup
Guava	125ml	½ cup
Litchi	125ml	½ cup
Mango	125ml	½ cup
Orange	125ml	½ cup
Pear	125ml	½ cup
Pineapple	125ml	½ cup
Prune	85ml	1/3 cup

MILK LIST

One exchange equals 12 grams carbohydrate and 8 grams protein.
All milk products have a low GI.

Nutrition tips:

- Try to include at least 500ml milk or milk products per day.
- Check the food label for nutrition information. Milk and yogurt are good sources of calcium and protein.
- The higher the fat content of milk and yogurt, the greater the amount of saturated fat and cholesterol. Choose lower-fat varieties.

SKIMMED OR FAT-FREE MILK

One exchange equals 1 g fat and 375kJ per serving

	Mass	household measure
Skimmed milk	250ml	1 cup
1 % Milk	250ml	1 cup
Buttermilk	250ml	1 cup
Nonfat dry milk	60ml	¼ cup dry
Plain nonfat yogurt	250ml	1 cup
Nonfat yogurt, artificially sweetened	250ml	1 cup

LOW FAT MILK

One exchange equals 5 g fat and 525kJ per serving

2 % Milk	250ml	1 cup
Plain low-fat yogurt	85ml	¾ cup
Evaporated low-fat milk	125ml	½ cup

WHOLE MILK

One exchange equals 8 g fat and 640 kJ per serving

Whole milk	250ml	1 cup
Whole milk powder	35g	7 tbs
Evaporated whole milk	125m	½ cup
Goat's milk	250ml	1 cup
Inkomazi (Maas)	250ml	1 cup
Amazi	190ml	¾ cup

VEGETABLE LIST

Vegetables that contain small amounts of carbohydrates and kilojoules are on this list. Vegetables contain important nutrients. Try to eat at least 2 or 3 vegetable choices each day. In general, one vegetable serving is:

- ½ Cup of cooked vegetables or vegetable juice,
- 1 Cup of raw vegetables.

Nutrition tips:

- Fresh and frozen vegetables have less salt added than canned vegetables. Drain and rinse canned vegetables if you want to remove some salt.
- Choose more dark green and dark yellow vegetables, such as spinach, broccoli, carrots, chilies and peppers.
- Broccoli, Brussels sprouts, cauliflower, peppers, spinach and tomatoes are good sources of vitamin C.
- Vegetables contain 1 to 4 grams of fiber per serving.

One exchange equals 5 grams carbohydrate, 2 grams of protein, 0 grams fat, and 120 kJ.

Artichoke hearts
Artichokes
Asparagus
Baby marrow
Bean sprouts
Beans, green
Brussels Sprouts
Cabbage
Carrots
Cauliflower
Celery
Cucumber
Eggplant
Gem squash
Green onions or scallions
Leeks
Mixed vegetables (without corn, Peas or pasta)
Mushrooms
Okra
Peppers (all varieties
Radishes
Sauerkraut*
Salad greens (endive, lettuce, romaine, spinach)
Spinach
Summer squash
Tomato
Tomatoes, canned
Tomato sauce*
Tomato/ vegetable juice
Turnips
Water chestnuts

*= *400 mg or more sodium per exchange.*

MEAT AND MEAT SUBSTITUTES LIST

Meat and meat substitutes that contain both protein and fat are on this list. In general, one meat exchange is:

- 30 grams of Meat, fish, poultry or cheese,
- ½ Cup of dried beans.

Based on the amounts of fat they contain, meats are divided into very lean, lean, medium-fat, and high-fat lists. This is done so that you can see which ones contain the least fat.

Nutrition tips:

- Choose very lean and lean meat choices whenever possible. Items from the high-fat group are high in saturated fat, cholesterol, and kilojoules and can raise blood cholesterol levels.
- Unprocessed meats do not have any fiber or carbohydrates.
- Dried beans, soy products, peas, and lentils are good sources of fiber and carbohydrates.
- Some processed meats, seafood, and soy products may contain carbohydrates when consumed in large amounts. Check the nutrition information on the label to see if the amount is close to 15 grams. If so, count it as a carbohydrate choice as well as a meat choice.

Selection tips:

- Weigh meat after cooking and removing bones and fat. 120 grams of raw meat is equal to 90 grams of cooked meat. Some examples of meat portions are:
  30 grams of cheese = matchbox size.
  60 grams of meat = 2 meat choices, such as 1 small chicken leg or thigh OR ½ cup of cottage cheese or tuna.
  90 grams of meat = 3 meat choices, such as 1 medium chop OR 1 small, meat patty *or* 1 chicken breast *or* 1 fish fillet.
- Limit your choice from the high fat group to three times per week or less.
- Read labels to find products that are low in fat and cholesterol eg. 5 grams or less fat per serving.
- Dried beans, peas, and lentils are also found on the Starch list.
- Peanut butter, in smaller amounts, is also found on the Fats list.
- Bacon, in smaller amounts, is also found on the Fats list.

Meal planning tips:

- Bake, roast, broil, grill, poach, steam, or boil these foods rather than frying.
- Place it on a rack so the fat will drain off during cooking.
- Use a nonstick spray and a nonstick pan to brown or fry foods.
- Trim off visible fat before or after cooking.
- If you add flour, breadcrumbs, coating mixes, fat, or marinades when cooking, ask your dietitian how to count it in your meal plan.

VERY LEAN MEAT AND SUBSTITUTES LIST

One exchange equals 0 grams carbohydrate, 7 grams protein, 1 gram fat, and 155 kJ.

One very lean meat exchange is equal to any one of the following items:

	Mass	household measure
Poultry: Chicken or turkey (white meat, no skin)	30 g	
Fish: Fresh or frozen, tuna canned in water	30 g	
Shellfish	30 g	
Game: Duck or pheasant (no skin), venison, buffalo, ostrich	30 g	
Fat free cottage cheese	60ml	¼ cup
Other: processed sandwich meats with 1 gram or less fat per gram, such as thin, shaved meats	30 g	
Egg whites	30g	2
Dried beans, peas, lentils (cooked) – count as one very lean meat and one starch exchange.	100g	½ cup

LEAN MEAT AND SUBSTITUTES LIST

One exchange equals 0 grams carbohydrate, 7 grams protein, 3 grams fat, and 230 kJ.

