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## UNIT 5 THE MACRONUTRIENTS-II : PROTEINS AND FATS

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### Structure

- 5.1 Introduction
- 5.2 Proteins
- 5.3 Fats
- 5.4 Summing Up
- 5.5 Glossary
- 5.6 Answers to Check Your Progress Exercises

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### 5.1 INTRODUCTION

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In Unit 4 you learnt about two categories of macronutrients i.e. carbohydrates and water. This unit will cover another two categories of macronutrients i.e. proteins and fats. It discusses the nature, functions and food sources of proteins and fats. In addition, the processes of digestion, absorption and utilization of proteins and fats in the body are also discussed.

#### Objectives

After studying this Unit, you will be able to:

- list the food sources of proteins and fats
- state the role of proteins and fats in the body, and
- describe the processes of digestion, absorption and utilization of proteins and fats in the body.

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### 5.2 PROTEINS

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You have so far studied about carbohydrates and water. Let us now concentrate on the study of yet another category of macronutrients i.e. proteins.

The basic building blocks of proteins are called amino acids. Proteins are built up of just 22 amino acids. Food has an almost endless variety of proteins and no two proteins have similar structure. This is because the twenty or more amino acids are present in varying proportions and are arranged in varying sequences in different kinds of proteins. Of these about 8 cannot be manufactured by the body while the rest can. Those which cannot be manufactured by the body must be supplied by the diet. These amino acids are called *essential*. The amino acids which can be manufactured by the body need not, of course, be supplied by the diet. They are hence called *non-essential*. Here the terms "essential" and "non-essential" only refer to whether it is essential or not essential to provide them in the diet. We must remember that for the synthesis of body proteins both essential and non-essential amino acids are equally important.

The quality of food proteins depends on the number and the proportion of essential amino acids contained in them. Proteins are obtained from both animal and plant foods. The proteins in animal foods are of good quality because they contain all essential amino acids in the required amounts and proportions.

On the other hand, the proteins in plant food generally lack one or two essential amino acids and, therefore, are not of good quality. While cereals lack one amino acid, pulses lack another. However, when cereals are combined with pulses in the same meal, then the quality of protein improves. This is because each makes up the lacking amino acid in the other food. Protein quality of plant food can be thus improved by the combination of one or more kinds of foods of plant origin. If you look at the traditional Indian diets (whatever the region you may belong to), you will find many dishes which are prepared by using either a *cereal-pulse combination* as in dosa (rice, urad dal); dāl-roti; ricc-dal or a *cereal-animal food combination* as in dalia (milk, broken wheat); rice-fish. This is

one of the ways of improving the quality of food proteins. *By a judicious combination of foods of animal and plant origin, you can ensure that the protein consumed will be of good quality.* You must remember that even small amounts of animal protein with vegetable protein in a meal greatly improves protein quality.

**Food Sources:** Here is the list of some of the rich sources of proteins. The list is vast and includes: milk, milk products (like curd, khoa, paneer), flesh foods (meat, fish, poultry), eggs, nuts and oilseeds (groundnuts, almond, cashewnut, walnut) and pulses (bengal gram, lentils, green gram, rajmah, soyabean). Among pulses, soyabean is particularly rich in protein.

If you look at the current prices of foods of animal origin like meat, fish, poultry, you will find that most of these are very costly. The only animal foods which are relatively less expensive (though expensive as compared to plant foods) are milk and eggs. As the protein in foods of animal origin are of good quality, one should try to include small amounts of these foods in the daily diet. Milk is the only animal food used by both vegetarians and non-vegetarians. It contains protein of very good quality. Hence, even a small amount of milk added to a basic Indian diet of dal-roti greatly enhances the protein quality of the whole diet. One should therefore try to include at least a small amount of milk in the daily diet. Non-vegetarians, who cannot afford meat, fish and chicken can eat eggs which are cheaper and as nutritious as meat, fish or chicken.

Let us now take a look at the foods of plant origin. Pulses, nuts and oilseeds are rich sources of proteins. But these foods are also very expensive. Pulses are the major source of protein in Indian diets. One can try to improve the quality of cereal proteins by combining them with pulses. As mentioned earlier, a small amount of milk, if it can be afforded, will further improve the quality of food protein.

