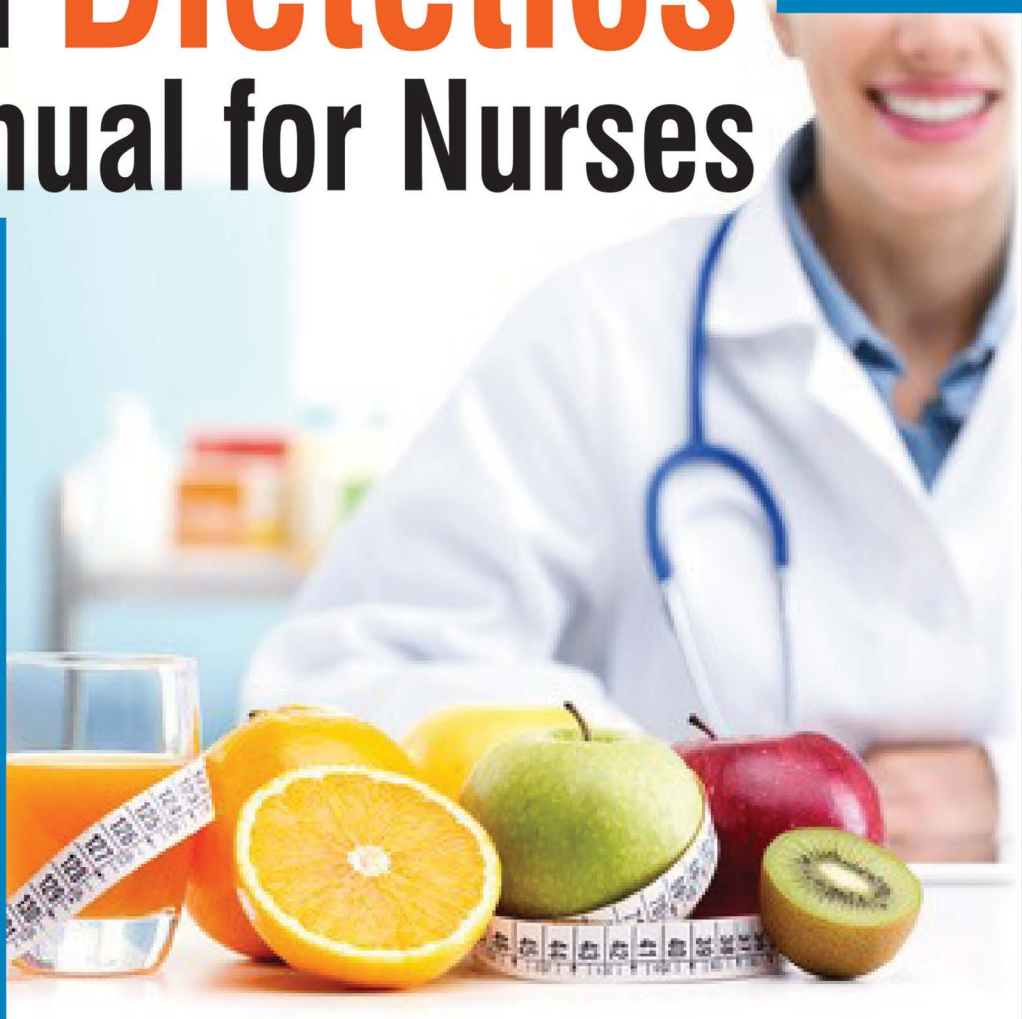
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Clinical Nutrition and Dietetics Manual for Nurses



V Supriya

Foreword
Lalitha Ramaswamy

JAYPEE

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University Question Paper Pattern

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3

Carbohydrates

ABSTRACT

Among the macronutrients in foods, carbohydrates and fiber play an important role in variety of metabolic functions. In this chapter, carbohydrates in foods and their functions in human body are described systematically. Carbohydrates and their metabolism would give us a complete understanding of their action in the human body. Its digestion, absorption and assimilation are the need of the hour as the incidence of diabetes keeps growing in proportion. Glucose metabolism and uptake are maintained by the intake of carbohydrates from foods as well and that is discussed in detail here. Dietary fiber, its importance and its food sources are highlighted here in detail.

OBJECTIVES

The objective of this chapter is to understand and study the classification, functions, sources, requirements and storage of carbohydrates.