One lean meat exchange is equal to any of the following items:

	Mass	household measure
Beef: Lean beef trimmed of fat, such as round, sirloin, and flank steak; tenderloin; roast (rib, chuck, rump); steak (T-bone, porterhouse, cubed); ground lean	30 g	
Pork: Lean pork, such as fresh ham	30 g	
Lamb: Roast, chop, leg	30 g	
Veal: Lean chop, roast	30 g	
Poultry: Chicken, turkey (dark meat, no skin), chicken (white meat, with skin)	30 g	
Fish:		
Herring, Mackerel, Kipper	30 g	
Oyster		6 med
Salmon (fresh or canned), catfish	30 g	
Sardines, canned		2 med
Tuna (canned in oil, drained)	30 g	
Game: Goose (no skin), rabbit	30 g	
Cheese: Low fat cottage cheese	60ml	¼ cup
Other: Liver, heart (high in cholesterol)	30 g	

MEDIUM-FAT AND MEAT SUBSTITUTES LIST

One exchange equals 0 grams carbohydrate, 7 grams protein, 5 grams fat, and 310 kJ.

One medium-fat exchange is equal to any of the following items:

	Mass	household measure
Beef: Most beef products fall into this category eg. Ground beef, meatloaf, corned beef, short ribs, prime grades of meat trimmed of fat	30 g	
Pork: Top loin, chop	30 g	
Lamb: Rib roast, ground	30 g	
Veal: Cutlet, ground or cubed	30 g	
Poultry: Chicken (dark meat, with skin), ground chicken or ground turkey, fried chicken (with skin)	30 g	
Fish: Any fried fish product	30 g	
Cheese:		
Low fat feta	30 g	
Mozzarella	30 g	
Ricotta	60 g	
Ground Parmesan	60g	2 tbsp
Other:		
Egg (high in cholesterol, limit to 3 per week)	55g	1
Vienna with 5 grams or less fat per serving		1 med
Soy milk	250ml	1 cup
Tofu	120g	½ cup
Bacon, Like-it-Lean		3 slices

HIGH-FAT MEAT AND SUBSTITUTES LIST

One exchange equals 0 grams carbohydrate, 7 grams protein, 8 grams fat, and 420 kJ.
Count as one high-fat meat plus one fat exchange.

Remember these items are high in saturated fat, cholesterol, and kilojoules and may raise blood cholesterol levels if eaten on a regular basis. One high-fat exchange is equal to any one of the following items:

	Mass	household measure
Pork: Spareribs, ground pork, pork sausage	30 g	
Cheese: all regular cheeses such as cheddar, Gouda, Camembert, Edam, Brie	30 g	
Other:		
Processed sandwich meats with 8 grams or less fat per serving, such as pimento loaf, salami	30g	
Boerewors	30 g	
Vienna sausage		1 med
Bacon		3 Slices
Kidney (high in cholesterol)	30 g	
Peanut butter (contains unsaturated fat)		2 tbsp

FAT LIST

Fat are divided into three groups, based on the main type of fat they contain: monounsaturated, polyunsaturated, and saturated. Small amounts of monounsaturated and polyunsaturated fats in the foods we eat are linked with good health benefits. Saturated fats are linked with heart diseases and cancer. In general, one fat exchange is:

- 1 teaspoon of regular margarine or vegetable oil,
- 1 tablespoon of regular salad dressing.

Nutrition tips:

- All fats are high in kilojoules. Limit serving sizes for good nutrition and health.
- Nuts and seeds contain small amounts of fiber, protein, and magnesium.
- If blood pressure is a concern, choose fats in the unsalted form to help lower sodium intake, such as unsalted peanuts.

Selection tips:

- Check the nutrition information on food labels for serving sizes. One fat exchange is based on a serving size containing 5 grams of fat.
- Soft margarines are not as saturated as block margarines. Soft margarines are healthier choices. Avoid those listing hydrogenated or partially hydrogenated fat as the first ingredient.
- When used in smaller amounts, bacon and peanut butter are counted as fat choices. When used in larger amounts, they are counted as high-fat meat choices.

MONOUNSATURATED FAT LIST

One exchange equals 5 grams fat and 190 kJ.

	Mass	household measure
Avocado, medium	35g	1/8
Oil (canola, olive, peanut)	5ml	1 tsp
Olives, ripe (black)	50g	10

	Mass	household measure
Nuts:		
• Almonds, cashews	10g	5 nuts
• Peanuts	10g	10 nuts
• Pecans	10g	4 halves
Peanut butter, smooth or crunchy	10g	2 tsp
Sesame seeds	10g	1 tbsp

POLYUNSATURATED

One exchange equals 5 grams fat and 190 kJ.

Margarine:		
• Tub or brick	5ml	1 tsp
• Lower fat eg. Flora Light	10ml	2 tsp
Mayonnaise:		
• Regular	10ml	2 tsp
• Reduced-fat	12ml	1 tbsp
Nuts, walnuts	10g	4 halves
Oil (cornflower, safflower, soybean, sunflower)	5ml	1 tsp
Salad dressing: *		
• Regular	12ml	1 tbsp
• Reduced–fat	25ml	2 tbsp
• Miracle Whip	10ml	2 tsp
Seeds, sunflower	10g	1 tbsp

SATURATED FAT LIST

One exchange equals 5 grams fat and 190 kJ.

Bacon, cooked		1 slice
Butter, brick	5ml	1 tsp
Coconut, shredded	25ml	2 tbsp
Cream	12ml	1 tbsp
Cream cheese:		
• Regular	12ml	1 tbsp
• Reduced fat	25ml	2 tbsp
Shortening or lard	5ml	1 tsp
Sour cream, regular	25ml	2 tbsp

OTHER CARBOHYDRATES LIST

You can substitute food choices from this list for a starch, fruit, or milk choice on your meal plan. Some choices will also count as one or more fat choices.

