HUMAN NUTRITION

CHAPTER NOTES

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CONTENT

MODULE – 1

Fundamental of Human Nutrition

Introduction

- Human Nutrition studies how our foods impact our growth and development, diseases risk, and physical performance.
- Nutrition impacts the health of individuals and populations.

Definition

Human Nutrition is the process by which substances in food are transferred in body tissues to provide energy for the physical and mental activities that make up human life.

➢ Foods which is the primary source of Human Nutrition

- Cereals
- Starchy roots
- Legumes
- Vegetable and fruits
- Meat, fish, and eggs
- Milk and milk products
- Fat and oils
- Beverages

Nutrition

- A physiological process of acquiring energy from the food source for the growth and metabolic activities of body.

  The body starts absorbing these nutrients as digestion begins.
- A nutrient is a substance an organism uses to survive, grow and reproduce.
- Poor health can be caused by a lack of required nutrients or, in extreme cases, too much of a required nutrient.

There are two major categories of nutrients:

1. Micronutrient
2. Macronutrient

❖ **Micronutrient**

→ These nutrients extend components required for the metabolic activity of the body.

→ They also repair and build the damaged tissues to support the organs.

→ Micronutrients such as calcium, iron, vitamins, etc.

→ Our body needs micronutrients in smaller quantities.

Major micronutrients are:

- Vitamins
- Trace elements
- Minerals

❖ **Macronutrient**

→ Macronutrients are the crucial energy source in the body, produced by breaking down food items.

→ Our body requires macronutrients in large amounts.

Major macronutrients are:

- Carbohydrate
- Fats
- Proteins

Important Nutrients in Food

❖ Carbohydrate

- It is one of the significant sources of energy for human beings. It comprises three types of carbohydrates: fiber, sugar, and starch.
- They are usually low in calories and thus help in maintaining a healthy diet. It - provides 70-90% of the calorie needed.

- ***Dietary fibers*** are a carbohydrate. It consists mainly of cellulose, an indigestible carbohydrate polymer because humans do not have the required enzymes to disassemble it.

❖ Proteins

- They are made of amino acids. We can obtain protein in nuts, beef, rice, etc. Most meats contain all the essential amino acids needed for humans.
- Proteins from the enzymes that control chemical reactions throughout the body.
- The body requires amino acids to produce new proteins and replace damaged ones. Excess amino acids are typically discarded in the urine.
- Excess amino acids from protein can be converted into glucose and used for fuel through gluconeogenesis.

❖ Minerals

- Minerals are essential micronutrients that help build strong bones and maintain a healthy heart rate.
- Sodium chloride, magnesium, sulfur, phosphorus, and calcium are vital minerals for the human body.

❖ Vitamins

- Vitamins are essential nutrients that the body needs in small amounts. Typically, the body can't produce vitamins. Thus, it needs to be consumed in the diet.
- They are grouped as water-soluble and fat-soluble.

  Vitamins A, D, E, and K are fat-soluble, excreted easily through the kidneys.
- On the other hand, folate, riboflavin, vitamin C, vitamin B12, Vitamin B6, niacin, and thiamine are water-soluble vitamins stored in body cells.

❖ Water

- Every human needs two liters of water per day.
- It helps form digestive juices, the basis of blood, urine, and sweat.
- In addition, water is required to regulate body temperature, reduce the risk of cystitis, maintain cell health, lubricant cushion joints, and keep the bladder clean from bacteria.

- Water is sometimes called the *Silent Nutrient.*

The energy provided by the oxidation of bulk organic nutrient

→ The first requisite of an adequate diet is a source of energy provided by the oxidation of the three bulk nutrients:

a. Carbohydrates
b. Fats
c. Proteins

→ Recommended daily allowances by Food and Nutrition Board

Collage age male require-2900Kcal/day

Collage age Female require- 2100Kcal/day

MODULE – 2
Concept of a Balanced Diet

Introduction

- ***Clinical Nutrition*** is a medical specialty dealing with the relationship between disease and Nutrition.
- Acute and chronic illnesses are caused by the deficiency of dietary components and others by their excess.
- ***Malnutrition*** is characterized by inappropriate quality, quantity, digestion, absorption, or utilization of ingested nutrients.
- *It includes* **a) Undernutrition-** *low food intake* and **b) Overnutrition-** *consuming too much food.*
- There are 45-50 chemical entities known to be required by humans. These can be divided into six main categories: Carbohydrates, Fats, Proteins, Vitamins, and Inorganic elements, essential in maintaining good health.
- Humans need many nutrients to enjoy a healthy and active life.
- The term essential or dietary essential means that we must obtain the nutrient from our diet.

Balanced Diet

- A diet is all that we consume in a day.
- A balanced diet is a diet that contains an adequate quantity of the nutrients that we require in a day.
- A balanced diet includes six primary nutrients, i.e., Fats, Proteins, Carbohydrates, Fibre, Vitamins, and Minerals.