INTRODUCTION

Carbohydrates or hydrates of carbon are organic compounds made up of carbon, hydrogen and oxygen. Those that yield energy upon oxidation are called energy nutrients, e.g. carbohydrates, proteins and fats.

The literal meaning of carbohydrates is hydrated carbon. They ordinarily contain carbon with oxygen in the same proportion as in water. It is utilized as a fuel for the human body. Carbohydrates are the most vital source of energy for the nervous tissue. The cheapest and most important source of energy for a vast majority of the people carbohydrates.

HISTORY

Initial history of carbohydrates is the story of sugarcane and the human passion for sweetness. In 1844, Schmidt found carbohydrates as compounds that contained carbon, hydrogen and oxygen. Later, French physiologist Claude Bernard discovered the animal storage form of carbohydrates, i.e. liver glycogen.

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CLASSIFICATION OF MONOSACCHARIDES

Carbon, hydrogen and oxygen are formed into units called saccharide groups. Classification is based on the number of saccharide units present.

Monosaccharide: It contains only one molecule of sugar and cannot be broken down by hydrolysis. They contain 2 to 7 carbon atoms and are classified as follows:

- **Dioses** are monosaccharide which contains 2 carbon atoms, e.g. glycolaldehyde.
- **Triose** is one which has 3 carbon atoms with polyhydroxylic group, e.g. glyceraldehyde is an aldotriose and dihydroxyacetone is a ketotriose.
- **Tetroses** are compounds which has 4 carbon atoms, e.g. Erythrose, threose.
- **Pentose** as the name implies, these compounds possess 5 carbon atoms, e.g. ribose and deoxyribose are constituents of nucleic acids.
- **Hexose** are otherwise known as common monosaccharides which has 6 carbon atoms, e.g. glucose (sugar contained in blood), fructose (present in fruits), galactose (a component of lactose), mannose (found in tubers, yeast).
- **Heptoses** are compounds with 7 carbon atoms, e.g. Sedoheptulose.

Disaccharide: It yields two molecules of monosaccharides on hydrolysis, e.g. sucrose, maltose, lactose.

Glucose + Fructose → Sucrose
Glucose + Glucose → Maltose
Glucose + Galactose → Lactose

- ***Sucrose:*** It does not exist in the body, but present in cane sugar, carrots, sweet potato, honey and it is extracted from sugarcane and sugar beets. It is otherwise termed as table sugar. Glucose and fructose linked together is sucrose by the brush border enzyme sucrose/invertase.
- ***Maltose:*** It is hydrolyzed to two units of glucose by enzyme maltase. It occurs in malted (sprouted) wheat, barley and also in the production of malted and brewing foods.
- ***Lactose:*** It is found naturally only in milk and milk products. One molecule of glucose and one molecule of galactose on hydrolysis in the presence of the enzyme lactase yields lactose. Lactose intolerance occurs because of the enzyme lactase deficiency.
- ***Oligosaccharide:*** It yields 2–10 monosaccharides on hydrolysis, e.g. raffinose is a trisaccharide, stachyose is a tetrasaccharide, verbascose is a pentasaccharide.

Polysaccharide: It yields more than 10 molecules of monosaccharides on hydrolysis. e.g. starch, glycogen, cellulose, dextrins, pectin, hemicellulose, gums.

- ***Cellulose:*** It is made up of β-glucose molecules which are linked by 1–4 linkages.
- ***Glycogen*** is the reserve carbohydrate found in muscles and liver of animals and human beings.
- ***Dextrins*** are formed by the partial hydrolysis of starch by an enzyme amylase.

FUNCTIONS

Energy

- Carbohydrates provide energy for the immediate use of the body.
- 1g carbohydrate = 4 kcal.

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- Body store of carbohydrate is = 300 g, therefore 300 × 4 = 1200 kcals, enough to last only for few hours.
- Blood sugar is maintained through continuous replenishment by gluconeogenesis from fats and proteins.
- Blood and RBC's depend on glucose for their metabolism.

Liver

- Glycogen protects the liver from bacterial toxins and poisonous substances.
- Glucoronic acid produced by the liver from carbohydrates, converts harmful substances containing alcoholic or phenolic groups into harmless compounds that are excreted.
- Also produces the acetyl group, mainly from carbohydrates, which combines with substances like sulfonamides, to produce harmless acetylated forms that are excreted by the kidneys.

