BASICS OF FOOD CHEMISTRY

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FOREWORD

It gives me great pleasure to introduce the book titled **"Basics of Food Chemistry**" authored by three of my former students in Post graduate classes at Lucknow Christian College (Mr. Ekhlakh Veg, Dr. Mohammad Imran Ahmad and Dr. Tahmeena Khan). The book covers some of the most important aspects of Food chemistry. A total of six very informative chapters on food components such as water, proteins, fats, carbohydrates, enzymes and vitamins have been included in the book and explained in a very simple way. Furthermore, the topics have been well explained with the help of informative illustrations and tables. The book would be very useful for undergraduate as well as postgraduate students, particularly those pursuing their curriculum as per the New Education Policy 2020. I strongly recommend this book to the readers and I am sure that it will cater to academicians and students ably.

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PREFACE

This book titled **'Basics of Food Chemistry'** is written for Undergraduate and Postgraduate students as per the new National Education Policy (NEP-2020).This book covers important aspects of Food Chemistry, which is an important branch of science and deals with the study of chemical processes and interactions of all biological and non-biological components of foods.

The purpose of this book is to provide comprehensive information about the crucial aspects of food chemistry. With an aim to cater undergraduate and postgraduate students, the book is designed to serve as the basis of food chemistry with the assumption that the instructor will make selective reading assignments as deemed appropriate. Individual chapters in the book would formulate the basis of specialized topics in food chemistry such as Chemistry of Water, Carbohydrates, Dyes and Pigments, Proteins, Lipids, Enzymes and Vitamins. The chapters on these topics and organization and comprehension of the book are quite simple and well explained. The authors have also included a number of questions at the end of each chapter for self-assessment.

The authors hope the book would be useful to students and academicians and attract wider readership.

Ekhlakh Veg

Mohamamd Imran Ahmad

Tahmeena Khan

CHAPTER-1

WHAT IS FOOD

"Let food be your medicine and medicine be your food."
Hippocrates, father of medicine.

1.0 Introduction

Food is any substance (mainly solid or liquid) consumed by an organism for nutritional support. Food is usually of plant, animal, or fungal origin and contains essential nutrients such as carbohydrates, fats, proteins, vitamins, or minerals. The substance is ingested by an organism and assimilated by the organism's cells to provide energy, maintain life, or stimulate growth. Different species of animals have different feeding behaviours that satisfy the needs of their metabolisms and have evolved to fill a specific ecological niche within specific geographical contexts.

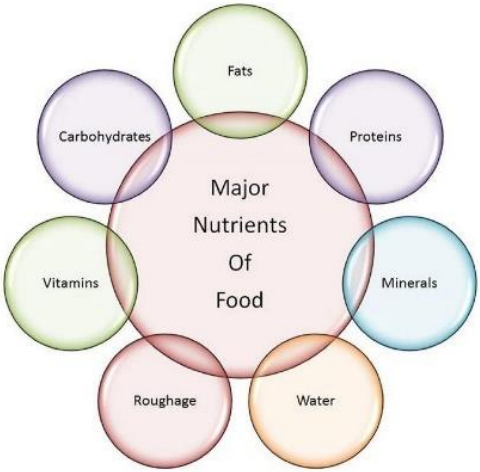

Figure1.1 Major Components of food

CHAPTER-2

CHEMISTRY OF WATER

"Life cannot be imagined without water."

2.0 Introduction

The word "water" comes from the Old English word *water* or the Proto-Germanic *water* or German *Wasser*. All of these words mean "water" or "wet." H_2O is the chemical formula for water, which is an inorganic compound. This chemical substance is clear, tasteless, odourless, and almost colourless.

It is the primary component of Earth's hydrosphere and the fluids found in all known living things, where it functions as a solvent. Even though it doesn't include organic micronutrients or dietary energy, it is essential for all known forms of existence.

The angle at which the hydrogen atoms are joined with the oxygen atom is 104.45°. The liquid condition of H_2O at standard pressure and temperature is also referred to as "water"

2.1 States of Water

Water exists on Earth in three states: solid, liquid, and gas. Water exists as steam or water vapour when it is gaseous.

CHAPTER-3
CARBOHYDRATES

3.0 Introduction

Carbohydrates are macronutrients and are one of the three main ways by which our body obtains its energy. They are called carbohydrates as they comprise ***carbon***, ***hydrogen*** and ***oxygen*** at their chemical level. Carbohydrates are essential nutrients which include sugars, fibers and starches. They are found in grains, vegetables, fruits in milk and other dairy products. They are the basic food groups which play an important role in a healthy life. In food science and many informal contexts, the term "carbohydrate" often means any food that is particularly rich in the complex carbohydrate starch (such as cereals, bread and pasta) or simple carbohydrates, such as sugar (found in candy, jams, and desserts). This informality is sometimes confusing since it confounds chemical structure and digestibility in humans.

