International Standard
Colored Edition

Based on **INC Syllabus 2021-22**

II
Semester

Textbook of

Nutrition & Dietetics

for BSc Nursing Students

As per the Revised INC Syllabus (2021-22) for BSc Nursing

Special Features

- Thoroughly updated and revised edition
- A Perfect amalgamation of theory and Clinical Aspects
- 200+ Figures, Tables and Flowcharts
- Dietetics part covered extensively
- A Special Section on Nutrition and Dietetics in a nutshell

3rd EDITION

CBS Publishers & Distributors Pvt. Ltd.

Monika Sharma

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Nutrition & Dietetics

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3rd Edition

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Preface to the Third Edition

Our body is very important to us and we should take utmost care of it. If we take proper care of it, the performance of our body will be at its best. The human body is like a finely-tuned engine. To function properly, it requires the right fuel in the form of right food and right fluids. Nurses require a great deal of training and knowledge regarding nutrition due to the fact that there is a connection between nutrition, diet and health. Knowledge regarding nutrition is even helpful for the wellbeing of the nurses too.

Nursing is a challenging career with long working hours. The most obvious reason why nurses should be well versed in nutrition is that it can help them in making their patients to learn more about nutrition and nutrition-related problems. This can be made possible only, when they are themselves well-equipped with the basic concepts of nutrition. To fulfil this motive, this book has been updated and designed to meet the requirements of BSc (Nursing) and post-basic BSc nursing students in the best manner possible. This textbook has been written keeping in mind the revised curriculum framed by the Indian Nursing Council.

This textbook has been written in simple language and styled in well-organized and systematized way. It is hoped that the content of this book will be useful for all the nursing students and will meet the requirements of students effectively in accordance with the advancements in the field of nursing. This book not only provides information regarding the basics of nutrients, but also provides information regarding cooking rules and preservation of nutrients, balanced diet and the role of nurses in nutritional programs, food additives, food standards, assessment of nutritional status, etc. This book also covers recent guidelines regarding RDAs, updated Health Policies and Acts. Not even a single topic is missed in this book according to INC syllabus. After reading each chapter, student can assess herself or himself by using questions given at the end of each chapter.

I believe that this book will become a standard book for nutrition in nursing. Constructive criticism for the book is always welcome.

Monika Sharma

Preface to the First Edition

Rich or poor, wise or foolish we all are having one body to take care of. The body's performance depends on the intelligent care we give to it. The human body is like a finely-tuned engine. To function properly, it requires the right fuel, the right food and the right fluids. Nurses require a great deal of training and knowledge regarding nutrition due to the fact that there is a connection between nutrition, diet and health. Even knowledge regarding nutrition is helpful for the wellbeing of the nurses too. Nursing is a stressful career with long working hours. The most obvious reason why nurses should be well versed in nutrition is that it can help them to help their patients to learn more about nutrition and nutrition related problems. This can be possible only, when they are themselves knowledgeable regarding basic concept of nutrition. To fulfill this motive, this book has been designed to meet the requirements of BSc nursing and post basic BSc nursing students. This textbook has been written keeping in view the curriculum framed by the nursing council of India. This textbook has been written in simple language and styled in well organized and systematized way. It is hoped that content of this book will be useful for all the nursing students and will meet the requirement of students effectively. This book not only provides nutrients information but also provides information regarding cooking rules and preservation of nutrients, balanced diet and role of nurse in nutritional programs, food additives, food standards, assessment of nutritional status, etc. This book also covers recent guidelines regarding RDAs. Not even a single topic is missed in this book according to INC syllabus. After reading each chapter, student can assess herself or himself by using questions given at the end of each chapter.

I believe that this book will become a standard book for nutrition in nursing.

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Special Features of the Book

LEARNING OBJECTIVES

- Describe the classification, functions, sources and recommended daily allowances (RDA) of carbohydrates
- Explain BMR and factors affecting BMR

Learning Objectives enlist what the students will learn after studying the entire chapter.

CHAPTER OUTLINE

Concepts

- Terminology of Nutrition
- History of Nutrition
- Concepts of Nutrition
- Importance of Food in Health and Disease
- Role of Nutrition in Maintaining Health

Every chapter starts with a **Chapter Outline** to give a brief view of the content covered in the chapter.

KEY TERMS

- **Acidosis:** The accumulation of acid and hydrogen ions or depletion of the alkaline reserve (bicarbonate content) in the blood and body tissues, resulting in a decrease in pH.
- **Allowances:** Something permitted or allowed.
- **Anthocyanins:** Anthocyanins arenatural pigments that occur in plants, fruits and vegetables. They give plants the blue and red colors as seen in blueberries and plums. They belong to a group of plant compounds called flavonoids, and are believed to behave as antioxidants.

Important **Key Terms** used in the chapters are highlighted in the beginning to make students familiar with the basic terms and concepts.

INTRODUCTION

Carbohydrates are hydrates of carbon. The presence of carbon, hydrogen and oxygen in carbohydrates is in the ratio of 1:2:1. Chemically, carbohydrates are defined as polyhydroxy aldehydes or polyhydroxy ketones or substances that yield compounds on hydration. The general formula is $C_nH_{2n}O_n$. The term saccharide is derived from the Latin word "Sacchararum" means the sweet taste of sugars. Carbohydrates are widely distributed in plants in which they are formed from carbon dioxide of the atmosphere by photosynthesis. Carbohydrates are sources of quick and sustained energy for our body.

A brief **Introduction** to the chapter has been added in the beginning to arise the interest of the students.

Supplemented with numerous **Figures** for easy grasp of the relevant topic.

Fig. 6.1 Dietary sources of minerals

Table 6.1: Vitamins and minerals: A comparison

	Vitamins	Minerals
Chemical composition	Complicated, organic substances	Simple, inorganic substances
Source	From plants and animals	Found in soil and rock
Vulnerability	Destroyed by cooking with heat or chemical reaction	Not vulnerable to heat, chemical reactions
Nutritional requirement	All vitamins are necessary for the body to function properly	Not all minerals required for nutrition

Numerous **Tables** are used to supplement the text for easy and quick understanding.

At the end of every chapter, **Assess Yourself** section covering Long Answer Qs, Short Answer Qs and Multiple Choice Qs have been added for self-evaluation.

Assess Yourself

Long Answer Questions

1. Give classification of carbohydrates. Discuss disaccharides in details.
2. What do you mean by energy? Write down factors affecting energy requirement.

Short Answer Questions

1. What are carbohydrates mostly made of?
2. What are the seven types of carbohydrates?

Multiple Choice Questions

1. Simplest form of carbohydrate is:
   a. Aldehyde and Ketone groups
   b. Carboxyl and Alcohol group
   c. Carboxyl group
   d. Hydrogen and Hydroxyl group
2. Major function of carbohydrates is:
   a. To transport material
   b. Storage
   c. To storage and structural framework
   d. For structural framework

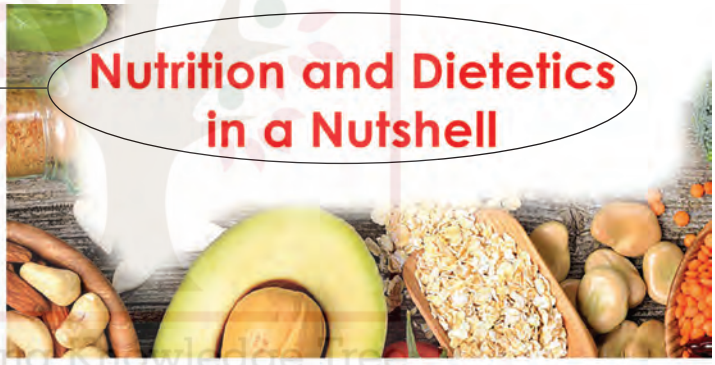
ANNEXURE II

NATIONAL NUTRITION POLICY

It is a set of nationwide guidelines that specify how the nutritional needs of the population will be met. National nutrition policy was adopted by Government of India in 1993 under the department of women and child development. It advocated a multisectoral strategy for eradicating malnutrition and achieving optimum nutrition for all. Policy advocates the monitoring of nutrition levels across the country. Also sensitizing government machinery on the needs for good nutrition and prevention of malnutrition.

Important **Appendices** including High yield topics and facts have been covered to keep yourself abreast of the Important facts.

In the Beginning of Book special section on **Nutshell** have been given for a quick glance to facts and information related to nutrition and dietetics in one go.



Types of Carbohydrates

Concentrated forms of simple and compound sugars are a poor source of energy. They get into the blood too fast and cause an insulin over-reaction.

- **Simple sugars:** Monosaccharide—single sugar unit
  - **Glucose:** Blood sugar
  - **Fructose:** Mostly fruits, berries and honey
  - **Galactose:** Does not occur free in nature, it is always bonded to something else.

Nutrition and Dietetics

Placement: II Semester **Theory:** 3 credits (60 hours)

Course description: The course is designed to assist the students to acquire basic knowledge and understanding of the principles of Nutrition and Dietetics and apply this knowledge in the practice of Nursing.