Central Nervous System

- Brain uses glucose for energy at the rate of 5 g/hr.

Heart

- The efficiency of the heart as a pump depends on the availability of carbohydrates as a fuel.
- This supply is derived from blood and glycogen stored in the heart muscle.
- Unlike brain tissue, heart has a reserve store of glycogen that can be used in an emergency.
- When there is a temporary reduction in the blood sugar, a healthy heart is not damaged because of this reserve.
- When a damaged heart, containing little reserves of glycogen, is subjected to low blood pressure, anginal pain may be experienced—in extreme cases death may follow.

Muscle Contraction

- Carbohydrate is the most efficient and economical fuel for muscles, energy is derived from glycogen in muscles.
- With adequate oxygen supply, the lactate produced is also oxidized for energy, with inadequate oxygen supply; carbohydrate breakdown raises blood lactate to produce lactic acidosis.

Protein Sparing Effect

- When carbohydrates and fats are supplied to meet the demand for energy, proteins are spared for growth and repair effect.
- The endogenous breakdown of protein is reduced if the patient is given a daily minimum of 150 g of carbohydrate for energy.
- When carbohydrates are insufficient to meet the energy requirements, amino acids are deaminated for glucose formation and nitrogen is converted to urea by the liver and excreted by the kidneys.

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Ketosis and Carbohydrate Metabolism

- During normal metabolism, fat is broken down by the liver into acetoacetic acid, acetone and beta-hydroxylbutyric acid. These are collectively known as 'ketone bodies.'
- Ketone bodies are used as a source of energy but only to a limited extent.
- When carbohydrates are not readily available as in starvation or cannot be utilized as in severe deficiency of insulin, fats are broken down in greater quantities for energy and increased amounts of ketone bodies are produced.
- Ketone bodies in blood—ketonemia.
- Ketone bodies in urine—ketonuria.

Conversion of Carbohydrates into Fats

- After fulfilling the energy demands and replenishing the stores in the liver and muscles, excess of ingested carbohydrates is converted into fats and stored in fat depots, which can be expanded to an unlimited capacity, leading to obesity.

Part of Body Tissues

- CHO's combined with proteins or fats serve as components of many body tissues.
- They form essential compounds like heparin (anticoagulant).

Stimulates Growth of Intestinal Bacteria

- Carbohydrates provide energy to many bacteria that inhibit the intestinal tract.

Aids in the Absorption of Other Nutrients

- Certain sugars enhance the absorption of nutrients from the intestinal tract, glucose inhibits a positive effect on the absorption of sodium, while lactose favors calcium absorption.

Carbohydrates Provide Fiber or Bulk

- Cellulose is resistant to human digestive enzymes, therefore it moves quickly through the digestive tract and regulates the movement of food through the intestine. 1g of soluble fiber yields 2 kcals.

DIGESTION OF CARBOHYDRATES

Most dietary carbohydrates are consumed in the form of starch, disaccharides and monosaccharides.

In the Mouth

The digestion of starch begins in the mouth, chewing of high fiber foods slows eating and stimulates the flow of saliva. The enzyme salivary amylase starts to work, splitting starch into shorter polysaccharides and maltose.

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Starch —(Salivary amylase)→ Maltose, oligosaccharides

As food is in the mouth for only a short time, very little digestion takes place here.

In the Stomach

The swallowed bolus gets mixed up with stomach's acid (hydrochloric acid), gastric juice and protein—digestive enzymes. Amylase deactivates after contact with hydrochloric acid and then the food is passed into the small intestine.