The food containing carbohydrates is converted into glucose or blood sugar during the process of digestion by the digestive system.

Our body utilizes this sugar as a source of energy for the cells, organs and tissues. The extra amount of energy or sugar is stored in our muscles and liver for further requirements. The term 'carbohydrate' is derived from the French term '***hydrate de carbone***' meaning '*hydrate of carbon*'. However, the term carbohydrate is not correct as carbon does not form hydrate. Then a new term is adopted, called saccharide (Greek: *sákkharon meaning* sugar). The general formula of this class of organic compounds is $\mathbf{C_m(H_2O)_n}$ (where m may or may not be different from n).

CHAPTER-4
PLANT PIGMENTS

4.0 Introduction

Colour is considered to be the primary feature perceived by the senses that represent a crucial role for centuries in the acceptability of foods to enhance their actual appearance and quality. Plant pigments, the impeccable natural source of colour, display enormous potential to substitute many synthetic colourants. Chlorophylls, carotenoids, anthocyanins, and betalains are the extensive classes of natural colours contributing comprehensive colour shades to foods.

Plant pigments are the unique chemical substances that are responsible for colourful appearances and the visual attraction of fruits and vegetables. They are mainly considered secondary plant compounds that play essential roles in critical biological processes of plants including metabolism, light-harvesting in photosynthesis, regulation in development and defence, and protection from photo-oxidative damage. Their consumption has been associated with decreased chances of developing various diseases in humans

There are good perspectives for the inclusion of plant pigments in the food industry. Their incorporation into food products is very challenging, as they are chemically unstable and exhibit poor bioavailability.

Encapsulation is an excellent process to enhance its bioaccessibility, digestibility, and controlled release. During food fortification, efficient encapsulation technologies are needed to prevent the degradation of pigments and reserve their bioavailability in the human gastrointestinal system.

CHAPTER-5
FATS AND LIPIDS

5.0 Introduction

Lipids are a heterogeneous group of molecules related to fatty acids. They are hydrophobic and are characterized by sparing solubility inwater but high solubility in non-polar solvents such as ether, benzene etc. The lipids may be classified into-

a. Simple or homo-lipids

a. Fats and oils (triglycerol)

b. Waxes

b. Compound or hetrolipids

a. Phospholipids

b. Sphingolipids

c. Glycolipid

d. Lipoprotein

c. Derived lipids

a. Terpenes

b. Steroids

A small amount of fat is an essential part of a healthy, balanced diet. Fat is a source of essential fatty acids, which the body cannot make itself.Fat helps the body absorb vitamin A, vitamin D and vitamin E. These vitamins are fat-soluble, which means they can only be absorbed with the help of fats.

CHAPTER-6
PROTEINS

6.0 Introduction

Proteins are biopolymers composed of α-amino acids, of which there are 20 commonly found in biological chemistry. These fundamental amino acid sequences are specific and their arrangements are controlled by the DNA. Since our body cannot synthesize these essential amino acids on its own, we should have plenty of protein foods in our everyday diet to keep our body metabolisms stable.

6.1 Amino Acids

Amino acids are organic compounds containing the basic amino groups (-NH_2) and carboxyl groups (-COOH). The ingredients present in proteins are amino acids. Both peptides and proteins are long chains of amino acids. Altogether, there are twenty amino acids, which are involved in the construction of proteins.The L-isomer of each amino acid is usually the more biologically relevant form as compared to the D isomer.

CHAPTER-7
ENZYMES AND VITAMINS

7.0 Introduction

An enzyme is a protein by nature or RNA produced by cells. They are catalytic to their specific substrates and known as biological catalysts. They are nitrogenous molecules and organic in nature, and produced by plants and animals. Enzymes are polypeptides and have high molecular mass and catalyse natural processes. Enzymes can catalyse chemical reactions in organisms efficiently under mild conditions.

Enzymes have been used to bring about desirable changes in food since a long time. Use of malted barley in brewing, yeast in the production of alcoholic beverages, and wrapping of meat in the bruised leaves of papaya tree for tenderizing meat, are techniques that have been used for centuries. In bread and cheese making also enzymes have been used.

Enzymes are distributed among the animal and plant cells and tissues. Some cellular enzymes are present in solution in the cytosol, while most exist bound to the subcellular organelles. Some subcellular enzymes are characteristics of the organelle, while others occur at different subcellular and tissue locations, catalysing the same reaction. Many enzymes depend on the cofactors for their activity. The complete active enzyme consisting of both the protein and cofactor is called the holoenzyme. The protein component without its cofactor is termed apoenzyme. The substance on which the enzyme acts is termed the substrate. Isoenzymes are multiple forms of an enzyme occurring in the same species. They catalyse the same reaction and arise from genetically determined differences in the primary structure of the enzyme protein. Some specific characteristics of enzymes are given below:

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