Unit	Time (Hrs)	Learning objectives	Content	Teaching learning activities	Assessment methods
I	2 (T)	Define nutrition and its relationship to health	**Introduction to Nutrition** *Concepts* • Definition of nutrition and health • Malnutrition—under nutrition and over nutrition • Role of nutrition in maintaining health • Factors affecting food and nutrition *Nutrients* • Classification • Macro and micronutrients • Organic and inorganic • Energy yielding and non-energy yielding *Food* • Classification—food groups • Origin	• Lecture cum discussion • Charts/slides	• Essay • Short answers • Very short answer
II	3 (T)	• Describe the classification, functions, sources and recommended daily allowances (RDA) of carbohydrates • Explain BMR and factors affecting BMR	**Carbohydrates** • Composition—starches, sugar and cellulose • Recommended daily allowance (RDA) • Dietary sources • Functions **Energy** • Unit of energy—Kcal • Basal metabolic rate (BMR) • Factors affecting BMR	• Lecture cum discussion • Charts/slides • Models • Display of food items	• Essay • Short answer • Very short answer
III	3 (T)	Describe the classification, functions, sources and RDA of proteins	**Proteins** • Composition • Eight essential amino acids • Functions • Dietary sources • Protein requirements—RDA	• Lecture cum discussion • Charts/slides • Models • Display of food items	• Essay • Short answer • Very short answer

Contd...

Unit	Time (Hrs)	Learning objectives	Content	Teaching learning activities	Assessment methods
IV	2 (T)	Describe the classification, functions, sources and RDA of fats	**Fats** • Classification—saturated and unsaturated • Calorie value • Functions • Dietary sources of fats and fatty acids • Fat requirements—RDA	• Lecture cum discussion • Charts/slides • Models • Display of food items	• Essay • Short answer • Very short answer
V	3 (T)	Describe the classification, functions, sources and RDA of vitamins	**Vitamins** • Classification—fat soluble and water soluble • Fat soluble—vitamins A, D, E, and K • Water soluble—thiamine (vitamin B_1), riboflavin (vitamin B_2), nicotinic acid, pyridoxine (vitamin B_6), pantothenic acid, folic acid, vitamin B_{12}, ascorbic acid (vitamin C) • Functions, dietary sources and requirements—RDA of every vitamin	• Lecture cum discussion • Charts/slides • Models • Display of food items	• Essay • Short answer • Very short answer
VI	3 (T)	Describe the classification, functions, sources and RDA of minerals	**Minerals** • Classification—major minerals (calcium, phosphorus, sodium, potassium and magnesium) and trace elements • Functions • Dietary sources • Requirements—RDA	• Lecture cum discussion • Charts/slides • Models • Display of food items	• Short answer • Very short answer
VII	7 (T) 8 (L)	Describe and plan balanced diet for different age groups, pregnancy, and lactation	**Balanced Diet** • Definition, principles, steps • Food guides—basic four food groups • RDA—definition, limitations, uses • Food exchange system • Calculation of nutritive value of foods • Dietary fiber **Nutrition Across Life Cycle** • Meal planning/menu planning—definition, principles, steps • Infant and young child feeding (IYCF) guidelines—breastfeeding, infant foods • Diet plan for different age groups—children, adolescents and elderly • Diet in pregnancy—nutritional requirements and balanced diet plan	• Lecture cum discussion • Meal planning • Lab session on: ▪ Preparation of balanced diet for different categories ▪ Low cost nutritious dishes	• Short answer • Very short answer

Contd...

Unit	Time (Hrs)	Learning objectives	Content	Teaching learning activities	Assessment methods
			• Anemia in pregnancy—diagnosis, diet for anemic pregnant women, iron and folic acid supplementation and counseling • Nutrition in lactation—nutritional requirements, diet for lactating mothers, complementary feeding/ weaning		
VIII	6 (T)	Classify and describe the common nutritional deficiency disorders and identify nurses' role in assessment, management and prevention	**Nutritional Deficiency Disorders** • Protein energy malnutrition—magnitude of the problem, causes, classification, signs and symptoms, severe acute malnutrition (SAM), management and prevention and nurses' role • Childhood obesity—signs and symptoms, assessment, management and prevention and nurses' role • Vitamin deficiency disorders—vitamin A, B, C and D deficiency disorders—causes, signs and symptoms, management and prevention and nurses' role • Mineral deficiency diseases—iron, iodine and calcium deficiencies—causes, signs and symptoms, management and prevention and nurses' role	• Lecture cum discussion • Charts/slides • Models	• Essay • Short answer • Very short answer
IX	4 (T) 7 (L)	Principles of diets in various diseases	**Therapeutic Diets** • Definition, objectives, principles • Modifications—consistency, nutrients • Feeding techniques. • Diet in diseases—obesity, diabetes mellitus, CVD, underweight, renal diseases, hepatic disorders constipation, diarrhea, pre- and post-operative period	• Lecture cum discussion • Meal planning • Lab session on preparation of therapeutic diets	• Essay • Short answer • Very short answer
X	3 (T)	Describe the rules and preservation of nutrients	**Cookery Rules and Preservation of Nutrients** • Cooking—methods, advantages and disadvantages • Preservation of nutrients • Measures to prevent loss of nutrients during preparation • Safe food handling and storage of foods	• Lecture cum discussion • Charts/slides	• Essay • Short answer • Very short answer

Contd...

Unit	Time (Hrs)	Learning objectives	Content	Teaching learning activities	Assessment methods
			• Food preservation • Food additives and food dulteration • Prevention of Food Adulteration Act (PFA) • Food standards		
XI	4 (T)	Explain the methods of nutritional assessment and nutrition education	**Nutrition Assessment and Nutrition Education** • Objectives of nutritional assessment • Methods of assessment—clinical examination, anthropometry, laboratory and biochemical assessment, assessment of dietary intake including food frequency questionnaire (FFQ) method • Nutrition education—purposes, principles and methods	• Lecture cum discussion • Demonstration • Writing nutritional assessment report	• Essay • Short answer • Evaluation of nutritional assessment report
XII	3 (T)	Describe nutritional problems in India and nutritional programs	**National Nutritional Programs and Role of Nurse** • Nutritional problems in India • National nutritional policy • National nutritional programs—vitamin A supplementation, anemia Mukt Bharat Program, Integrated Child Development Services (ICDS), Midday Meal Scheme (MDMS), National Iodine Deficiency Disorders Control Program (NIDDCP), Weekly Iron Folic Acid Supplementation (WIFS) and others as introduced • Role of nurse in every program	Lecture cum discussion	• Essay • Short answer • Very short answer
XIII	2 (T)	• Discuss the importance of food hygiene and food safety	**Food Safety** • Definition, food safety considerations and measures • Food safety regulatory measures in India—Relevant Acts • Five keys to safer food • Food storage, food handling and cooking • General principles of food storage of food items (ex. milk, meat) • Role of food handlers in food borne diseases • Essential steps in safe cooking practices	Guided reading on related Acts	• Quiz • Short answer

Food born diseases and food poisoning are dealt in Community Health Nursing I.

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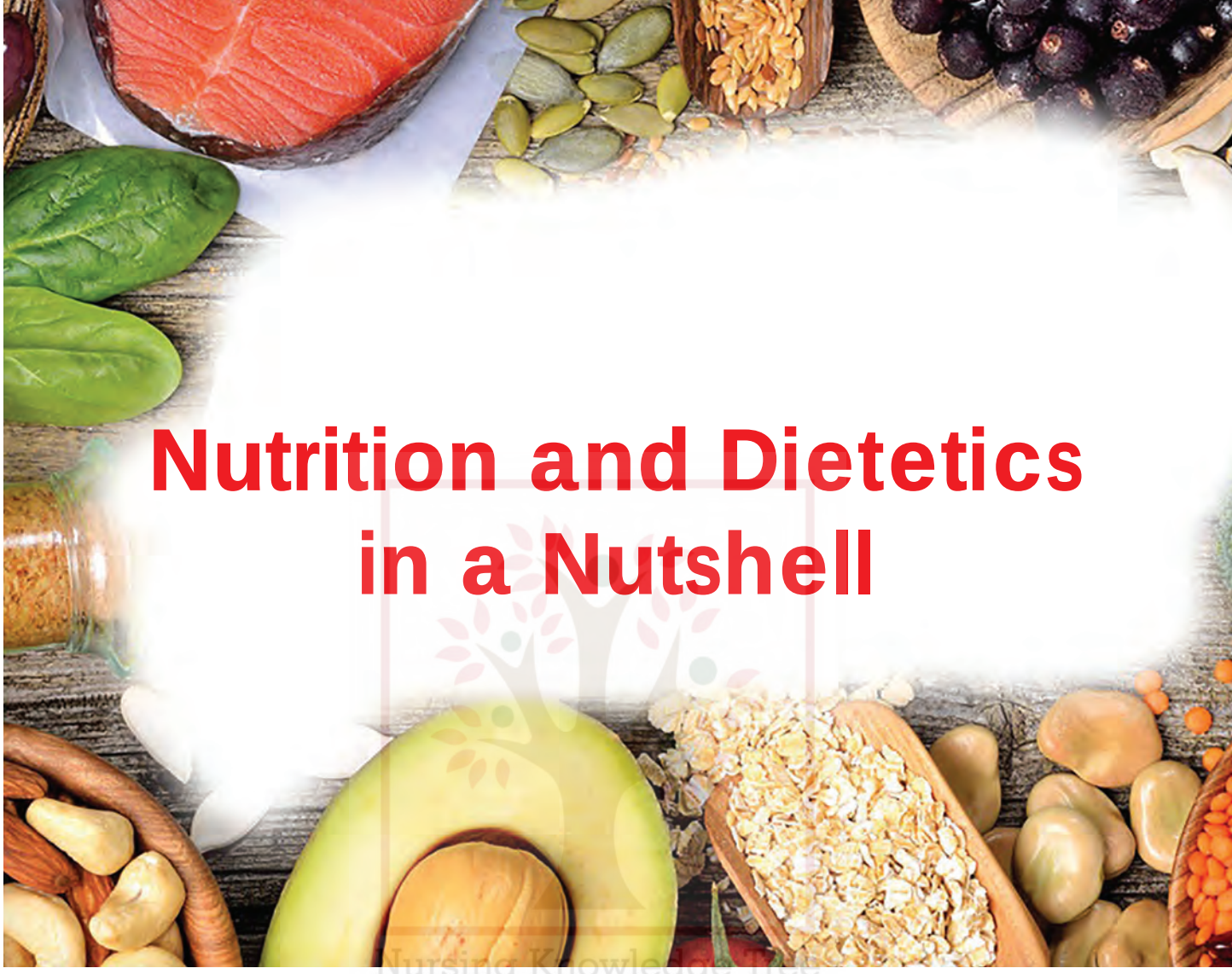


Nutrition and Dietetics in a Nutshell

Types of Carbohydrates

Concentrated forms of simple and compound sugars are a poor source of energy. They get into the blood too fast and cause an insulin over-reaction.