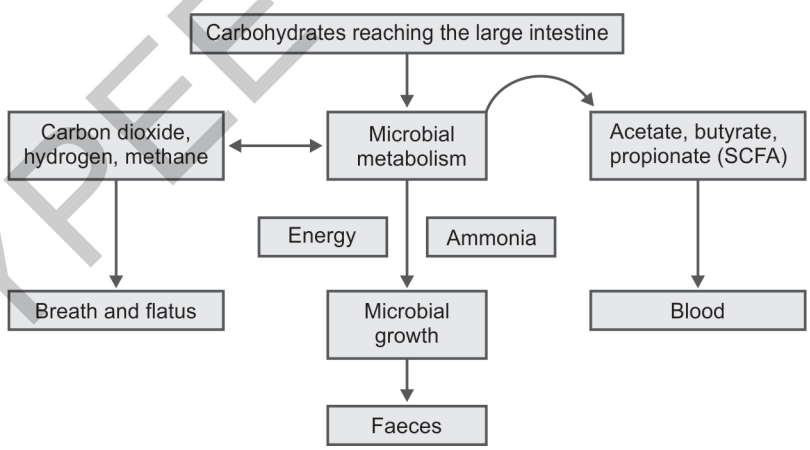
In the Small Intestine

Most carbohydrate digestion takes place here. Pancreatic amylase, the enzyme present in the small intestine continues breaking down the polysaccharides to shorter glucose chains and disaccharides.

As the food passes into the brush border, it is acted upon by their respective enzymes and is broken down into monosaccharide (glucose), which is readily absorbed by the body.

Starch	—(Pancreatic amylase)→	Maltose, oligosaccharides
Lactose	—(Lactase)→	Glucose + galactose
Sucrose	—(Invertase)→	Glucose + fructose

In the Large Intestine



The carbohydrates (sugars, resistant starches, non–starch polysaccharides) are fermented by colonic bacterial flora, to produce short chain fatty acids (SCFA's) and volatile gases. SCFA's produced are acetate, butyrate, propionate; butyrate is the preferred fuel for the colonocytes. SCFA's play an important part in the regulation of the absorption of sodium and water from the colon.

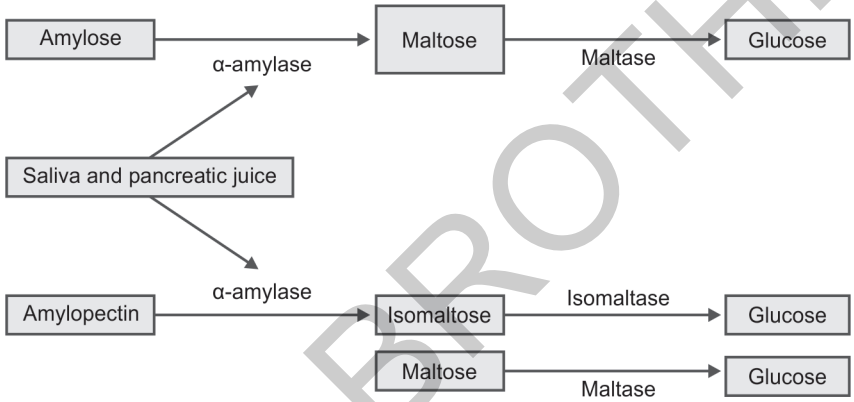
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The main gases produced are carbon dioxide, hydrogen and methane. When production of gas exceeds absorptive capacity of the colon, gases are expelled through rectum. At low levels, the gases are largely absorbed and excreted through the lungs.[1]

Absorption

Absorption of sugars occurs by two different pathways:

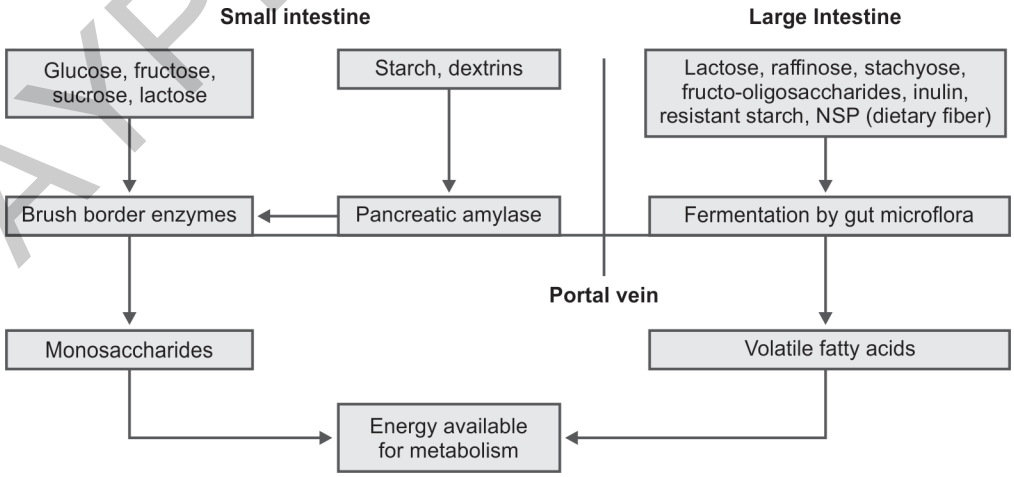
1. Glucose and galactose are thought to be actively transported; a Na^+ gradient from the extracellular to the intracellular environment energizes glucose transport.
2. Fructose appears to be transported by passive facilitated fructose mechanism.
3. Disaccharidase activity is highest in the apical half or two-thirds of villus. Therefore maximum absorption takes place in villi.