Importance of a Balanced Diet

- A balanced diet leads to a reasonable physical and a good mental health.
- It helps in the proper growth of the body.
- It increases the capacity to do work.
- A balanced diet increases the ability to fight or resist diseases.

MODULE – 3

Nutrient Requirement of Different Age Groups

Introduction

- Although some nutritional principles stay the same throughout life, certain phases of life require different nutritional priorities.
- Babies have no teeth, so they can't eat solids, and their developing brains require fat and cholesterol.
- Teenage girls and boys need different amounts of iron and protein, and aging adults usually need to curtail calorie consumption while getting plenty of fiber, water, and nutrient-rich foods.

Recommended Dietary Allowances (RDA)

- The Food and Nutrition Board of the National Academy of Sciences develops RDA.
- RDAs are defined as the "*levels of intake of essential nutrients considered, in the judgment of the committee of dietary allowances of the Food and Nutrition Board, based on available scientific knowledge to be adequate to meet the known nutritional needs of practically all healthy persons*."
- RDA represents an average level of daily intake of nutrients.
- Food energy intake must equal the energy expended for the person to maintain their body weight.
- According to RDA, Protein recommendations are mainly based on the individual's body weight. The average protein requirement is 0.6g per kilogram of body weight; the RDA is 0.8g; this is said to meet 97.5% of the population's needs.

Minimal Dietary Requirement (MDR)

- The minimum amount of a nutrient from exogenous sources is required to sustain normality.

  To express the quality of any food concerning its content of the specific nutrient, the term "Nutrient density" is used:

Nutrient Density is defined as the concentration of a nutrient per unit of energy. For any nutrient, the higher the nutrient density, the better the food source.

- **Metabolism**

Metabolism is the process by which your body converts what you eat and drink into energy. During this complex process, calories in food and beverages are combined with oxygen to release the energy your need to function.

- **Anabolism**

Anabolism is a biochemical process in metabolism where simple molecules combine to generate complex molecules. The process is endergonic, which means it is not spontaneous and requires energy to progress the anabolic reaction. The complex molecules obtained are further used to store energy as ATP.

- **Catabolism**

Catabolism is the breakdown of complex molecules. Catabolism is the breakdown of the complex substance into their constituent parts, which form substrates for metabolic pathways.

- **Basic Four Food Groups**

Group	Food	Major Nutrient
Milk	Milk and other dairy products	Calcium, protein riboflavin
Meat	Meat, poultry, fish, eggs, beans, peas, nuts, seeds (Meat Substitute)	Protein, fat, iron, and other minerals
Fruits and Vegetables	All varieties of fruits and vegetables, green and yellow vegetables.	Vitamin C and Vitamin A precursors
Bread and Cereal	Bread, cooked cereal, dry cereal, rice pasta	B vitamins, iron, Carbohydrate

The Need for Energy

- The human body needs a continuously regulated supply of nutrients. Even at rest, the body requires energy for muscle contraction, active transport of molecules and ions, and synthesis of macromolecules and other biomolecules from simple processes.
- The heart pumps approx. 8,000 L/day of blood in about 80,000 pulsations.
- A resting human consumes about 40kg of ATP in 24hrs

MODULE – 4

Evaluation of Nutrient Value of Food

Introduction

An indication of a food's contribution to the diet's nutrient content. This value depends on the quantity of food which is digested and absorbed and the amounts of the essential nutrients it contains. This value can be affected by soil and growing conditions, handling, storage, and processing.

Bomb Calorimeter

- A bomb calorimeter is a type of constant volume calorimeter used in measuring the heat of combustion of a particular reaction.

  "or"

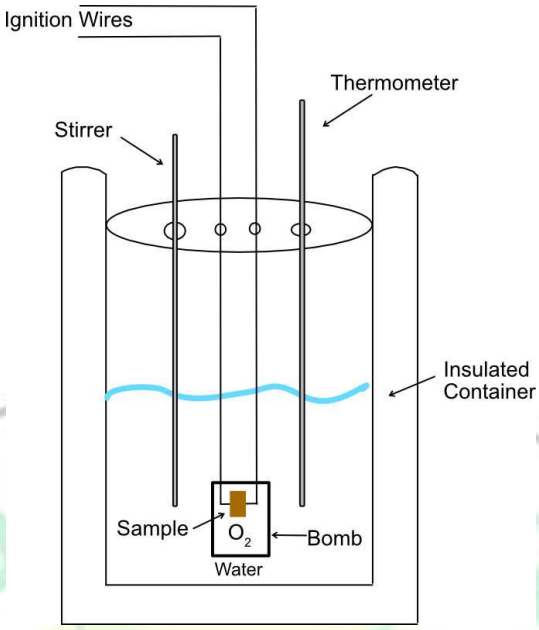
- The calorimeter used to accurately determine the energy change during a reaction is known as a bomb calorimeter.