- **Simple sugars:** Monosaccharide—single sugar unit
  - **Glucose:** Blood sugar
  - **Fructose:** Mostly fruits, berries and honey
  - **Galactose:** Does not occur free in nature, it is always bonded to something else.
- **Compound sugars:** Disaccharide—two sugar units
  - **Sucrose:** Sugar cane and sugar beets
  - **Maltose:** Germinating seeds
  - **Lactose:** Milk sugar
- **Complex carbohydrate (starch):** Polysaccharide—many sugar units.

Processed Sugar

- It is not a nutrient but sometimes it is confused as a carbohydrate. All nutrients are removed from sugar through the refinery process.
- **Contains empty calories:** It has no any nutritional value, but it fills you up.
- Processed sugar robs the body of vitamins and minerals. Vitamins and minerals are used up when we digest the food—usually we are repaid by the nutrients in the food, but there are no nutrients in sugar.
- Sugar is hidden in many labels under a variety of different names. Add all the sugar together and they equal to the number one ingredient:
- Brown sugar, dextrose, beet sugar, maltose, glucose, corn syrup, fructose, molasses, galactose.

Processed Sugars Effect on Behavior

- **First:** Hyper activeness due to speed that sugar gets into the blood.
- **Next:** Drops glucose level due to an insulin over-reaction.
- **Then:** Low sugar levels in the blood shuts off the 'cerebral brain' which controls learning, attention span, moral values, etc.
- Now, the animal (hypothalamus) brain is left to run the body which controls survival instincts and self-gratification.
- **Hypoglycemia:** Low blood sugar due to an over secretion of insulin.
- **Symptoms begin** 2–5 hours after a meal.
- **Symptoms:** Rapid heartbeat, sweating, lack of energy, dizziness, shaking, faintness, and headaches.

Test for the Carbohydrates

Test	Purpose
Molisch test	General test for all Carbohydrates
Benedict's test	Test for reducing substances
Barfoed's test Moore's test Fehling's test	Test to differentiate monosaccharides and disaccharides
Seliwanoff's test Foulger's test rapid furfural test	Test to differentiate aldoses and ketoses
Feulgen staining	Test to detect deoxy sugar
Bial's test	Test for pentoses
Mucic acid test	Test for galactose

Protein Requirements

- The Indian Council of Medical Research (ICMR) recommended 1 g/kg/day for an Indian adult.
- Average adult male—60 g/day and female—55 g/day.
- Pregnant women require additional 15 g/day and lactating women 25 g/day protein
- Infants and children require 2–2.2 g/kg/day for normal health and development.

Shapes of Proteins

Fibrous protein	Globular protein
Elongated/needle-shaped/cylindrical/rod-like	Spherical/oval/spheroidal
Minimum solubility in water	Easily water soluble
Mainly structural proteins (collagen, elastin, and keratin)	Metabolic proteins (transport protein—albumin and globulin; Hb; myoglobin, antibodies, enzymes and hormones)

Conjugated Protein

Conjugated protein	Constituents	Example
Glycoproteins	Protein + carbohydrate	Blood group antigens, immune globulins, mucin of saliva, plasma proteins (except albumin, TSH, FSH, LH)
Lipoproteins	Protein + lipids	LDL, HDL, VLDL, chylomicrons
Nucleoproteins	Protein + nucleic acids	Histones
Phosphoprotein	Contains phosphorus	Casein of milk and vitelline of egg yolk

Classification of Amino Acids

Essential amino acids	Non-essential amino acids
Leucine	Alanine
Isoleucine	Aspartic acid
Histidine	Glutamine
Lysine	Glutamic acid
Methionine	Arginine
Phenylalanine	Asparagine
Tryptophan	Serine
Valine	Cysteine
Threonine	Glycine
	Proline
	Tyrosine

Types of Fats

- **Saturated fats:** Solid or semisolid at room temperature
  - A fatty acid carrying the maximum possible number of hydrogen atoms.
  - **Source:** Mostly from animal products—meats, poultry, fish, milk, cheese and eggs.
- **Polyunsaturated fats:** Liquid at room temperature:
  - A fatty acid that has two or more hydrogen bonds missing

- **Source:** Mostly from plants
- **Lowers** cholesterol, but also slightly lowers HDL (good cholesterol)
- They supply essential fatty acids.

- **Monounsaturated fats:** Liquid at room temperature:
  - A fatty acid that has **one** hydrogen bond missing
  - Slightly lowers **LDL cholesterol**, but some studies show that it may slightly raise **HDL**
  - Other studies show its effect on **HDL in neutral**
  - **Canola oil** had both polyunsaturated a monounsaturated fat.
- **Fish oils: Omega-3** polyunsaturated fatty acids that come from fish:
  - They do not have much effect on cholesterol.
  - They lower the total amount of fat in the blood (reduce triglycerides).
  - They help prevent blood clots.
  - Smart to eat fish 2 or 3 times a week.
- **Trans fatty acids:** The process of adding hydrogen to unsaturated fats to make it more solid and resistant to chemical change:
  - Causes it to **lose** its polyunsaturated character and health benefits.
    Example: Butter: Margarine (partially hydrogenated vegetable oil).

Two Types of Cholesterol

1. **Low-density lipoproteins (LDL):** Bad cholesterol:
   - Fat in the blood stream that is on its way to cell for storage, (including the cells that line the artery walls)
   - Saturated fat causes the body to produce LDL
2. **High-density lipoproteins** (HDL) good cholesterol:
   - Fat in the bloodstream that is en route to the liver where it is processed and excreted from the body.
   - **HDL** works to minimize the harmful effects of LDL by causing it to be removed from the blood stream and excreted.
   - Cannot get HDL from the foot you eat.
   - The trick is to get your body to make it:
   - Losing weight
   - Not smoking
   - Aerobic exercise

Normal Value of Different Lipoproteins

- Total blood cholesterol should be less than 200 mg/dL (total blood cholesterol is the sum of the cholesterol in three lipoprotein)
- LDL cholesterol should be less than 130 mg/dL
- HDL cholesterol should be more than 40 mg/dL
- Organs whose major energy source is glucose is: Brain, RBC (in both in fed and starving state), cornea, retina, renal medulla and testes.
- Canola oil had both polyunsaturated and monounsaturated fats.
- **PUFA a**re mostly found in vegetable oils and saturated fats mainly in animal fats.

- **Trans fatty acids:** the process of adding hydrogen to unsaturated fats to make it more solid and resistant to chemical change.
- Water soluble vitamins are excreted in urine and hence cannot accumulate to toxic levels in the body.
- **All B-complex** vitamins wash out easily from the body except B_{12} and folate (stored in liver)
- Sulfur containing vitamins are thiamine (B_1) and biotin
- Folic acid and vitamin B_{12} are called hematopoietic vitamins since they are required for normal maturation of RBCs because of their role in DNA synthesis.

Kwashiorkor: The term Kwashiorkor is derived from the Ga language of Chana and means "the sickness of the weaning".

Williams first used the term in 1993, and it refers to an inadequate protein intake with reasonable caloric (energy) intake.

Marasmus: The term, Marasmus, is derived from the Greek word 'marasmos', which means withering or wasting.

Fluorine is a double-edged sword: Inadequate intake is associated with dental caries, whereas excess intake with dental and skeletal fluorosis.

Level >1.5 ppm: Dental fluorosis (mottling)

Level 3–6 ppm: Skeletal fluorosis

Level >10 ppm: Crippling fluorosis

- **Double fortified/Twin salt fortified:**
  - Contains 40 mcg Iodine and 1 mg iron per gram of salt
  - Developed by National Institute of Nutrition.
  - The most recommended defluoridation method is Nalgonda Technique.
- **Defluoridation** is removal of excess fluorides from water.
  - Best source of vitamin D is sunlight.
  - **Wernicke's** encephalopathy is due to the deficiency of vitamin thiamine.
  - Magenta red tongue seen in the deficiency of riboflavin.
  - Richest Source of essential fatty acids (EFA): Safflower oil
- **Pellagra is characterized by 4Ds**
  i. Diarrhea
  ii. Dementia
  iii. Death
  iv. Dermatitis
    - First sign of vitamin A deficiency is conjunctival xerosis (dryness of eye)
    - Kanawati index is used for protein-energy malnutrition.

Vitamins are Divided into Two Groups

1. **Fat soluble vitamin (vitamin A, D, E, K)**
2. **Water soluble vitamin (vitamin B group & C)**
   - Fat-soluble vitamins deficiency mainly occurs in disease that interferes with the digestion of fat (such as steatorrhea), but it accumulates in organs, like the liver when taken in excess.
   - Water-soluble vitamins are readily lost from the body in urine and sweat.

- Deficiency of any vitamin causes specific deficiency disease except vitamin E, which deficiency disease is yet not known.
- Three vitamins, like pro-vitamin A (carotene), vitamin C & vitamin E are termed anti-oxidant vitamin because they inactivate or remove free radicals (o-) from body.