Factors Affecting Absorption

The absorption of digested carbohydrates is affected by the following factors:

- Rate at which digested carbohydrates enter the small intestine affects its absorption.
- Type of food mixture present influences the competition for absorptive sites.
- Absorption is influenced by the condition of intestinal membrane.



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Storage and Metabolism

On action by enzymes of saliva, pancreatic and intestinal juices to simple sugars, they are absorbed by the villi of small intestine, which then passes into the blood, and is carried by the portal vein to the liver, where excess is stored as glycogen. Glycogen is insoluble and is stored in the liver until required for use.

When energy is required by the body, glycogen is converted back to glucose, passing to the bloodstream. Glucose is required by most tissues of the body—muscles, glands, brain.

The metabolism of carbohydrates is controlled by insulin, secreted by the pancreas. If insulin supply is normal, the amount of glucose in the blood varies, very slightly. Normally it is about 80–120 mg/100 mL of blood. After a meal, it will rise slightly, immediately stimulating pancreas to secrete more insulin, extra insulin cause the liver and muscles to store excess quickly and blood sugar falls back to normal.

In insulin deficiency, blood sugar rises too high, which occurs in diabetes condition, where pancreas fails to produce the adequate quantity of insulin, as a result blood contains excess sugar and sugar is excreted through kidneys into the urine.

Maintenance of Blood Glucose Levels

Blood glucose has to be maintained for a normal wellbeing because brain and other tissues depend only on blood glucose for energy.

- The fasting glucose level is between 80 and 120 mg/dL. After a meal rich in carbohydrates, blood glucose level normally rises to 130–140 mg/dL at 1 hour, but it returns to fasting levels after 2 hours of the meal.
- If the blood glucose falls to low levels (30–50 mg/dL), it is termed as hypoglycemia. It occurs when the brain is deprived of energy and symptoms include fatigue, irritability, sweating, headaches, etc.
- If the blood glucose falls further lower (<30 mg/dL) coma and death can also occur.
- Liver, being the most important organ in the metabolism of carbohydrates, performs various functions.
- Liver routes the glucose needed by the body, converts glucose into glycogen for storage following a carbohydrate rich meal.
- Normal blood glucose levels are being maintained even when there is no carbohydrate in the diet; non carbohydrates sources (proteins, fats) are converted to glucose- which is termed as gluconeogenesis.

Sources

Sugars, syrups, cereal grains—rice, wheat, bajra, jowar, pulses, dried fruits—are the richest source of carbohydrates. Fruits and vegetables widely vary in their carbohydrate content. Exceptional are bananas, dates, potatoes and sweet potatoes which have high carbohydrate content.

Egg, fish, poultry, cheese, fresh milk and meats (with exception of liver) contain little carbohydrate, whereas animal and vegetable fats contain none.

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Requirements

ICMR makes no exact recommendation for carbohydrates. A minimum of 50–60% of dietary calories may be from carbohydrates.

CHO Nutrition/Malnutrition

High CHO, low CHO, CHO restricted, high fiber/residue, low fiber/residue are the terms associated with CHO nutriture. CHO free diet is not an accepted terminology.

DISORDERS OF CARBOHYDRATE METABOLISM

Diabetes mellitus—disease involving blood glucose levels due to defect in CHO metabolism. There are two types.

Type I

Individuals with type I diabetes are referred to as 'juvenile diabetes' as the onset occurs before 30 years of age. These individuals require little or no insulin as there is deficiency or lack of insulin in the body.