Nutrition tips:

- These foods can be substituted in your meal plan, even though they contain added sugars or fat. However, they do not contain as many important vitamins and minerals as the choices on the Starch, Fruit, or Milk list.
- When planning to include these foods in your meal, be sure to include foods from all the lists to eat a balanced meal.

Selection tips:

- Because many of these foods are concentrated sources of carbohydrate and fat, the portion sizes are often very small.
- Always check nutrition information on the food label. It will be your most accurate source of information.
- Many fat-free or reduced-fat products made with fat replacers contain carbohydrate. When eaten in large amounts, they may need to be counted. Talk with your dietitian to determine how to count these in your meal plan.
- Look for fat-free salad dressings in smaller amounts on the "Free food" list.

One exchange equals 15 grams carbohydrate, or 1 starch, or 1 fruit, or 1 milk.

FOOD	MASS	HOUSEHOLD MEASURE	EXCHANGE PER SERVING
Brownie, small, unfrosted		5 cm square	1 carbohydrate, 1 fat
Cake, plain		5 cm	1 carbohydrate, 1 fat
Cake, with icing		5 cm	2 carbohydrate, 1 fat
Cookie, plain or with crème filling		2 small	1 carbohydrate, 1 fat
Cupcake, with icing		1 small	2 carbohydrate, 1 fat
Doughnut, plain	45 g	1 med	1 ½ carbohydrate, 2 fats
Doughnuts glazed or with jam	60 g	1 medium	2 carbohydrate, 2 fats
Ice lolly, fruit		1	1 carbohydrate
Fruit pastilles, gums	30 g	1 roll	2 carbohydrate
Marshmallows	20 g	2	1 carbohydrate
Super C	15 g	5	1 carbohydrate
Jelly tots	40 g	1 small packet	2 carbohydrate
Hard-boiled sweets e.g. Sparkles, Lifesavers	30 g	10	2 carbohydrate
Toffee	25 g	5	1 carbohydrate, 1 fat
Chocolate, plain	20g	4 blocks	1 carbohydrate, 1 fat
Chocolate, bar	50 g	1	2 carbohydrate, 3 fats
Granola bar		1 bar	1 carbohydrate, 1 fat
Hummus		1/3 cup	1 carbohydrate, 1 fat
Ice cream		½ cup	1 carbohydrate, 2 fats
Ice cream, light		½ cup	1 carbohydrate, 1 fat
Ice cream, fat-free, no sugar added		½ cup	1 carbohydrate
Jam or jelly, regular		1 tbsp	1 carbohydrate
Potato chips eg. Simba	30 g		1 carbohydrate, 2 fats
Pudding, made with low-fat milk		½ cup	2 carbohydrates
Pudding, sugar free, low-fat milk		½ cup	1 carbohydrate
Salad dressing, fat free		¼ cup	1 carbohydrate
Sherbet, sorbet		½ cup	2 carbohydrate
Spaghetti or pasta sauce, canned		½ cup	1 carbohydrate, 1 fat
Syrup, regular		1 tbsp	1 carbohydrate
Yogurt, frozen, low-fat		1/3 cup	1 carbohydrate, 1 fat
Yogurt, low fat with fruit		1 cup	3 carbohydrate, 1 fat
Vanilla wafers		5	1 carbohydrate, 1 fat

FREE FOODS LIST

A free food is any food or drink that contains less than 84 kilojoules or less than 5 grams of carbohydrate per serving. Foods with a serving size listed should be limited to three servings p day. Be sure to spread them out throughout the day. If you eat all three servings at one time, it could affect your blood glucose level. Foods listed without a serving size can be eaten as ofter you like.

FAT-FREE OR REDUCED-FAT FOODS

Nonstick cooking spray	
Salad dressing, fat-free	1 tbsp
Salsa	¼ cup
Orley Whip	2 tbsp

SUGAR-FREE OR LOW-SUGAR FOODS

Candy, hard, sugar-free	1 candy
Jelly, sugar-free	
Gum, sugar-free	
Jam, sugar-free	2 tbsp
Sugar substitutes	

DRINKS

Bouillon, broth, consommé	Club soda
Bouillon or broth, low-sodium	Diet soft drinks, sugar-free
Carbonated or mineral water	Drink mixes, sugar-free
Coffee	Tea
Tonic water, sugar-free	
Cocoa powder, unsweetened (1 tbsp)	

CONDIMENTS

Tomato sauce (1 tbsp)	Pickles, dill* (1 ½ large)
Horseradish	Soy sauce
Lemon juice	Limejuice
Mustard	Vinegar

SEASONINGS

Be careful with seasonings that contain sodium or are salts, such as garlic or celery salt, and lemon pepper.

Flavoring extracts	Pimento
Garlic	Tabasco or hot pepper sauce
Herbs, fresh or dried	Wine, used in cooking
Worcestershire sauce	

*= *400 mg or more sodium per choice.*

APPENDIX E

Food Labelling

Food Labelling and Advertising Regulations

Compiled by Gabi Steenkamp, Registered Dietician, Johannesburg

With the first half of the new South African food labelling and advertising regulations having been passed in March 2010, all labels and advertising of food products in South Africa must be compliant. At present our advice is based on the passed first phase of the regulations of March 2010 as well as the published third draft of the regulations as a guideline for those issues not covered by the first half of the passed regulations. Some of the finer detail will probably still change in the second half of the regulations when they are passed, but we try to ensure that this will be kept to a minimum when compiling the report on your product label evaluation.

See the government website for more details:
http://www.doh.gov.za/healthtopics.php?t=Food Control

Why new legislation?

In the past, South African food manufacturers have used marketing strategies that mislead the consumer, not only directly with blatant untruths printed on labels, but also by misleading the consumer with half truths or by implication on label and marketing information.

A good example of this are the vegetable oils that are labeled 'contains 0% cholesterol', when in fact all vegetable oils DO NOT contain cholesterol. By implication, consumers would then assume that only those oils labeled with the 'contains 0% cholesterol' are the healthier choice as only they contain no cholesterol.