Based on response to heat, vitamin is divided into the following two groups:

1. **Heat stable vitamins** (A, D, E, K)
2. **Heat unstable vitamins** [vitamin c and some vitamin B like thiamine (B_1) and folic acid]

Vitamin A Deficiency Disease

- **Night blindness:** Deficiency of vitamin A causes night blindness. It is first clinical symptom.
- **Conjunctival xerosis:** Dryness of conjunctiva (a membrane which covers the eyeball and inner sides of eyelids). It is the first clinical sign of vitamin A deficiency.
- **Bitot's spot:** Triangular, pearly white or yellowish, foamy spots on conjunctiva on either side of cornea.
- **Corneal xerosis:** The cornea becomes dry and eventually opaque. It is a serious condition.
- **Keratomalacia:** Liquefaction or extremely softening of cornea called *keratomalacia*. It is a grave medical emergency.
- All above ocular manifestation of vitamin A deficiency from night blindness to keratomalacia **called xerophthalmia (dry eye).**
- The most frequent cause of blindness in developed countries are accidents, glaucoma, diabetic retinopathy, hypertensive retinopathy and cataract.
- In south-east Asia, like India, the principal cause of blindness is cataract, responsible for 62.6% of all cases.
- Vitamin A deficiency, which is responsible for most of childhood blindness now declining slowly.
- There are two major forms of vitamins K—K_1 & K_2.
- Vitamin K_1 mainly is found in fresh fruits and green vegetables, like dark green vegetable.
- Vitamin K_2 is synthesized by intestinal bacterial flora.
- Cow milk (60 g/L) is the richest source of vitamin K, than human milk (15 g/L).
- Long-term administration of antibiotic may cause suppression of intestinal flora and may cause a deficiency of vitamin K.
- Vitamin K is stored in the liver.
- Vitamin K is essential for production of clotting factor II, VII, IX and X, so in deficiency of vitamin K, blood clotting time (CT) becomes prolonged.
- The newborn infants are deficient in vitamin K due to deficient intestinal bacterial flora and minimal stores of prothrombin (because of immature liver) at birth.
- IM injection (into vastus lateralis muscles) of menadione (vitamin K3, a synthetic vitamin that can be converted in the body to active vitamin K) 0.1–0.2 mg use at birth.
- Within the kidney, vitamin K acts to inhibit calcium oxalate stone formation.

Iron Requirement

- Adult male—28 mg/day (ICMR, 2001)
- Adult male—17 mg/day (ICMR, 2010)
- Adult female—30 mg/day (ICMR, 2001)

- Adult female—21 mg/day (ICMR, 2010)
- Pregnant women—38 mg/day (ICMR, 2001)
- Pregnant women—35 mg/day (ICMR, 2010)

Dietary Sources of Energy

Source	Energy in kcal	Energy in kJ
1 g of protein	4 kcal	17 KJ
1 g of carbohydrate	4 kcal	17 KJ
1 g of fat	9 kcal	37 KJ

Recommended Daily Allowance for Energy According to 2010

- Reference man (Weight 60 kg)—sedentary work—2425 kcal
- Moderate activities—2875 kcal
- Hard work—3800 kcal
- Reference female (weight 55 kg)—sedentary work—1875 kcal
- Moderate activities—2225 kcal
- Hard work—2925 kcal
- Pregnant Female—350 kcal/day additional energy
- Lactating Mother (0–6 month)—600 kcal/day
- Lactating Mother (after 6 month)—520 kcal/day

Principal Clinical Manifestation of Kwashiorkor and Marasmus

Clinical features	Muscle wasting	Edema	Weight according height	Appetite	Serum albumin	Deficiency
Marasmus	Obviously	None	Very low due to loss of subcutaneous fat	Usually good	Slightly decreased	Severe energy deficiency
Kwashiorkor	Present but hidden by edema	Pitting edema on lower leg, face and abdomen (due to decreased osmotic pressure in to blood)	Low but hidden by edema	Poor	Very low, less than 3 g/dL (total protein—6–8 g/dL albumin—3.5–5.5 g/dL, globulin—1.5–3 g/dL)	Severe protein deficiency

Protein Energy Malnutrition (PEM)

Features	Skin change	Hair change	Face
Marasmus	Appears loose and sags	No	Sunken face and eye (monkey-like face)
Kwashiorkor	Flaky paint dermatosis	Band of hypopigmented and normal pigmented hair called "flag sign"	Moon face

Types of Marasmus

According to progressive loss of subcutaneous fat from:

- Grade-1—buttocks
- Grade-2—grade 1+ axilla and groins
- Grade-3—grade 1+ grade 2 + abdomen, chest, spine
- Grade-4—grade 1+ grade 2 + grade 3 + buccal pad

Classification of PEM

According indian academy of pediatrics:

- 1st degree—weight between 70–80% of expected
- 2nd degree—weight between 60–70% of expected
- 3rd degree—weight between 50–60% of expected
- 4th degree—weight below 50% of expected

Mid-arm Circumference

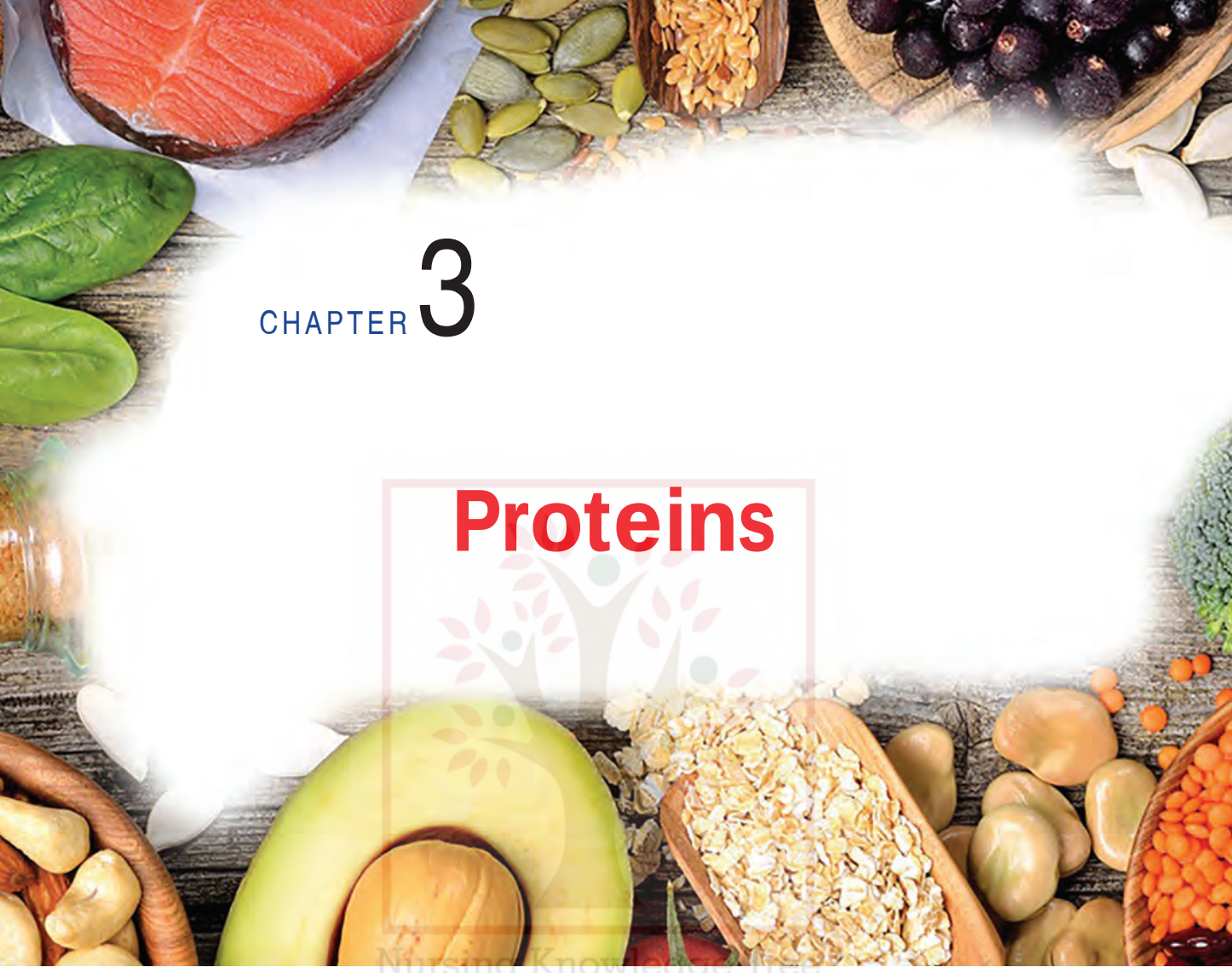
- No more change in mid-arm circumference between first 5 years of age.
- Mid-arm circumference measure uses to assess nutrition status of children between 1 and 5 years of age.
- Not use in less than 1 year children

Shakir's Tape

- Normal nutritional status—more than 13.5 cm (green)
- Border line PEM—12.5–13.5 cm (yellow)
- Severe PEM (wasted)—less than 12.5 cm (red)

Midday School Meal

Food substance	Amount
Cereals and millets	75 g/day/child
Pulses	30 g/day/child



CHAPTER 3

Proteins

LEARNING OBJECTIVE

Describe the classification, functions, sources and RDA of proteins

CHAPTER OUTLINE

- Types of Amino Acids
- Classification of Proteins
- Recommended Dietary Allowance
- Dietary Sources of Protein
- Essential Amino Acids
- Functions of Proteins
- Digestion, Absorption, Metabolism and Storage of Proteins

KEY TERMS

- **Amino acids:** They are fundamental blocks of proteins.
- **Conjugated proteins:** These proteins contain non-protein portion in their structure. Hemoglobin E (Protein + Heme) and Lipoprotein (Protein lipid).
- **Derived proteins:** These are produced by the action of acids, alkaline, heat and enzymes on native proteins, polypeptides, proteases, etc.
- **Enzyme:** Biological catalysts which enhance the role of chemical reactions in the body.