Management

Studies have proved that there is a strong relationship between pre-meal insulin dose and the post prandial response with regard to the carbohydrate content of the meal. For individuals receiving insulin therapy, the total carbohydrates in the meal did not cause any glycemic response, provided the pre-meal insulin was adjusted with the carbohydrate content of the meal.

Carbohydrate and monounsaturated fats both should provide an overall 60-70% of energy intake.

Type II

Individuals with type II diabetes produce little or the tissues poorly utilize insulin. It occurs usually over the age of 30. Obese and overweight individuals are very much prone to insulin resistance.

Management

Goals of dietary management is to reduce weight in case of obese individuals. Reduction in calories, high fiber especially soluble fiber can reduce the glycemic levels in the blood.

Meal planning of diabetic individuals involves consideration of food preferences, knowing the diet history, need for weight loss, gain or maintenance, cultural/ethnic background is ideal along with the calorie requirements and distribution of calories throughout the day.

Glycemic Index (GI)

It denotes degree of blood glucose response to the ingestion of specific CHO food in comparison with the response of a standard load.

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The rise of blood sugar after a meal does not depend only on the amount of carbohydrate ingested but also on the rapidity of absorption.

$$GI = \frac{\text{Blood glucose area of test food}}{\text{Blood glucose area of reference food}} \times 100$$

White bread is preferred to be a reference food and is generally accepted. The Table 3.1 gives the glycemic index of 50 g carbohydrates in commonly used foods compared with 50 g carbohydrates. The glycemic index values of different food items are listed in Table 3.1.

Table 3.1: Glycemic index values of foods.

S. no.	*Food*	*GI*	*Amount in g containing 50 g available carbohydrates*
1.	White bread	100	101
2.	Whole wheat (bread)	100	120
3.	Brown rice	81	60
4.	Potatoes	80	240
5.	Apple	52	544
6.	Banana	84	260
7.	Lentils	38	94

Very low GI <55; Intermediate GI 56–69; High GI >70.

Glycemic Load (GL)

It is defined as the product of the glycemic index value of a food and its carbohydrate content.

- Corrects GI for serving size.
- ***Glycemic load = GI × carbohydrate/100***
  (Watermelon as an example of calculating glycemic load).
- GI 72, in a serving of 100 g, it has 6 g of available carbohydrate. GL = (72/100) × 6 = 4.32 = 4 rounded.
- GI value of watermelon is not good, but its GL is low, so it is safe to eat.

GL of watermelon is 4

Table 3.2 depicts the standard GI and GL values

Table 3.2: Standard values of GI and GL

Glycemic index (GI)		*Glycemic load (GL)*
High	70 or more	20 or higher
Medium	56–69 inclusive	11–19 inclusive
Low	55 or less	10 or less

- Foods that have a low glycemic index invariably have a low glycemic load.

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- While foods with an intermediate or high glycemic index—very low to very high glycemic load.
- Reducing glycemic load—diet by limiting foods that have both a high glycemic index and high carbohydrate content**.**
- ***Fructosuria*** or hereditary fructose intolerance—Disorders associated with the utilization of fructose in the body.
- ***Galactosemia:*** Disorder of galactose utilization.
- ***Lactose intolerance:*** Disorder of lactose utilization, where there is a deficiency/lack of the enzyme lactase.

Excess/Over Consumption

Obesity: This is the condition where excess of carbohydrates gets converted to fats and stored up in subcutaneous fat, leading to obesity.
Too much insulin: Causes excess blood glucose to be stored and leaves insufficient glucose in bloodstream. This causes convulsions, coma and even death.

Fibers

Dietary fibers are plant constituents that are not digested by the enzymes of human gastrointestinal tract. They consist of cellulose, hemicelluloses, pectin, mucilages and gums.

Classification of Fibers

Scientists have classified fiber into crude fiber and dietary fiber. There are two types of dietary fiber—Insoluble and soluble fibers.