The facts however are:

- All vegetables oils are naturally free of cholesterol
- Vegetable oils have differing fatty acid compositions which function differently in the body – this is the pertinent information the consumer should be given
- All vegetable oils have the same energy value (kJ or Cal), and there is no such thing as a 'lite' vegetable oil
- Vegetable oils are manufactured by different methods, and this may affect the nutritional content of the oil. Again, information the consumer should be made aware of.

To address these problems, the Food Directorate of the Department of Health, has been hard at work reformulating the Food Labelling Regulations.

In essence, the objective is to create an equal platform for all products by stating:

- only facts
- not confusing the consumer by word or implication
- using the label as a platform for consumer education

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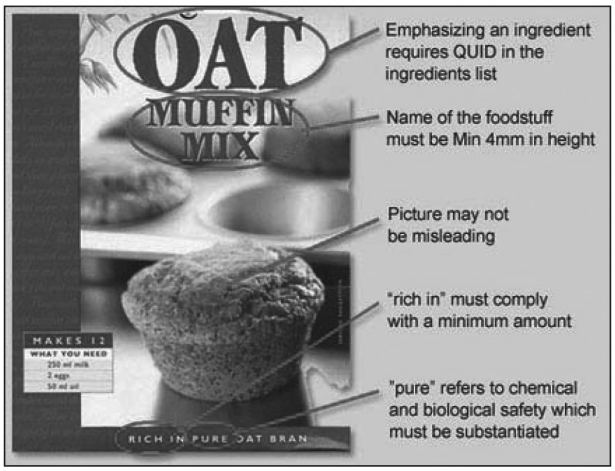
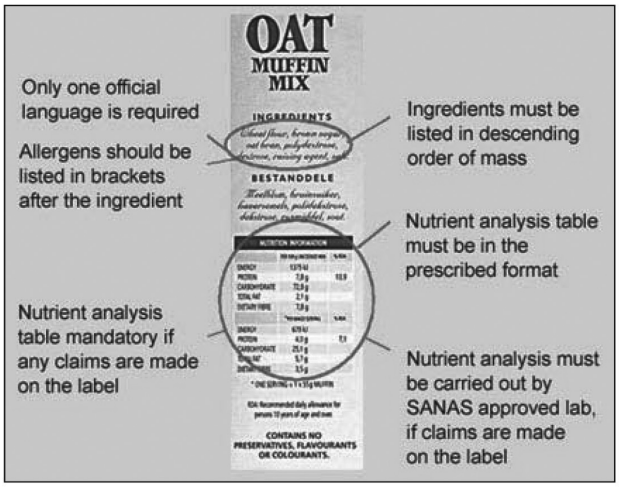
Food Labelling example





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Below is a brief summary of some of the regulations pertaining to the labelling and advertising of foods in South Africa.

SOME MANDATORY INFORMATION REQUIRED ON LABELS

- Accurate name of the product informing the consumer of exactly what is in the packaging.
- Ingredients in descending order of mass
- All allergens must be identified in the prescribed format
- Country of origin
- Batch identification number
- Use by date / Best before date
- Typical Nutritional Information Table for ALL products with claims, in the prescribed format. Products **without** claims may have a voluntary Typical Nutritional Information Table but this is not mandatory.
- Name and address in South Africa of the manufacturer or importer or distributor

- Net contents in metric units
- Agricultural products must also comply with the relevant agricultural standards act for that specific food.

DESCRIPTIVE WORDS

The following words may not appear on any food product:

- x% fat free. Must state contains xx % fat
- Nutritious or other words implying the same thing
- Healthy / healthful / health or other words implying the same thing
- Wholesome / complete nutrition / balanced nutrition and other words implying the same thing
- “Sugar free” and “Fat free” are only allowed, if specific conditions, as set out in the Food Labelling Regulations are met.
- "Suitable for those with diabetes", "diabetic friendly" or words with a similar meaning, may technically not be used until phase two of the legislation is passed. When passed, there will be stipulated criteria that need to be met before such a claim may be made. (e.g. low GI, lower fat, controlled sodium)
- All descriptive words must be carefully chosen to ensure that no implied claims are inadvertently made and that descriptions such as "home made" or "natural" etc. fall within the CODEX definitions.

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CLAIMS

- Phase one only makes provision for limited specific claims with specific wording that must be included on the label and/or advertising of the product.
- If any claim is made, certain provisos must be met, the least of which is that the nutritional analysis of the product must be done by a reputable SANAS accredited laboratory, following accredited procedures as set out in the regulations. No calculated nutritional information is allowed in this case.
- Phase two will contain the rest of the claims. For example glycemic index claims (absorption rate of a carbohydrate containing food), must be properly tested as set out in the regulations by a SANAS accredited organization.
- The endorsement programme of DIABETES SA is run by the Glycemic Index Foundation of SA (GIFSA), which is run by qualified dietitians. This endorsement has been approved by the Department of Health until phase two of the regulations has been passed.
- Endorsement of a product may only be granted by an organization where the endorsement programme is run by professionals, and where the specifications have been set up in keeping with the latest research. No company or member of the HPCSA may endorse its own products.

See the government website for more detailed information.

For a food labelling consultant, or food labelling workshops contact Gabi Steenkamp

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SERVICES OFFERED:

Food label evaluation

What is it?

All food labels in South Africa have to comply with the latest food labeling and advertising legislation in South Africa.

We can thoroughly evaluate your labels to ensure that no regulations of the act are contravened.
Should a complaint have been lodged against one of your labels or advertisements, we can assess where the error lies and how to correct it.

Please note that we are not graphic artists and do not design labels.

How do I go about it?

Email your label to us in PDF format with the label measurements and we will quote on the work to be done. For example a detailed evaluation with regard to the latest food labelling and advertising legislation in South Africa or proof reading after corrections or calculated nutritional analysis for products without claims.

Once the quote has been accepted, a time frame will be worked out and the completion date will be emailed to you.

What do I get for my money?

Once complete you will receive:

- Detailed report with recommendations
- Detailed nutrition or function claims information, if requested
- Assistance with correct wording that may be missing or needs correction

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APPENDIX F

What is the Glycemic Index (GI) all about?