Contd...

- **Lactoferrin:** Minor protein of milk containing iron.
- **Peptide bond:** Peptide bond is synthesized when the carboxyl group of one amino acid molecule reacts with the amino group of the other amino acid molecule, causing the release of a molecule of water.
- **Polypeptide:** A long chain of amino acids linked by peptide bonds.
- **Protein:** A macromolecule composed of one or more polypeptide chains, each with a characteristic sequence of amino acids linked by peptide bonds and is essential for muscle mass.
- **Transport or carrier proteins:** Certain proteins are involved in the transportation of many essential biological factors to various parts of organisms. These are known as carrier or transport proteins.

INTRODUCTION

Proteins are one of the most abundant and important components of the body. It accounts for about 16% of body weight. The term has a Greek origin derived from the word "proteios" means "primary" or "first place".

Proteins contain carbon, hydrogen, and oxygen and also nitrogen. In contrast to other macromolecules in the body, namely carbohydrates and fats, proteins contain sulfur, phosphorus, iron and cobalt.

The basic units of proteins are the amino acids that are linked through peptide bonds. Each amino acid contains an acidic group and an amino group. About 21 amino acids have been found to occur in proteins. Proteins differ from one another primarily due to their sequence of amino acids.

TYPES OF AMINO ACIDS

Amino acids are the basic units of protein. Before we start proteins, it is necessary to understand amino acids. There are two types of amino acids—essential and nonessential amino acids (Table 3.1).

- **Essential amino acids:** The 10 essential amino acids that cannot be synthesized in the body but have to be supplied in the diet are essential amino acids.
- **Non-essential amino acids:** The amino acids that can be synthesized by the body are called non-essential amino acids.
- **Semi-essential amino acids:** Arginine and histidine are called semi essential amino acids as they are required in the diet of children, pregnant women and lactating women. They are not essential for normal adult.

TABLE 3.1: Types of amino acids

Essential amino acids	Non-essential amino acids
Histidine	Alanine
Isoleucine	Arginine
Leucine	Aspartic acid
Lysine	Cysteine
Methionine	Glutamic acid
Phenylalanine	Glutamine
Threonine	Glycine
Tryptophan	Proline
Valine	Tyrosine
	Serine

CLASSIFICATION OF PROTEINS

Different methods of protein classification are discussed as follows:

- Classification based on chemical composition and solubility
- Classification based on the structure
- Classification based on the biological function
- Classification based on the source of protein molecule

Classification Based on Chemical Composition and Solubility

- **Simple proteins:** These proteins are made up of amino acids only. For example, plasma albumin, collagen and keratin.
- **Conjugated proteins:** These proteins contain non protein portion in their structure. For example, hemoglobin (Protein + Heme) and lipoprotein (protein lipid).
- **Derived proteins:** These are produced by the action of acids, alkaline, heat and enzymes on native proteins, polypeptides, proteases, etc.

Classification Based on the Structure

- **Globular proteins:** They have compact and more or less spherical structure. For example, globular proteins, blood transport proteins, antibodies and hormones. These proteins perform a variety of functions.
- **Fibrous proteins:** They have primarily mechanical and structural functions, providing support to the cell as well as the whole organism. They resemble long ribbons or fibers in the shape (Fig. 3.1). These are mainly of animal origin and are insoluble in all common solvents such as water, dilute acids, alkalies and salts and also in organic solvents. The fibrous proteins are extremely strong. They include the proteins of connective tissues, bones, blood vessels, skin, hair, nails, horns, wool and silk.

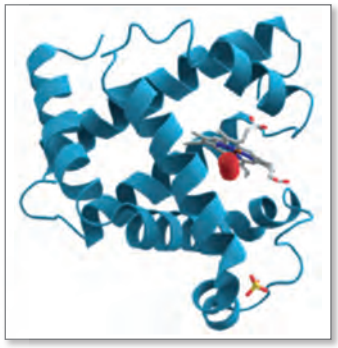


Fig. 3.1 Fibrous proteins

Classification Based on the Biological Function

- **Enzymatic proteins:** In living organisms, almost all reactions are catalyzed by special proteins called enzymes. Life can exist without their action. Chemically some enzymes are simple proteins containing only amino acid. Others are complex proteins, containing a major protein part and a small non-protein part. Urease, amylase, catalase, cytochrome C are some of the examples of enzyme proteins.
- **Transport or carrier proteins:** Certain proteins are involved in the transportation of many essential biological factors to various parts of organisms. These are known as carrier or transport proteins (Figs 3.2 and 3.3). Each carrier protein is designed to recognize only one substance or one group of similar substances.

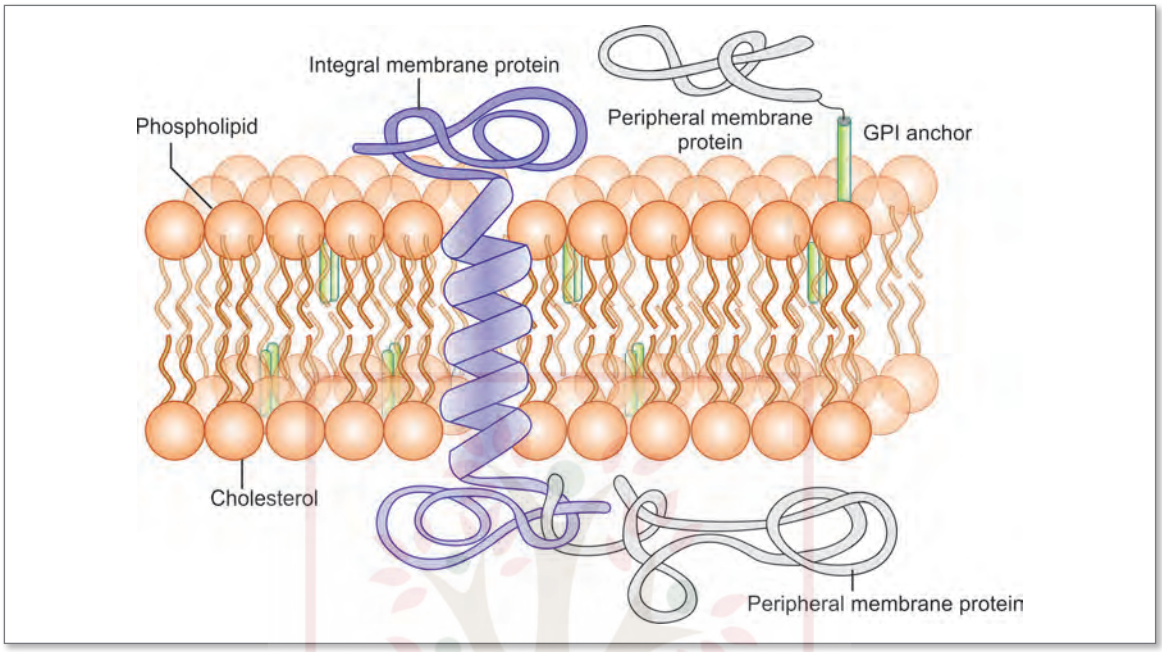


Fig. 3.2 Transport protein in cell membrane (Integral membrane proteins and peripheral membrane proteins are embedded in a phospholipid bilayer)

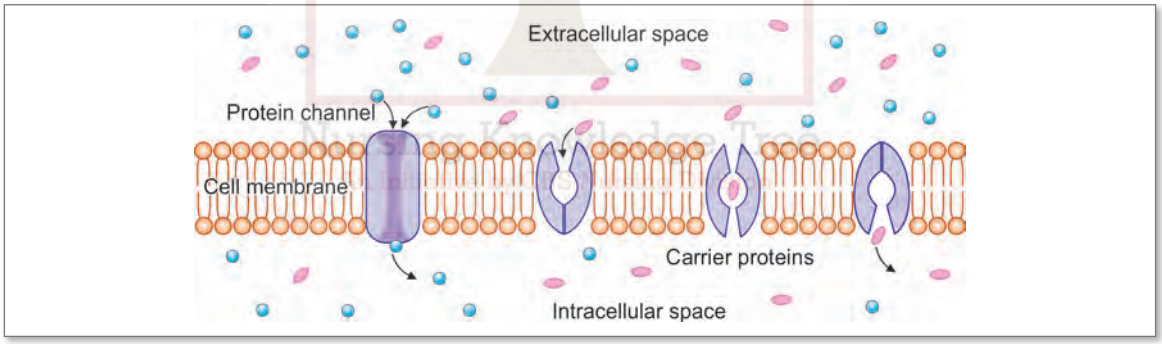


Fig. 3.3 Carrier proteins in the cell membrane

For example: GLUI1 is a named carrier protein found in almost all animal cell membranes that transports glucose across the bilayer.

- **Nutrient and storage proteins:** Storage proteins are biological reserves of metal ions and amino acids used by organisms. They are found in egg whites, plant seeds and milk. For example, ferritin is a storage protein that stores iron. Iron is the component of the heme, which is contained in the transport protein hemoglobin.

  Some storage proteins store amino acid. These amino acids are used in embryonic development of animals and plants. For example, casein is a milk protein and ovalbumin is found in egg white.