- ***Crude fiber*** is defined as the residue which remains after the treatment with hot sulphuric acid, alkali and alcohol. Crude fiber is a component of dietary fiber.
- ***Dietary fiber*** is the carbohydrate part of the plant food, which is resistant to hydrolysis by the enzymes of the human gastrointestinal (GI) tract and resistant to digestion and absorption in the GI tract.
  - **Insoluble Fibers**
    Cellulose is the most abundant molecule present in cell walls, e.g. bran of cereal grains.
    Hemicelluloses, are found in the cell walls of many plants. They are branched polymers of pentose and hexose sugars, e.g. plant foods such as carrots, cabbage, apples, pears, peaches and whole grains.
  - **Soluble Fibers**
    Pectins are a complex of colloidal polysaccharides. Apples, citrus fruits are important sources, while cereals contain very little.
    Mucilages and gums are nonstructural components of plant cells, e.g. fenugreek (mucilage), oat gum, gum acacia (gums).
    Table 3.3 indicates the therapeutic usage of fibers and their mechanism of action.

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Table 3.3: Therapeutic uses of fiber and their mechanism.

Therapeutic condition	*Type of fiber*	*Mechanism*
Colon cancer	Soluble fibers—guar gum, mucilages, gum arabic, oat gum	Production of short chain fatty acids—acetic, propionic and butyric acids—they escape digestion and reach the colon where fermentation by colonic bacteria forms volatile gases and short chain fatty acids
Gallstones	Soluble fibers—psyllium, pulpy portion of fruits, oats, pectin	It increases the excretion of steroids
Irritable bowel syndrome	Insoluble fibers—cellulose, cereal bran	It reduces the transit time. Volatile fatty acids which are released by the bacteria have a laxative effect
Hemorrhoids	Insoluble wheat bran, outer skin of fruits, cellulose	Faster bowel emptying due to increased intraluminal mass bulk

Dietary Fiber Content of Foods

High dietary fiber content foods are listed in Table 3.4.

Table 3.4: High dietary fiber content of foods.

Name of food stuff	*g/100 g*
Curry leaves	16
Wheat whole	11
Green gram whole	10
Ragi	19
Black gram whole	17
Potato	10
Tomato	2
Banana	2

Sources of Fiber

Fiber	*Sources*
Insoluble	
• Cellulose	• Whole wheat flour, bran
• Hemicellulose	• Bran, whole gram
• Lignin	• Wheat, mature vegetables, strawberries
Soluble	
• Gums	• Oats, guar (made from cluster beans), barley
• Pectins	• Apples, guavas, carrots, citrus fruits

Role of Dietary Fiber

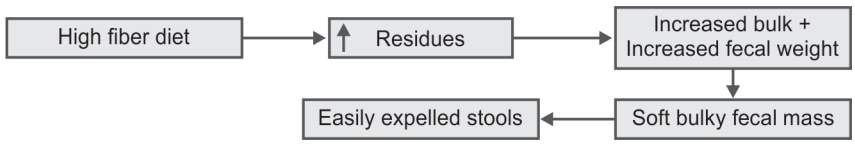
- Insoluble dietary fiber holds water making the stools softer, bulkier and easily eliminated. Thus a high fiber intake prevents or relives constipation.

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- Dietary fiber increases the motility of small intestine and colon, thereby decreases the transit time.
- Soluble fibers alter the viscosity of food and prevents metabolic disorders like diabetes and hypercholesterolemia.

Clinical Effects of Dietary Fiber

- ***Fiber and obesity:*** Dietary fiber helps in reduction of body weight. When fibrous food is eaten it needs to be chewed, so that more saliva is swallowed into the stomach. Thereby causing delayed gastric emptying time and increasing the feeling of satiety. Soluble fibers helps in this effect. High fiber diets are therefore suggested for weight reduction, 1 g of fiber provides 2.2 kcals. Studies on fiber supplementation such as guar gum, psyllium are found to produce loss in weight with supplementation carried out for a period of 2–3 months.
- ***Fiber and heart disease:*** Fiber provides protection against heart disease, fibers especially pectins, tend to bind cholesterol and reduce its absorption from the intestinal tract. Oat products have been found to reduce total cholesterol and low density lipoprotein (LDL) due to their high beta—glucan content.
  Cholesterol synthesis is inhibited by acetic, propionic and butyric acids (short chain fatty acids) released by colonic bacteria and concurrent clearance of LDL cholesterol by increasing the excretion of steroids.
- ***Fiber and cancers:*** Fiber has a protective role against colorectal cancer. High fiber in the form of grains, cereals and fruits increases the acidity of stools by fermentation, which reduces the bacterial production of carcinogens. It increases the stool bulk by diluting carcinogens. Fiber reduces the production of ammonia and increases the production of butyrate which, in turn reduces the liability of cells to multiply to malignant cells.
  Higher intake of fiber has also been hypothesized to reduce the risk of breast cancer by interrupting the enterohepatic circulation of estrogens.
  High fiber intake in the form of vegetable fiber, fruit fiber and grain fiber was strongly associated with reduced incidence of oral and pharyngeal cancer.[2]
- ***Fiber and diabetes:*** Soluble fibers, which is soluble in water, forms highly viscous fluid. The high viscosity is responsible for the delayed absorption of glucose in the intestines and reduces the post prandial glucose levels in diabetics.
- ***Fiber and constipation:*** Constipation is defined as a condition in which the waste matter in large intestine or bowel is difficult to pass or the emptying time of the feces is so delayed that discomfort or uncomfortable symptoms results. A high fiber diet and increased water intake is used in the treatment of constipation.