A Quick look at the topic

The glycemic index (GI) is a relatively new nutritional tool used to fine tune carbohydrate intake. It is a measure of the real physiological response to food, giving an indication of the rate of absorption of carbohydrates in foods.

Using this glycemic index information, one can easily differentiate between fast release, and slow release carbohydrates, which enables one to optimise 'fuel' levels in the body.

This is of particular relevance to sportsmen and women, slimmers and those with diabetes. Eating mainly slow release (Low GI) carbohydrates before a sporting event, ensures good 'fuel' levels in the early stages of the event, as well as preventing the dreaded sports induced hypo's afterwards. Re-fuelling with fast release (high GI) carbohydrate drinks, maximizes glycogen stores immediately afterwards, preventing exhaustion, hypo's and resulting in better recovery after the event.

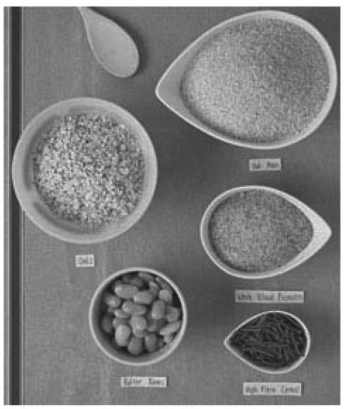
In diabetes optimum blood glucose control can easily be achieved if mostly slow release carbohydrates are eaten in the correct amounts.

And in slimmers, by preventing surges of blood glucose levels, by eating mostly low GI (slow release) carbohydrates, the stimulation of fat STORAGE is prevented. Insulin, the hormone that helps to clear glucose from the blood is also the hormone that stimulates the body to store fat. Thus the more fast release carbohydrates are eaten, the more fat is stored.

Implementing the GI is easy when using the correct ingredients

Rolled oats contain soluble fibre that lowers cholesterol and effectively lowers the GI of meals.

Mashed **butterbeans** can replace half of the high GI cake flour in cake recipes.



Oat bran contains soluble fibre that slows down glucose absorption. Up to half of the flour in any batter can be replaced with oat bran.

Wholewheat Pronutro gives good texture to baked goods and lowers the GI.

High Fibre Cereal adds bulk and fibre to batters, without to much increase on the glycemic load of the recipe.

Sweet potatoes are full of soluble fibre and can

Plain or flavoured low fat yoghurt in batters gives depth of flavour,

be added to batters and raw or cooked

Mashed **butterbeans** can replace half of the high GI cake flour in cake recipes.

improves texture and lowers the GI

Low fat or skim milk is better in dishes than water

Grated raw apple or canned pie apples can replace some of the fat and sugar in a batter. Apples are an effective and cost effective way of lowering the GI of all baked goods.

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A more in depth look at the topic

The Glycaemic Index (GI) is a rating of foods according to their actual effect on blood glucose levels. It is not a test carried out in a chemical laboratory.

To determine the glycemic index of foods, the foods are eaten by individuals, and their blood glucose levels tested after eating, to assess the effect of the food on blood glucose levels. In other words the glycemic index gives us an indication of how different foods affect the body's "petrol" levels.

One could say that the GI of a food represents its blood glucose raising ability.

Introduction

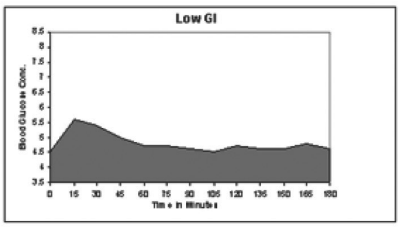
In the past, it was assumed that complex carbohydrates or starches, such as potatoes, mealiemeal (cornmeal) and bread, were digested and absorbed slowly, resulting in only a slight rise in blood glucose levels. Simple sugars, on the other hand, were believed to be digested and absorbed quickly, producing a large and rapid rise in blood glucose levles. Today, we know that these assumptions were incorrect, and that the general public, as well as diabetics, no longer need to avoid sugar altogether, provided it is used correctly. In fact, table sugar has a slightly more favourable effect on blood glucose levels than for example, potatoes, SA standard bread or rice cakes.

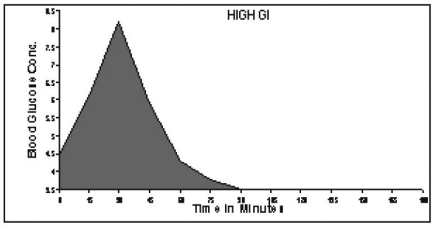
As early as the 1930's scientists challenged the traditionally held view that the metabolic effects of carbohydrates can be predicted by classifying them as either "simple" or "complex". In the 1970's, researchers such as Otto and Crapo, examined the glycemic impact of a range of foods containing carbohydrates. To standardise the interpretation of glycemic response data, Jenkins and colleagues of the University of Toronto, Canada, proposed the Glycaemic Index (GI) in 1981.

This work disproved the assumption that equivalent amounts of carbohydrate from different foods cause similar glycemic responses (the same rise in blood glucose levels). Furthermore, the researchers concluded that the carbohydrate exchange lists that have regulated the diets of most diabetics, do not reflect the physiological effect of foods, and are therefore no longer sufficient in controlling blood glucose levels! Both the amount of carbohydrate, and its rate of digestion and absorption (the glycemic index) determines the physiological response of the body.

Research done all over the world since then, confirms that the new way of ranking foods according to their actual effect on blood glucose levels is scientifically more correct. Consequently the Glycaemic Index (GI) was developed, whereby foods are ranked on a scale from 0 – 100, according to their actual effect on blood glucose levels. In South Africa, glucose is taken as the reference food and allocated a GI value of 100, since it causes the greatest and most rapid rise in blood glucose levels. All other carbohydrate foods are rated in comparison to glucose. Since the GI is a ranking of foods based on their actual effect on blood glucose levels, instead of on assumptions, it is much more accurate to use in the regulation of blood glucose levels.

Using the glycemic index (GI) concept, those suffering from diabetes or low blood sugar (hypoglycaemia), slimmers, children with Attention Deficit Disorder and sportsmen, can all optimize their blood glucose control.