- **Defense proteins:** Antibiotics involved in the immune response are proteins. Similarly, fibrinogen and thrombin are blood clotting proteins that prevent loss of blood due to injury. These defense proteins defend organism against invasion by other species or protect them from injury (Fig. 3.4).
- **Contractile or motor proteins:** These are the proteins that move itself along a filament or polymer molecule using energy generated by the hydrolysis of adenosine triphosphate (ATP). For example, myosin protein is present in muscles of animals. Actin and myosin function in contractile systems of skeletal muscles and another example is tubulin in microtubule.

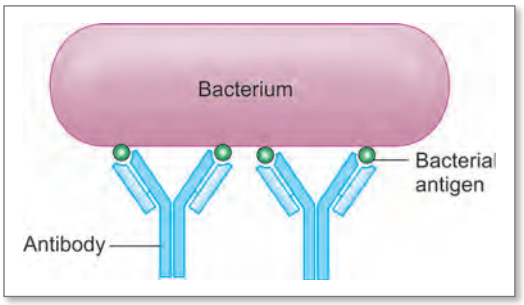


Fig. 3.4 Defense protein

- **Regulatory proteins:** Some proteins regulate cellular or physiological activity. Many proteins are involved in signal transduction. For example, insulin regulates sugar metabolism and growth hormone is required for bone growth.
- **Toxic proteins**: Some proteins act as toxic substances such as snake venom, toxic plant proteins like ricins and bacterial toxins.
- **Structural proteins**: The structural proteins are usually inert to biochemical reactions. They maintain the native form and position of the organs. The cell wall and primary fibrous constituent of the cell have structural proteins. Collagen, which has very high tensile strength is the most abundant protein of animal. It is found in connective tissues such as tendon, cartilage matrix of bones and cornea of eye.

Classification Based on the Sources of Protein

- **Animal proteins**: These are the proteins derived from animal sources such as eggs, milk, meat and fish. They are usually called higher quality proteins because they contain adequate amounts of all essential amino acids.

  Lean meat are meats which contain relatively low fat content. For example, skinless chicken, turkey and red meat, pork chops with the fat trimmed off.
- **Plant proteins:** These are called lower quality proteins since they have a low content of one or more of the essential amino acids. Although plant proteins have limit amount of same amino acids but it should not be concluded that they are poor protein sources.
- **Protein from sea food:** It is a form of protein found in sea life which is consumed as food by humans, prominently including fish and shellfish. Many species of molluscs such as oysters, clams, mussels, octopus, etc. come under shellfish. Fishes contain high amount of proteins, low in saturated fats, high in omega 3, essential fatty acids, and are rich sources of vitamins and minerals.

RECOMMENDED DIETARY ALLOWANCE

Calories are needed to provide energy to body for proper functioning. The number of calories in a food depends on the amount of the energy food provides.

One gram of protein gives 4 kcals. The recommended daily allowances (RDA) for protein are given in Table 3.2.

TABLE 3.2: Recommended dietary allowance for proteins

Group	Particulars	Protein (g/day)
Man	Sedentary work Moderate work Heavy work	60
Woman	Sedentary work Moderate work Heavy work Pregnant woman	55 50 + 15
Lactating mother	0–6 months 6–12 months	50 + 25 50 + 18
Infants	0–6 months 6–12 months	2.05/kg 1.65/kg
Children	1–3 years 4–6 years 7–9 years	22 30 41
Boys	10–12 years	54
Girls	10–12 years	57
Boys	13–15 years	70
Girls	13–15 years	65
Boys	16–18 years	78
Girls	16–18 years	63

DIETARY SOURCES OF PROTEIN

Animal products are rich sources of proteins. Animal protein has a balanced combination of all the amino acids, hence it is called complete protein. On the other hand, plant protein is incomplete except soybean protein. So a vegetarian person requires a variety in plant protein sources for proper development. Incomplete protein is deficient in one or more of the essential amino acids and Table 3.3 and Figure 3.5 shows the dietary sources of protein.

TABLE 3.3: List of high or low protein food sources

Protein food source contents g/100 g	Estimated proteins
1/2 cup legumes	7 g
1/2 cup tofu	14 g
2 ounce meat, fish, poultry	14 g
1–2 ounce of nuts	14 g
1 cup raw vegetables	2 g

Animal Sources

Meat, egg, milk, cheese, fish are the animal sources of proteins. Egg proteins are considered to be the best among food proteins because of their high biological value and digestibility.

Vegetable Sources

It includes pulses, beans, cereals, nuts and oilseeds. In developing countries like India, cereals and pulses are the main sources of dietary protein because they are cheap, easily available and consumed in bulk.

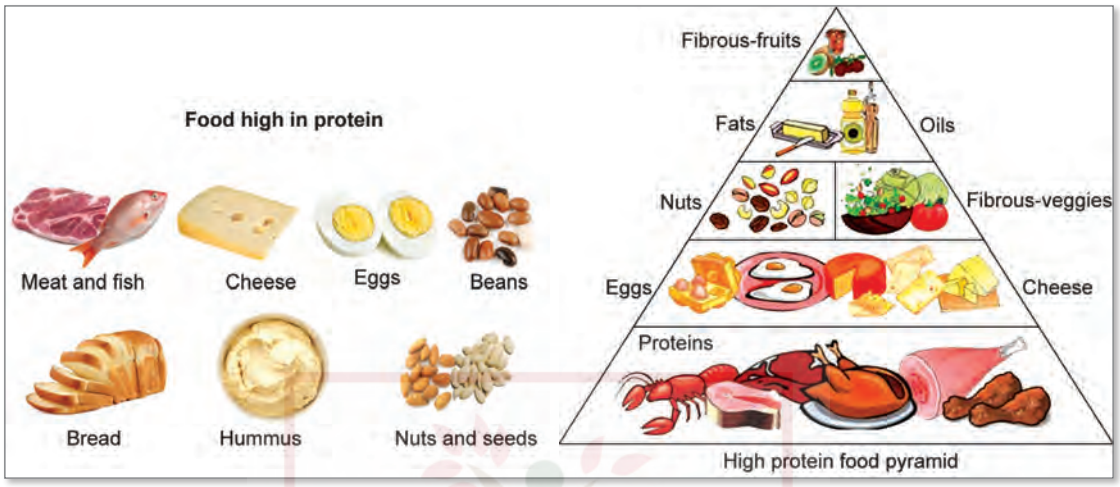


Fig. 3.5 Dietary sources of protein

ESSENTIAL AMINO ACIDS

As we know amino acids are the building blocks of proteins. They are made up of nitrogen, carbon, hydrogen and oxygen along with variable side chain group. Our body needs 20 different types of amino acids for its growth and functioning. Out of these 20 amino acids, 9 amino acids are classified as essential amino acids. Unlike nonessential amino acids, essential amino acids cannot be made by our body but must be obtained through our diet. These nine essential amino acids are histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonin, tryptophan and valine.

Sources of Essential Amino Acids

Most common sources of essential amino acids are (Fig. 3.6):

- **Lysine:** Main sources are meat, eggs, soy, black beans, quinoa, and pumpkin seeds.
- **Histidine:** Main sources are meat, fish, poultry, nuts, seeds, and whole grains.
- Cottage cheese and wheat germ contain high quantities of **threonine**.
- **Methionine** is in eggs, grains, nuts, and seeds.
- **Valine** is in soya, cheese, peanuts, mushrooms, whole grains, and vegetables.
- **Isoleucine** is plentiful in meat, fish, poultry, eggs, cheese, lentils, nuts, and seeds.
- Dairy, soy, beans, and legumes are sources of **leucine.**
- **Phenylalanine** is in dairy, meat, poultry, soy, fish, beans, and nuts.
- **Tryptophan** is in most high-protein foods, including wheat germ, cottage cheese, chicken, and turkey.

Roles of Essential Amino Acids in our Body

- **Valine**: It helps stimulate muscle growth and representation and is involved in energy production.
- **Phenylalanine:** It is a precursor for the neurotransmitters tyrosine, dopamine, epinephrine and norepinephrine. It plays very important role in the structure and function of proteins and enzymes and production of other amino acids.