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CONCLUSION

Carbohydrates, being widely present in large group of compounds form a dietary essential among the proximate principles. Their metabolism and defects have to be well understood in planning a menu for a diabetic individual.

MULTIPLE CHOICE QUESTIONS

1. The only form of carbohydrate that the brain uses for energy is:
   a. Glycogen
   b. Galactose
   c. Glucose
   d. Glucagon
2. The three main groups of carbohydrates are:
   a. Fats, proteins and minerals
   b. Monosaccharides, disaccharides and polysaccharides
   c. Sucrose, cellulose and glycogen
   d. Glycogen, glucose, maltose
3. Lactose intolerance is caused by the deficiency of the enzyme:
   a. Maltase
   b. Lactase
   c. Sucrase
   d. Invertase
4. The enzyme in the mouth that begins the digestion of starch is:
   a. Salivary lipase
   b. Salivary amylase
   c. Sucrase
   d. Lipase
5. Glycogen is stored in the:
   a. Heart and lung
   b. Liver and muscle
   c. Pancreas and gallbladder
   d. Small intestine and large intestine

Ans.

1. c **2.** b **3.** b **4.** b **5.** b

Write Short Notes on

1. Disorders of carbohydrate metabolism.
2. Classification and functions of carbohydrates.
3. Digestion, absorption and metabolism of carbohydrates.
4. Clinical effects of fiber.
5. Sources and functions of fiber.

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Clinical Nutrition and Dietetics
Manual for Nurses

The purpose of this book is to provide a workable knowledge of nutrition support and emphasize its importance in patient care. It is expected that the book will be beneficial to the undergraduate medical and nursing students, in particular, to prepare the subject from the examination point of view and also to the physicians. The chapters were selected as per the latest syllabus of Indian Nursing Council (INC). Since nutrition is clubbed with biochemistry for the nursing students, a single book on nutrition will provide a compact and comprehensive approach towards the subject. Hence, this particular book would be a valuable guide to the nursing students. Be it the students or teachers, whosoever goes through this book, is sure to get clear-cut knowledge about the concept of clinical nutrition and dietetics.

The book will have a wide range of uses and would help its application for the practice of nursing.

Strengths of the book include:

- Planning menus/Nutrition education module provided would be of great help to the students
- Multiple-choice questions as a reference tool for the students' examinations
- Simple language, concise, compact, and student-friendly guide
- Useful for planning the diets of patients based on their therapeutic conditions
- Designed to cater to the needs of the nursing students.



V Supriya MSc MPhil RD PhD is a clinical nutritionist and has completed her postgraduation with specialization in Food and Nutrition. She is an academically proven candidate with various proficiency prizes to her credit. Her doctoral study has focused on antioxidants in Sports Nutrition. Apart form this, she is a registered dietitian. Dr Supriya is currently employed as Lecturer in the Department of Clinical Nutrition at Sri Ramachandra University (SRU), Chennai, Tamil Nadu, India. Her professional practice includes clinical services of multispecialty dietetic practice. She also has a teaching experience of over eleven years to undergraduate and postgraduate students at SRU.

Dr Supriya has actively participated, presented and won for the best papers at many National/International conferences and workshops. She has twelve research papers published in National and International journals of repute. She is a life member of Indian Dietetic Association (IDA), Indian Society for Parenteral and Enteral Nutrition (ISPEN), and Nutrition Society of India (NSI).

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