By using the GI concept in combination with low fat eating, both triglycerides and blood pressure can be lowered and HDL-cholesterol (the "good" cholesterol) can be increased. For those wanting to lose weight, the increased satiety given by the lower GI foods, and the fact that less insulin (a hormone that also encourages the body to store fat) is secreted by a low GI diet, results in better fat loss. Even people suffering from cancer, gout and irritable bowel syndrome can benefit from low fat eating and the GI concept.

Remember, foods with a low GI, release glucose slowly and steadily into the bloodstream and do not over stimulate insulin secretion.

High insulin levels are implicated in all the diseases of our modern lifestyle such as high blood pressure, high cholesterol, high triglycerides, diabetes, hypoglycaemia, ADHD, obesity and coronary heart disease (CHD).

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HOW THE GLYCAEMIC INDEX IS DETERMINED

In order to find out the GI of a given food, the food has to be consumed, and the blood glucose levels tested after eating the food. For GI testing purposes, the test food must contain exactly 50g of carbohydrate. The amount of food that contains 50g of carbohydrate varies greatly. For example, two dinner plates full of spinach would contain 50g of carbohydrate, but only 2 tablespoons of jam contain 50g of carbohydrate.
The test food is eaten by a specially trained team, within 15 minutes. Blood glucose levels are measured before eating the food and then every 15 minutes after eating the food for two to three hours, and recorded. The blood glucose (glycemic) response of the test food is then compared to the glycemic response of each tester to 50g pure glucose and it is the ratio of the test food compared to glucose that gives us the glycemic index of each food.

Sometimes bread is used as the reference food instead of glucose. The problem is that breads can vary and so it was decided that glucose (which is standard throughout the world) would be used as the reference food in South Africa.

When looking at different GI lists, be very careful to check which reference food was used in the determinations of the GI values, as different reference foods used in the testing could create the impression that some GI values from different sources seem to differ. In addition, many authors mix up the two without realizing it!

To convert a GI with bread as the reference food, simply multiply the value by 0,7. To convert from glucose as the reference food, to bread, multiply by 1,43.

GI conversion factors for different reference foods

Glucose to bread x 1,43

Bread to glucose x 0,7

Often the GI of a given food is not what one would expect.

For example, the GI of South African standard brown bread is 75 - 80, whereas that of sweetened low fat fruit yoghurt is only 33. Previously one would have assumed that the yoghurt with the sugar in it, would result in a sharper rise in blood glucose after ingestion. But when tested in real people in real life situations, the opposite was found to be true. For this reason all carbohydrate containing foods need to be tested in real people in order to determine their GI. By guessing the GI of a food, one could be very far out.

The GI of over 800 foods has been determined worldwide and more foods are being tested on a weekly basis, overseas as well as in South Africa. For a complete reference guide on the glycemic index of foods commonly used in South Africa, see The South African Glycemic Index Guide by Gabi Steenkamp and Liesbet Delport, available in most bookstores in South Africa or it can be ordered from this website.
To order Click here.

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Ongoing studies are revealing that the body's responses to food are much more complex than originally appreciated. The following factors have an influence on the digestion and absorption of carbohydrates, and thus on how carbohydrate foods affect blood glucose levels. In other words, these factors affect the glyemic index of the food, which is the measure, on a numerical scale from 0 - 100, of how carbohydrate foods affect blood sugar levels.

Factors affecting the Glycemic Index of foods

Gelatinisation of starches	Gelatinisation of starches occurs when the starchy food is exposed to liquid and heat (ie cooking). The water binds with the starch in the presence of heat and expands the starch granules. When we boil potatoes, the heat and water expand the hard compact granules, (which make raw potatoes difficult to digest), into easily digestible swollen potato granules. Some granules actually burst and free the individual starch molecules, and this is the reason why potatoes have a high glycemic index – they are easy to digest and absorb.
Particle size	Intact grains such as whole wheat, barley, whole corn and whole rye have much lower GI values than flours (tiny particles) made from the same grains.
Processing	Milling, beating, grinding, mixing, mashing and refining foods raise the GI of that food.
The chemical composition of the starch	Starches, such as rice, can have different types of starch structures which affect their digestibility. Some types of rice such as Basmati rice, have a higher amylose content. Amylose is made up of long straight chains of glucose molecules which are packed closely together, which are more difficult to digest. Other rice, with a higher amylopectin content, is much easier to digest and thus has a higher GI. Amylopectin are branched chains of glucose that do pack closely together and are thus much less dense and easier to digest.
Fibre: type and content	Foods containing soluble fibre, such as oats and legumes, have a lowering effect on the GI because they delay gastric emptying. Insoluble fibre such as that found in digestive bran, on the other hand, has very little effect on the digestability and absorption of the carbohydrate foods. Thus foods containing bran do not necessarily have a lower GI than those foods without the bran. For example South African standard brown bread and white bread both have high GI values.

Sugar	Sugar may lower the GI of foods that have a very high GI because the sugar competes with the starch for the liquid for gelatinization. For example rice crispies have a high GI. When they are sugar coated, the GI is lower and thus cocopops and strawberry pops have lower GI values than rice crispies! Likewise sugar free Weetbix has a higher GI than the ordinary one with the sugar. As mentioned above, sugar can also lower the GI of baked goods, since it is inclined to bind with the fluid in baking, preventing it from binding with the flour and thereby preventing gelatinisation.
Protein and fat	The presence of protein and fat in food may lower the GI. However, it is not advisable to add fat to lower the GI of foods for health reasons. Excess protein tends to wear out the body's insulin; and fat has the effect of decreasing the effectiveness of insulin. Protein also overtaxes the kidneys and high protein intakes can lead to osteoporosis, arthritis and gout .
Anti nutrients	Phytates, lectins and polyphenols (tannins) normally slow digestion and thereby decrease the GI. These are found in many vegetables and fruits
Acidity	The more acid a food, the lower the GI of that food. For example, beetroot salad with a vinegar dressing will have a lower GI than hot cooked beetroot without the dressing.
Cooking	Cooking usually increases the digestability of the food, and would thus have the effect of raising the GI of that food.
Resistant starch	When starches are cooked and then cooled, the crystalline structure within the food changes to resistant starch which is more difficult to digest. Thus cold cooked starches, (eg boiled, cold potatoes in a potato salad) have a lower GI. This is especially true for mealiemeal. Thus cooked cold maize porridge has a lower GI than the hot freshly prepared porridge.
Speed of eating	Studies have shown that blood glucose levels rise less rapidly when eating more slowly.