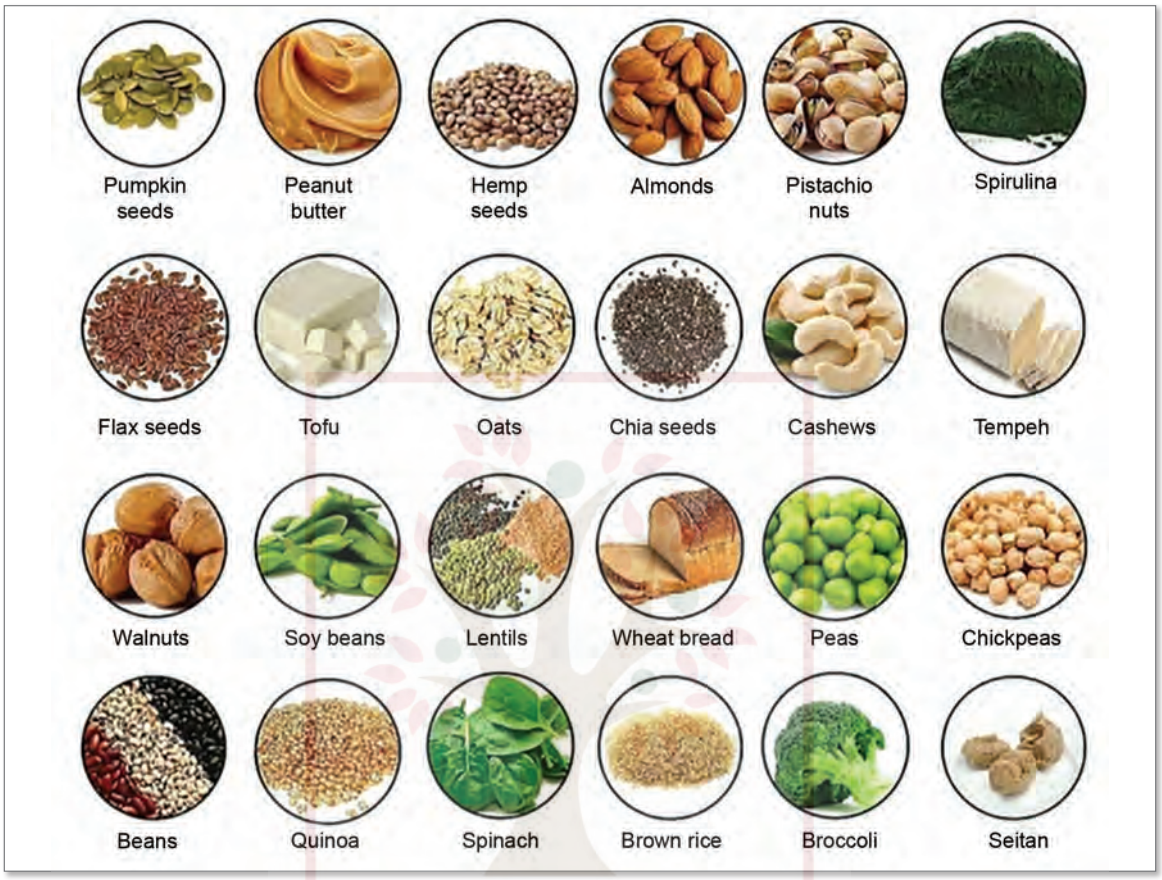


Fig. 3.6 Sources of essential amino acids

- **Threonine:** It is a part of structural proteins such as collagen and elastin. Collagen and elastin are the important components of the skin and connective tissues.
- **Leucine:** It is a required for protein synthesis and muscle repair. It also helps regulate blood sugar levels, stimulates wound healing and produces growth hormones.
- **Isoleucine:** It involves in muscle metabolism and is also important for immune function, hemoglobin production and energy regulation.
- **Lysine:** Plays important role in protein synthesis. Also plays role in hormone and enzyme production and absorption of calcium. It is important for the production of collagen and elastin. Produces energy and promotes immune function.
- **Histidine:** Used to produce histamine, a neurotransmitter that is vital to immune response, digestion, sexual function and sleep-wake cycles. It is critical for maintaining the myelin sheath, a protective barrier that surrounds nerve cells.
- **Methionine:** Promotes tissue growth. Promotes zinc, selenium and other minerals essential for the body. Plays important role in metabolism and detoxification.
- **Tryptophan:** Maintains proper nitrogen balance in the body needed for tissue synthesis and produces neurotransmitter serotonin that regulates sleep, appetite and mood.

FUNCTIONS OF PROTEINS

Protein is an important substance found in every cell of the human body. Protein is used in many vital processes and so it needs to be consistently replaced. The main functions of proteins are discussed as follows:

- **Repair and maintenance:** Proteins are called the building blocks of the body. It plays important role in the maintenance of body tissue including development and repair. Hair, skin, eye, muscles and organs are all made of proteins. All living cells and body fluids contain proteins except bile and urine.
- **Hormones:** Protein is involved in the creation of some hormones. For example, insulin is a hormone that regulates blood sugar level. Another example is of secretin, this substance assists in the digestive process.
- **Energy:** Protein is a major source of energy. Each gram of protein provides 4 kcal. If diet does not supply enough energy through carbohydrates and fats, then that requirement of energy is fulfilled by proteins of the food.
- **Enzymes:** Enzymes are the proteins that increase the rate of chemical reactions in the body. Most of the chemical reactions in the body are processed with enzymes only. These enzymes facilitate each step of digestion, absorption, anabolism and catabolism.
- **Antibodies:** Proteins form antibodies which help to prevent infection, illness and disease. These proteins identify and assist in destroying antigens such as bacteria and viruses. Antibodies are made up of proteins which protect us by increasing body's resistance to disease.
- **Transport and storage:** Protein is a major element of transportation for certain molecules. For example, hemoglobin is a protein that transports oxygen through the body. Protein is also some time used to store certain molecules. For example, ferritin combines with iron for storage in the liver.
- **Growth of fetus:** Proteins provide amino acids for growth of fetus in pregnancy and for the production of milk during lactation. So extra proteins are advisable during pregnancy and lactation.

Why Protein Diet is Preferred in Certain Situations?

- As proteins are structural and functional components of living cells.
- Half the proteins form muscles and bone
- For growth spurt, maturation and bone development
- To prevent diseases occurring due to deficiency of proteins in diet.

DIGESTION, ABSORPTION, METABOLISM AND STORAGE OF PROTEINS

Dietary proteins are large complex molecules that cannot be absorbed from the intestines. For the digestion it must be converted into small molecules of amino acids, which can be easily absorbed from the intestine (Fig. 3.7).

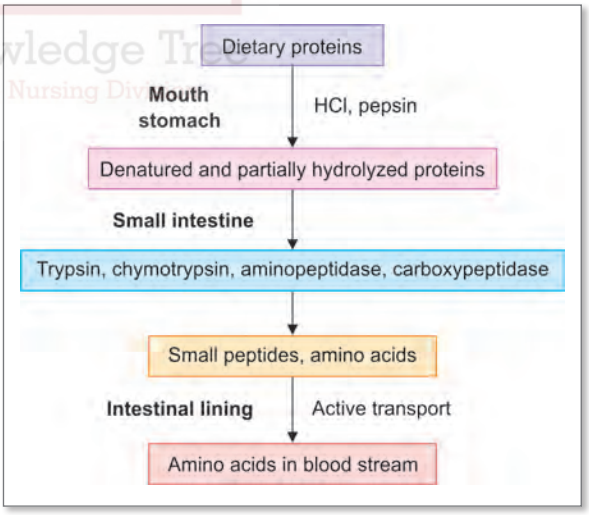


Fig. 3.7 Digestion, absorption, metabolism and transportation of protein

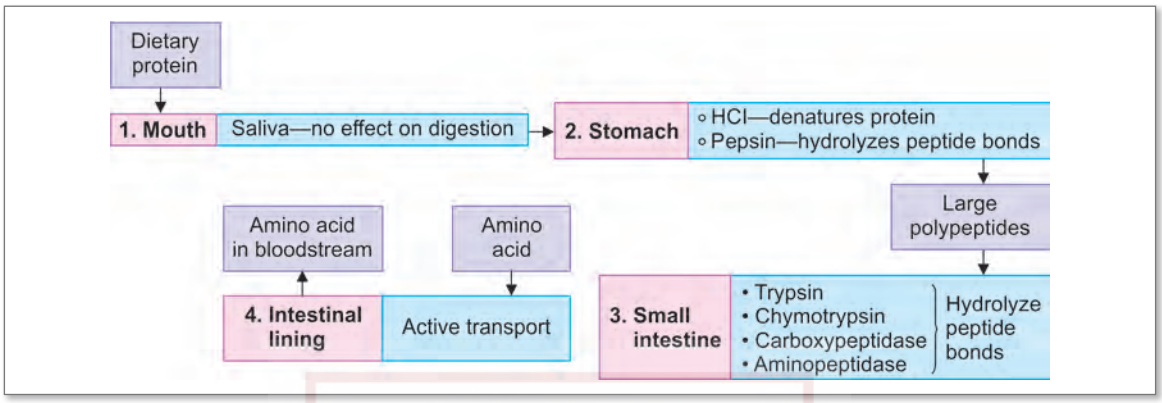


Fig. 3.8 Protein digestion in human body

Digestion of Proteins

Digestion of proteins takes place in two steps (Fig. 3.8):

1. Digestion of proteins in stomach
2. Digestion of proteins in the small intestine

There is no protein splitting enzyme secreted in the mouth, only mechanical breakdown of protein occurs in mouth. So protein reach the stomach as such.

Digestion in the Stomach

- **In adults:** Protein digestion begins in the stomach by gastric juices. Gastric juices contain enzyme pepsin.

$$\text{Pepsinogen} \xrightarrow{\text{HCl}} \text{Pepsin}$$

$$\text{Large polypeptides} \xrightarrow{\text{Pepsin}} \text{Small Peptides}$$

- **In infants:** Enzyme renin is secreted in infants and children from stomach. It is also known as milk clotting enzyme.

$$\text{Milk protein (casein)} \xrightarrow{\text{Renin}} \text{Paracasein}$$

$$\text{Paracasein + calcium ions} \longrightarrow \text{Calcium paracaseinate}$$

$$\text{Calcium paracaseinate} \xrightarrow{\text{Pepsin}} \text{Small peptides}$$

Digestion in Small Intestine

Digestion of proteins is completed in the small intestine by proteolytic enzyme present in pancreatic and intestinal juices.

Pancreatic Juices

Pancreatic juice contains trypsin, chymotrypsin and carboxyl peptidase. Each enzyme effectively breaks a particular peptide bond to produce amino acids. Trypsin hydrolyzes central peptide bond of polypeptide chain. It is secreted in an inactive form called trypsinogen, from pancreas.

$$\text{Trypsinogen (inactive form)} \xrightarrow{\text{Enterokinase}} \text{Trypsin}$$

$$\text{Protein trypsin} \xrightarrow{\text{Chymotrypsin}} \text{peptides + amino acids}$$

$$\text{Peptides} \xrightarrow{\text{Carboxypeptidase}} \text{amino acids}$$

Intestinal Juice

Next set of enzymes are provided by intestinal secretions, i.e., amino peptidase and dipeptidase and tripeptidase.

$$\text{Dipeptides} \xrightarrow{\text{Dipeptidase}} \text{amino acids}$$

$$\text{Tripeptides} \xrightarrow{\text{Tripeptidase}} \text{amino acids}$$

Digestion gets completed in the brush border by two active enzymes, i.e., amino peptidase and dipeptidase.