#### Check Your Progress Exercise 1

1) How can we improve the protein quality of cereals?

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2) List the sources of animal and vegetable proteins in your diet and compare their cost.

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**Functions:** Remember your childhood days when your parents/elders encouraged you to drink milk. They always said that you need milk for the proper growth of your body. Now, as an adult and a student of nutrition, you would realize that they were right. Milk is a good source of protein and proteins do play a role in growth and body-building. Let us now study the body-building and other functions of proteins in detail. Some of the functions of proteins are given below:

1) **Body-building:** Proteins supply amino acids for building new body tissues and for the replacement of worn out tissues. Thus they help in the growth and the maintenance of the body. For the constant growth of human beings from birth till adulthood, a regular supply of dietary protein is required. This does not mean that proteins are not needed when growth ceases. Even during adulthood worn out body

tissues need continuous replacement. Thus, proteins are required throughout life for the growth and maintenance of the body.

- 2) **Proteins as regulatory and protective substances:** Proteins are also part of some chemical substances essential for the regulation of vital body processes. You are aware of the role of enzymes in the process of digestion of food. All enzymes are proteins in nature. Like enzymes, hormones are also chemical substances vital for the regulation of metabolism as well as some other body processes. Some of the hormones (like insulin) are proteins. Antibodies which protect the body from illness are also proteins.
- 3) **Proteins as carriers:** Some of the proteins act as carriers and help to transport certain substances from one place to another. One prominent example is haemoglobin, the red coloured protein-containing substance present in the blood. Haemoglobin carries oxygen from the lungs to various body tissues and carbon dioxide from body tissues to the lungs.
- 4) **Energy-giving function:** Proteins can also be broken down in the body to provide energy. Each gram of protein yields about 4 Kcal. This, however, is not the major function of proteins and only takes place when the diet does not supply enough energy-giving nutrients such as carbohydrates and fats.

**Digestion, absorption and utilization:** Dietary proteins chiefly consist of proteins made up of small and large chains of amino acids. Digestion of proteins involves the breakdown of these amino acid chains to their constituent amino acids.

Since saliva does not contain any enzyme (which can bring about breakdown of proteins), protein digestion mainly occurs in the stomach and the small intestine. *Pepsin*, a proteolytic enzyme, present in gastric juice breaks down proteins into smaller amino acid chains. But pepsin itself cannot complete the digestion of proteins. Partly broken down proteins from the stomach are released into the small intestine where further digestion takes place in two steps: i) *Breakdown of partly digested proteins to smaller amino acid chains:* There are several enzymes in the small intestine which act on partly digested proteins and convert them to even smaller amino acid chains; ii) *breakdown of amino acid chains to amino acids.* Finally other kinds of enzymes act on amino acid chains and convert them to their constituent amino acids.

The metabolism of proteins is essentially the metabolism of amino acids as these are the end products of the process of digestion of proteins. After digestion, amino acids are carried by the blood to the liver. Here amino acids are used in three ways: a) some of them are used for building of blood proteins; b) some are retained in the liver and c) the rest enter the blood circulation as amino acids. Some of the amino acids remain in circulation and others are taken up by body tissues for protein synthesis whenever needed. It must be emphasized here that only proteins of good quality are maximally utilized by the body for synthesis of its own proteins.

**Check Your Progress Exercise 2**

- 1) Fill in the blanks.
  - a) ..... are the building blocks of all proteins.
  - b) Cereals and pulses both lack certain amino acids but when combined the protein quality .....
  - c) A good quality protein has the right ..... and ..... of all essential amino acids.
- 2) List four functions of proteins.
  - .....
  - .....
  - .....
  - .....

## 5.3 FATS

We use the term "fats" to refer to both fats and oils which are greasy in feel and insoluble in water. In addition to fats and oils there are certain fat-like substances such as cholesterol which are important in the body. You can learn more about cholesterol from Box 1 given at the end of this section.

Fats and oils are made up of fatty acids. They are needed in the diet mainly because they supply essential fatty acids.