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Some examples of the GI of South African foods

SLOW RELEASE CARBOHYDRATES (low GI)
Legumes: baked beans, sugar beans, lentils, etc. **Oat bran** **Barley** **Stampkoring** (wheat rice), **Dense & heavy breads** **Pasta** (Durum wheat) **Tastic rice, Brown rice** **Sweet potato** **Wholewheat Pronutro:** apple bake and original **Hi-Fibre Bran, Fibre Plus, BranFlakes** **Deciduous fruits:** apples, pears, grapes, etc **Citrus fruits:** oranges, grapefruit, naartjies, etc **Vegetables** (with a few exceptions) **Yoghurts:** low fat, fruit and plain

INTERMEDIATE RELEASE CARBOHYDRATES (med GI)
Cooked oats porridge **Basmati rice**

Couscous
Baby (new) potatoes
Original Pronutro
All Bran Flakes
Sweetened refined cereals with milk
Ryevita, rye breads (wheat free)
Tropical fruits eg banana, mango, litchi, pawpaw
Sultanas
Raisins
Fruit bars
Beetroot
Marog
Sugar
Raw honey
Jam (50% fruit content)
Fruit cordials, eg Oros, Soft drinks eg Coke, Fanta
Fruit Juices – most flavours

FAST RELEASE CARBOHYDRATES (HIGH GI)
Mealiemeal & other porridges
Sticky rice
Potatoes
Refined cereals: rice crispies, cornflakes, Weetbix,
Rice cakes, Corn thins
Breads: brown, white & whole wheat
Bread rolls, pita bread, etc.
Flours: wheat, cake, corn, potato, rice
Melons: watermelon, spanspek, sweet melon
Sports drinks: Energade, Sportsade, Game, Lucozade,
Sweets

Note: Product formulations differ from country to country even though they may have the same name

For example:

All Bran in Australia is very different to the All Bran Flakes in South Africa. In fact, the South African Kelloggs All Bran Hi-Fibre, commonly known as Hi Fibre Bran is the most similar to the Australian All Bran in its formulation (recipe). The Australian All Bran and the South African Hi Fibre Bran have almost the same GI (42 and 43 respectively). But all Bran Flakes in South Africa have a GI of 69.

Thus, be very careful which GI tables you use, stick to those for the country you live in.

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HOW TO MAKE THE GLYCAEMIC INDEX WORK FOR YOU

All foods that have a GI of 55 or less are slow release carbohydrates and classed as **LOW GLYCAEMIC INDEX FOODS.**

They are the best choices in preventing a large rise in blood glucose levels. The low GI foods are more satisfying and do not cause the release of as much insulin as high GI foods do. Therefore low GI foods also prevent the huge drop in blood glucose which occurs after the initial rapid rise in blood glucose levels after eating high GI foods.

High GI foods elicit a huge insulin response, the body's way of coping with the sudden, sharp rise in blood glucose. Often this insulin response is too much, and blood glucose levels then rapidly fall to below the starting point. A condition known as hypoglycaemia. This swing from very high to very low blood glucose levels, due to hyperinsulinaemia, is now believed to be a contributing factor to most of the lifestyle diseases. These diseases are actually caused by high insulin levels in the blood and could be prevented to a large extent if the general population would consume low fat, low GI foods. Researchers regard all foods with a GI of 62 or below as "safe", even though the theoretical cut off point for a low GI food in South Africa is 54.

Intermediate GI foods are those with a GI between 55 and 70.
They are the best choice in the following cases:
after low intensity exercise of short duration, in the morning after exercising the previous night, or directly after moderate activity in diabetics.

Foods with a GI higher than 70 are called high GI foods. High GI foods are excellent for the prevention of fatigue and hypoglycaemia in regular sportsmen after doing moderate to high intensity exercise (for example, sports drinks such as Powerade, Energade and others).

High GI foods should, however, be avoided by diabetics under normal circumstances, but are completely safe for diabetics after strenuous exercise, lasting 2-3 hours. High GI foods are also useful during a LOW blood glucose "attack". Any person wishing to have sustained energy during exercise, should not consume high GI foods before exercise or when they are inactive, but rather have low GI foods before exercise and during periods of inactivity.

Above is a sample table of the South African low fat foods that have been tested for their GI values. The list is by no means complete as GI testing only started in South Africa in 1998, and foods are being tested at this very moment.

For more information on the Glycaemic Index of South African foods contact the authors, Gabi Steenkamp or Glycaemic Index Foundation of South Africa website; wwwgifoundation.com

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APPENDIX G

A new concept, called the glycaemic load (GL), which was developed by scientists from Harvard University, USA, "fine tunes" the Glycaemic Index (GI) concept. It addresses concerns about rating carbohydrate foods as either "good" or "bad" on the basis of their GI. There is no such thing as a good or bad carbohydrate food. All carbohydrate foods can fit into a healthy diet") – it all depends on when you eat it, how much you eat and with what you combine it. For example, although low GI food is usually the preferred choice, a high GI sports drink is perfect during and after running a marathon, as a low GI drink during or after intense exercise could, in fact, can result in hypoglycemia and insufficient replenishment of carbohydrate in the muscle and liver.