End products of protein digestion are amino acid, dipeptide and tripeptides.

The end products, amino acids, dipeptides and tripeptides are absorbed at the intestinal villus.

Protein Absorption

It is an active process needs energy in the form of ATP, that takes place in duodenum and jejunum.

- Most amino acids enter the epithelial cells via active transport which needs energy through ATP. Absorption of one molecule of amino acid needs one ATP molecule. There are 7 carrier proteins, one for each group of amino acids. Each carrier protein has two sites, one for amino acid and one for Na^+.
- Some amino acids enter epithelial cells via Na^+ dependent secondary active transport.
- Dipeptide and tripeptide enter the epithelial cell via H^+ dependent secondary active transport.
- The peptides are then hydrolyzed to single amino acids inside the epithelial cells. These amino acids diffuse out of epithelial cells through intestinal fluid into the blood capillaries of villus.
- Figure 3.9 shows the carrier protein transport system.

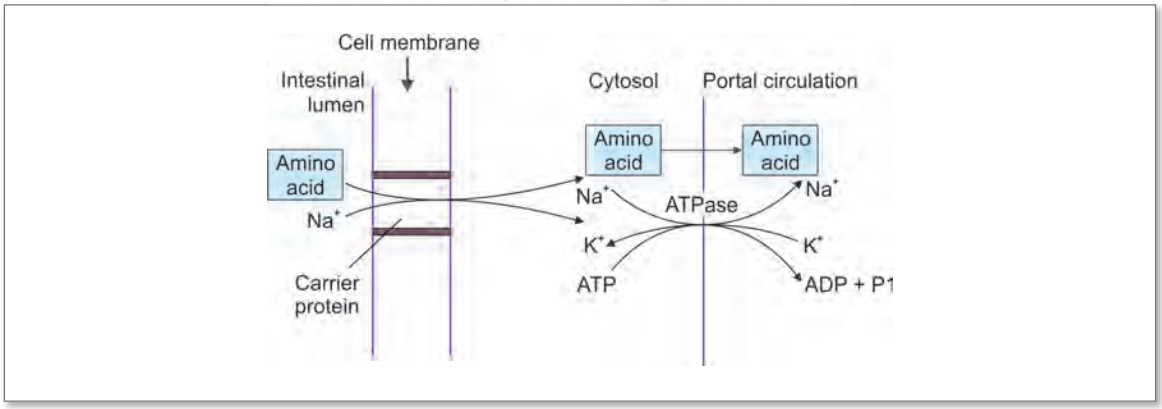
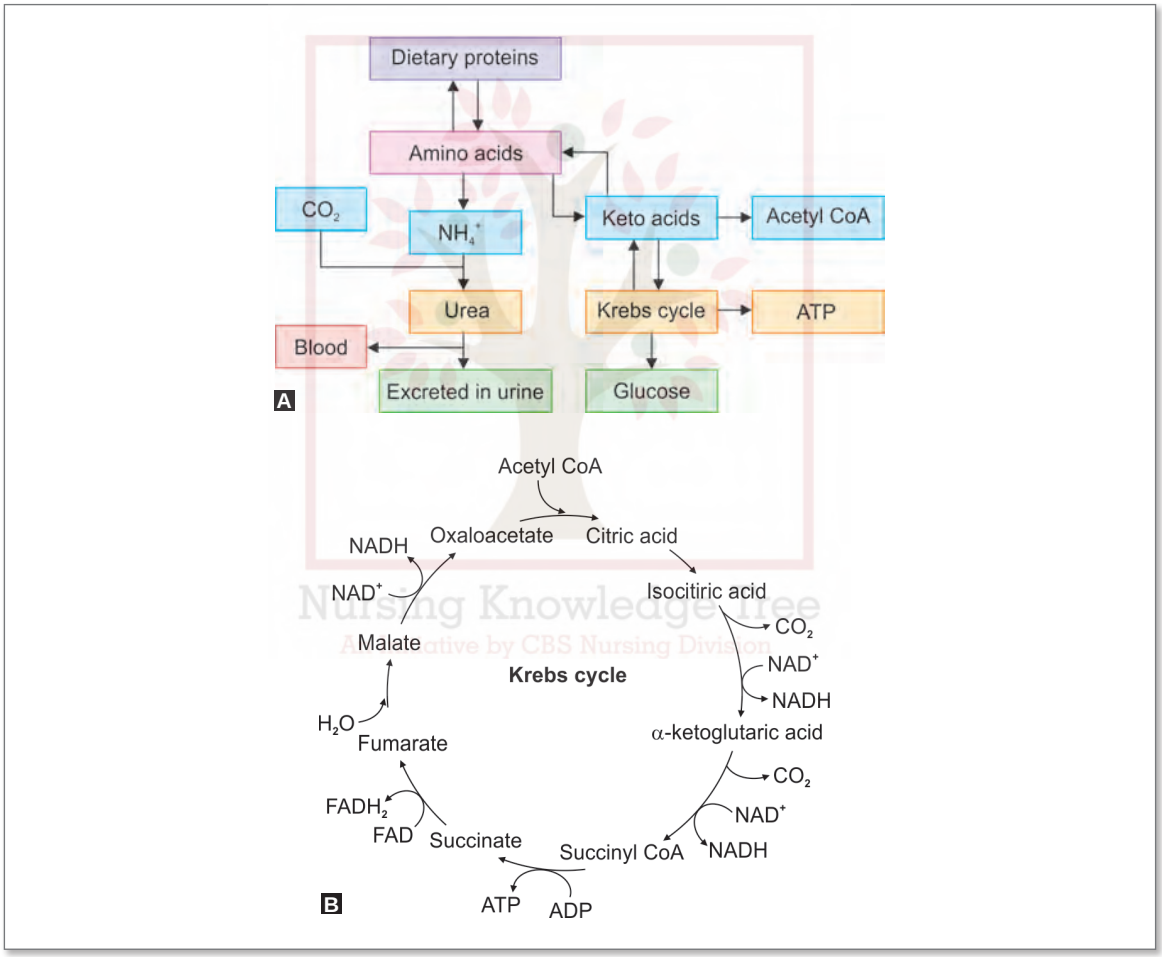


Fig. 3.9 Carrier protein transport system

Protein Metabolism and Storage

Carbohydrates and fats only contain the elements carbon, hydrogen and oxygen whereas amino acids contain nitrogen as well. Amino acid catabolism begins with the removal of nitrogen. Proteins that are metabolized are broken into their amino acids and then absorbed into blood stream. Amino acids are broken down further. Their amine is removed and ends up in urine. The remaining portion of amino acid is called keto acids. Keto acids are converted into chemicals that can enter Krebs cycle (Figs 3.10A and B).

Protein metabolism is a dynamic state and the synthesis and breakdown of tissue protein take place constantly. Overall protein catabolism produces carbon dioxide, water, ATP, urea and ammonia.



Figs 3.10A and B **A.** Protein metabolism; **B.** Krebs cycle

Assess Yourself

Short Answer Questions

1. What are proteins? Give their components.
2. Differentiate between hydrophobic and hydrophilic amino acid.
3. Differentiate between primary and secondary structure of proteins.
4. What is globular protein?
5. List down essential and non-essential amino acids.

Multiple Choice Questions

1. Protein is made up from how many amino acids?
   a. 30 b. 20
   c. 10 d. 50
2. Bond between amino acid is known as:
   a. Hydrogen bond b. Acidic bond
   c. Ionic acid d. Peptide acid
3. Food products that are high in protein content:
   a. Grains and legumes b. Milk and milk products
   c. Tofu and eggs d. All of these
4. Which elements are present in proteins?
   a. Oxygen, carbon, hydrogen b. Nitrogen, hydrogen, oxygen
   c. Hydrogen, carbon d. Hydrogen, nitrogen, carbon and oxygen
5. Proteins are made up of:
   a. Glycogen b. Fatty acid
   c. Lipids d. Amino acid
6. Simplest amino acid is:
   a. Glycine b. Serine
   c. Methionine d. Proline
7. Enzymes are:
   a. Carbohydrates b. DNA molecule
   c. Proteins d. Nucleic acid
8. One gram of protein contains:
   a. 4.2 kilocalories of energy b. 5.2 kilocalories of energy
   c. 5.4 kilocalories of energy d. 4.8 kilocalories of energy
9. Proteins are synthesized at:
   a. Ribosomes b. Golgi bodies
   c. Mitochondria d. Centrosomes
10. Messenger protein is also known as:
    a. Hormones b. Storage
    c. Enzymes d. Antibodies

Answers to MCQs

1. b 2. d 3. d 4. d 5. d 6. a 7. c 8. a 9. b 10. a

Textbook of

Nutrition & Dietetics for BSc Nursing Students

Salient Features

- The content has been thoroughly updated keeping in mind the recent updates and also the new INC syllabus for BSc Nursing students
- The book caters to both Basic BSc Nursing and Post-Basic BSc Nursing students
- Simple and lucid language has been used throughout the book for better understanding of the concepts
- An easy-to-digest and student-friendly content has been prepared with examination point of view
- Various Clinical Correlation facts are included in-between the chapters to help students understand the clinical relevance of the subject
- Presentation of content has been supplemented with illustrations to facilitate quick review
- Numerous tables on Food Values and Daily Requirements are added wherever necessary
- Important questions under Assess Yourself are given at the end of each chapter to prepare the students for their university examinations.

About the Author

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