Let us now see what is the difference between fats and oils. Fats are solid at room temperature e.g. ghee and butter. Oils, on the other hand, are liquid at room temperature e.g. mustard oil, groundnut oil. *Usually, the term fats is used for both fats and oils.*

**Food Sources:** Food sources of fats and oils include common fats and oils like ghee, vanaspati, mustard oil, groundnut oil, soya oil, coconut oil. They are almost 100 per cent fat.

The presence of fat is also evident in other foodstuffs like milk and milk products (curd, paneer, khoa), nuts and oilseeds (almond, groundnut, coconut, mustard seeds), eggs and flesh foods. These are known as *fat-rich foods*. They have 8 to 50 per cent fat in them.

You may be surprised to know that fat is present in very small quantities in almost all foodstuffs. Even foods like cereals, pulses, fruits have fats in them in minute quantities. These foods contribute a substantial amount of fat to Indian diets by virtue of being consumed in large quantities.

**Functions:** The term fats may be associated in your mind with a substance which is harmful for health. You may consider fats as substances which would make you overweight and may endanger your life by causing diseases like heart attacks. This is a negative view about fats. Fats as macronutrients play a crucial role in the body. Problems come up only if you take fats in excess amounts i.e. more than the requirement of the body. You would realize how important fats are for your body as you go through the following important functions that they perform:

- 1) **Source of energy:** Fat is a concentrated source of energy. Each gram of fat provides approximately 9 Kcal. This is more than double the amount of energy supplied by a gram of carbohydrate or protein. Usually only a small amount of fat is used to meet the energy needs of the body. Most of the excess fat is stored in the body in specific tissues called adipose tissue. Adipose tissue is present under the skin, and in the abdominal region among others.
- 2) **Satiety Value:** What happens when you consume fat-rich diets? Do you feel hungry sooner or later? In fact, as you would have noticed, you feel full and do not feel hungry for a long time. This is because fats remain longer in the stomach and take more time to digest. Hence, like fibre, fats also have a high satiety value.
- 3) **Insulation and padding:** You have read that fat is stored in the body in adipose tissue at specific places. Layers of stored fat under the skin act as an insulator and keep the body warm. A layer of fat is also present around the vital organs of the body like the kidney and the heart. This serves as a padding and protects them against injury.
- 4) **Source of essential fatty acids:** Fats serve as sources of essential fatty acids which have important functions in our body.
- 5) **Carrier of fat-soluble vitamins:** You have read about a category of micronutrients called vitamins. Some of the vitamins are soluble in fats and are termed as fat-soluble vitamins. Fats serve as carriers of fat-soluble vitamins in the body and also aid in their absorption.

**Digestion, absorption and utilization:** In the process of digestion fats are broken down to fatty acids. One of the two enzymes which aids in the digestion of fats is present in gastric juice and the other is poured into the small intestine from the pancreas. For enzyme action, fats need to be dispersed or mixed in water. You know fats are insoluble in water. A secretion from the liver called bile helps in fat digestion by breaking fat into small droplets. These fat droplets are then dispersed in the liquid digestive juice and are

easily acted upon by enzymes. Since bile is not present in the stomach, the action of gastric lipase is not very significant. This is the reason why fats are chiefly digested in the small intestine where the pancreatic enzyme breaks them into glycerol and fatty acids aided by the action of bile.

The end products of fat digestion i.e. glycerol and fatty acids present in the intestine move into the intestinal cells. The fatty acids cannot enter intestinal cells as such. Bile salts play an important role in fat absorption by dispersing the fatty acids into small tiny water-soluble units which can easily move into the intestinal cells.

Fatty acids and glycerol then get transported from the intestinal cells to blood circulation. They do not travel directly into the bloodstream but first enter the network of vessels (present in the villi of the small intestine) called lymph vessels. Then fatty acids from the lymph vessels enter the heart and from there move into the blood. Blood then carries them either to the adipose tissues where they are stored as concentrated sources of energy or to cells where they are broken down to provide energy (in a similar fashion as glucose and amino acids).