The glycaemic load (GL) of a specific food portion is an expression of how much impact ("oomph"), or power the food will have in affecting blood glucose levels. It is calculated by taking the percentage of the food's carbohydrate content per portion and multiplying it by its Glycaemic Index value

$$GL = \frac{\text{CHO content per portion} \times GI}{100}$$

It is thus a measure that incorporates both the quantity and quality of the dietary carbohydrates consumed. Some fruits and vegetables, for example, have higher GI values and might be perceived as "bad". Considering the quantity of carbohydrate per portion, however, the GL is low. This means that their effect on blood glucose levels would be minimal. Let us consider a few examples:

* The GI of watermelon is high (GI = 72), but its glycaemic load is relatively low (GL = 7), because the quantity of carbohydrate in a serving of watermelon (150 g or a 5 mm thick slice) is minimal, as it contains a lot of water. This does not hold true for watermelon juice, however, as the quantity of carbohydrate in a cup of watermelon juice (250 ml) is much higher and fruit juice is therefore a more concentrated source of carbohydrate.

* The GI of apples is 38 and the GL of one medium apple is 5. This means that eating one apple will have hardly any effect on blood glucose levels. If you eat an entire 500 g packet of dried apples, however, its GL would be 50, which means that it will have a huge effect on your blood glucose levels, despite its being low GI. This brings us back to the old principle that there is no license (I changed the second c to an s; spelling mistake) to overindulge in "good" or "bad" foods. But should you indulge in watermelon, it will have an even greater effect on blood glucose levels, due to its high GI value!

* The GI of SA brown bread is high (GI = 81) and the GL of two slices (2 x 40 g slices of bread containing 20 g carbohydrate each) is also high (GL = 32), because the quantity of carbohydrate in a hand-cut slice of bread is substantial. This means that a sandwich made with two slices of brown bread will have a marked effect on blood glucose levels as the bread will have an "oomph" of 32. On the other hand, if you use a thin slice of bread (30 g bread containing 15 g carbohydrate) as part of a mixed meal containing low GI baked beans, ham and salad vegetables, the GL of the meal will be lower and more acceptable (GL = 22). Note that the two slices of bread on their own have a higher GL than an entire meal, in which only one thin slice of bread is used in combination with other low GI foods.

* The glycaemic load (GL) of one slice of seed loaf is only 8. In contrast to this, a single hand-cut slice of brown or white bread has a GL of 16. This means that ordinary brown or white bread will spike blood glucose levels (higher GL), and the seed loaf will not (lower GL), but this still doesn't mean that you can over-indulge in seed loaf. Fortunately, seed loaf is more filling and it is not as easy to over-indulge in this bread, as it is to over-indulge in brown or white bread.

* In addition, the GL of a roll (equivalent to two slices of bread) is more than 20, and that of a bagel (equivalent to three slices of bread) is more than 30. Imagine what this does to blood glucose levels, as the GI is also high!

* From this we can see that it is quite acceptable to include small quantities of high GI foods in a meal, as long as the bulk of the meal contains lower GI carbohydrate foods (vegetables, fruit, low GI starches, legumes and/or dairy).

New evidence associates high GL meals with an increased risk for heart disease and diabetes, especially in overweight and insulin-resistant people. Therefore, it is advisable to restrict the GL of a typical meal to between 20 and 25 as far as possible, but definitely to keep it below 30. The GL of a typical snack should preferably be between 10 and 15, but if your meals are all close to 30, the total of your snacks should be no more than 10. This means that you would have to eat fruit for snacks, in order to keep your total daily GL below 100, as the GL of fruit is usually below 10.

What does it mean when a food has a low glycaemic load?

A carbohydrate food that has a low glycaemic load (GL) will have a small impact on blood glucose levels, as it is either not high in carbohydrate and/or has a low Glycaemic Index (GI) one would have to eat quite a lot of it before it will have any effect on blood glucose levels. In other words, eating any one of the muffins contained in this lower GI, lower fat recipe book or in Eating for Sustained Energy 1, should not raise blood glucose levels significantly, as they have a lower GL. Having a low GL and a low Glycaemic Index (GI) is doubly beneficial. A food with a low GI and very little "push" or "power" (GL) behind it, will naturally have a very small impact on blood glucose levels, such as low GI vegetables (tomatoes, lettuce, cucumber, onions, asparagus, mushrooms, etc). It follows then that these foods are also not very effective at lowering the GI of high GI foods such as white or brown bread.

Remember: The GI indicates the extent to which a food will raise blood glucose levels, whereas the GL is the "power" or "push" behind the GI.

High GI and high GL means trouble – blood glucose levels will shoot up. This means the food in question will have a lot of "power" behind the already high GI, and even a small portion will have a marked effect. Examples of this are cooked mealie meal and potatoes and the regular SA bread mentioned above. These foods are high in carbohydrates and therefore a small portion already contains a lot of carbohydrate. In addition they have high GI values, which aggravates the effect on blood glucose levels.

Low GI combined with a high GL will also impact on blood glucose levels. Remember that the GL is based on the quantity of carbohydrate in a food, and represents the GI in portion size. So the more carbohydrate there is in a food, the higher its GL i.e. the more "power" or "push" behind the GI.

So even low GI foods, if eaten in large quantities, can affect blood glucose levels quite significantly, especially if they are concentrated sources of carbohydrates e.g. most cakes, dried fruit and dried fruit bars, fruit juices, crisps, chocolates, etc. Crisps and chocolates are also high in fat and/or saturated fat, making them undesirable.

And lastly, a high GI food with a low GL will not necessarily affect blood glucose levels significantly. A good example here is the high GI vegetables (carrots, pumpkin, etc). They contain only a little carbohydrate and therefore, in normal portion sizes, will not impact on blood glucose levels even though they have a high GI, as there is not enough "power" behind the high GI. The proviso is, though, that they are not eaten with other high GI or GL foods.

Please note that the glycaemic load (GL) of the starch component of most of our low GI breakfasts (such as those in all our lower GI, lower fat recipe books) is about 15, the GL of the starch component of most low GI light meals in our recipe books is between 15 and 20 and the GL of most low GI main meals is about 20. This means that three meals per day should add up to a GL of between 55 and 70, as most people will add salad and/or fruit to breakfasts and light meals, which also contribute to the GL. This leaves 30 – 45 GL points for snacks and drinks, as most of these have a GL of 10 – 15, except for fruit, which has a GL of below 10.

The aim is to keep the total GL per day under 100.