<b>BOX 1</b>	<b>Cholesterol</b>
<p>Cholesterol and its relationship to health and disease is a hot topic of discussion. You would probably have encountered this term in conversation, advertisements, newspaper columns, magazines and books. What is cholesterol? Cholesterol is a fat-like substance present in foods. It is different in structure from fats and oils. Animal foods like milk, egg, organ meats, ghee, butter, cream are all rich sources of cholesterol. Plant foods like vegetable oils (mustard oil, groundnut oil, soya oil), nuts and oilseeds do not contain cholesterol. Some manufacturers of vegetable oils try to mislead the public by making claims that their products do not contain cholesterol. In fact, none of the vegetable oils contain cholesterol.</p> <p>Cholesterol plays many important roles in the body:</p> <ol style="list-style-type: none"> <li>a) It is the structural component of membranes of body cells.</li> <li>b) The breakdown of cholesterol by the liver produces bile salts. Bile salts are important for digestion and absorption of fats and some vitamins.</li> <li>c) Cholesterol is also necessary for the synthesis of many hormones in the body.</li> </ol> <p>However, extra cholesterol over and above body needs can be harmful. It can lead to heart disease.</p>	

**Check Your Progress Exercise 3**

1) List the steps involved in digestion, absorption and utilization of fats.

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2) Fill in the blanks.

- a) All fats and oils are made up of ..... and .....
- b) Each gram of fat provides approximately ..... Kcal.
- c) The amount of energy supplied by a gram of fat is ..... the amount of energy supplied by a gram of carbohydrate or protein.
- d) ..... is essential for digestion and absorption of fats and oils.

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## 5.4 SUMMING UP

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The discussion in this unit is on two categories of macronutrients i.e. proteins and fats. You have read that:

- Amino acids are the building blocks of proteins. Food and body proteins contain 22 different amino acids. These 22 amino acids are classified into two categories: essential and non-essential amino acids. The quality of food proteins depends on the relative proportion of essential amino acids present in them. As animal proteins generally contain enough of all the essential amino acids needed by the body, they are considered superior in quality as compared to plant proteins. The quality of plant proteins can be improved by combining plant foods with other plant foods or animal foods e.g. cereal-pulse combinations or cereal-milk combinations.

The end products of protein digestion in the body are amino acids which after absorption are utilized for several functions in the body. The chief function of proteins is growth and maintenance.

- Fatty acids are the chief constituents of all fats and oils. During the process of digestion, fats in the food are broken down to their constituent fatty acids. The fatty acids released as a result of digestion are concentrated sources of energy.

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## 5.5 GLOSSARY

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<b>Essential amino acids</b>	: The amino acids which cannot be synthesized in the body and hence have to be provided in the diet.
<b>Fatty acid</b>	: An organic compound composed of carbon, hydrogen and oxygen. In combination with glycerol, fatty acids form fat.
<b>Hormone</b>	: Secretions of some glands of the body which travel through the blood to specific target organs to exert their specific effects e.g. the hormone insulin is secreted by a gland (pancreas) and travel in blood to the target organ (i.e. muscle and adipose tissue)
<b>Haemoglobin</b>	: A protein-containing compound present in the blood which helps to carry oxygen from the lungs to the body tissues and carbon dioxide from the body tissues to the lungs.
<b>Non-essential amino acid</b>	: An amino acid which can be synthesized in the body and hence does not have to be provided in the diet.
<b>Reserve</b>	: Reserve here refers to stores of various nutrients in the body at specific sites.

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## 5.6 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

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### Check Your Progress Exercise 1

- 1) Cereals are lacking in one of the essential amino acids (lysine). Their protein quality can be improved by combination with other foods which are rich in lysine i.e. pulses or animal foods like milk, egg, meat.
- 2) Answer from your own experience.

### Check Your Progress Exercise 2

- 1) a) Amino acids      b) improves      c) proportion and amount
- 2) Body building, protection and regulation, carriers in transport of certain substances, energy-giving.

Check Your Progress Exercise 3

- 1) Digestion of fats mainly in small intestine after dispersion by bile; fatty acids move into intestinal cells and from there into blood via the lymph system; fatty acids move from bloodstream to body cells where they are used to release energy or to adipose tissue where they are stored.
- 2)
  - a) fatty acids and glycerol
  - b) 9
  - c) double
  - d) Bile