❖ Working on Bomb Calorimeter

- The bomb calorimeter has to withstand the considerable pressure within the calorimeter as the reaction is being measured.
- Electrical energy is used to ignite the fuel; burning fuel will heat the surrounding air, which expands and escapes through a tube that leads the air out of the calorimeter.
- When the air is escaping through the copper tube, it will also heat the air outside the tube.
- The temperature of the water allows for calculating the calorie content of the fuel.

❖ Construction of Bomb Calorimeter

- A bomb calorimeter consists of a small cup to contain the sample, oxygen, a stainless-steel bomb, water, a stirrer, a thermometer, the Dewar, and an ignition circuit connected to the bomb.



Crude Protein

- The classic protein concentration methods in food are the Kjeldahl and Dumas methods.
- These tests determine the total nitrogen in a sample.
- The only major component of most food which contains nitrogen is protein.
- The total protein can be determined if the amount of nitrogen is multiplied by a factor depending on the kinds of protein expected in the food. This value is known as the *"Crude Protein"* content.
- On the food labels, the protein is given by the nitrogen multiplied by 6.25 because the average nitrogen content of proteins is about 16%.

❖ Kjeldahl Method for Protein Estimation

- The Kjeldahl test is typically used because it is the method AOAC International adopted.
- *The working principle of Kjeldahl analysis is the three steps process:*

1. Digestion

The organic sample taken is firstly treated with a concentrated H_2SO_4. The solution is boiled at an extremely high temperature. The acid solution digests the sample to produce an ammonium sulfate solution.

2. **Distillation**

   The particular process is a combination of boiling and condensation. An excess base is added to the formed solution to convert the ammonium sulfate solution to NH_3 gas.

3. **Titration**

   To finally quantify the nitrogen in the sample, the product obtained from the previous process is titrated to give the final results.

Carbohydrate

- The carbohydrate content of food can be determined by calculating the percent remaining after all the other components have been measured:

  % carbohydrate = 100 – (%moisture + %protein + %lipid + %mineral)

Ether Extraction for Lipid Estimation

- This method was described by Soxhlet in 1879.
- The sample is dried, ground into tiny particles, and placed in a cellulose thimble.

  The thimble is placed in an extraction chamber (2), which is suspended above a flask containing the solvent (1) and below a condenser (4).
- The flask is heated, and the solvent evaporates and moves up into the condenser, where it is converted into a liquid that trickles into the extraction chamber containing the sample.
- The flask containing the solvent and lipid is removed at the end of the extraction process, which lasts a few hours. In some devices, a funnel (3) allows for solvent recovery at the end of the extraction after closing a stopcock between the funnel and the extraction chamber.

  The solvent in the flask (1) is then evaporated, and the mass of the remaining lipid is measured.

Milk Fat

- Even though the cholesterol level in Milk is low, milk fat is considered hypercholesterolemic. It is mainly because of its high saturated fatty acid content.

- Bovine milk fat contains a significant amount of short-chain fatty acids and a relatively lower concentration of C18 fatty acids than other animal fat sources, such as beef or pork.
- Bovine Milk is also a poor source of polyunsaturated fatty acids.

Biological Importance of Milk Proteins

- Milk proteins are the primary source of amino acids for the newborn. Casein micelles also provide Ca and P for skeletal development.
- Casein micelles are highly digestible by the proteolytic enzymes of the newborn.
- Some milk proteins have intracellular functions.
- Milk contains proteins such as lactoferrin and lysozyme.
- Colostrum is a vital way of transferring passive immunity from the mother to the newborn in many mammalian species, including bovines.

MODULE – 5

Nutritional Value of Cow, Buffalo, and Human Milk

- **Nutritive Value**

  An indication of a food's contribution to the diet's nutrient content. This value depends on the quantity of food which is digested and absorbed and the amounts of the essential nutrients it contains. This value can be affected by soil and growing conditions, handling, storage, and processing.

- **Nutritive Value of Milk**
  - Milk is the ideal food. It has high nutritive value. It supplies body-building proteins, bone-forming minerals, and health-giving vitamins and furnishes energy-giving lactose and milk fat.
  - Besides supplying certain essential fatty acids, it contains the above nutrients in an easily digestible and assimilable form.
  - A cup of Milk contains about 140-200 Calories of energy, 10-15 grams of carbs, 7-10 grams of fat, 12-15 grams of sugar, 7.5-8.0 grams of protein, and 0-1% fiber.
  - All these properties make Milk an essential food for all.
- **Nutritive Value of Cow Milk**
  - According to FSSAI, cow milk has a minimum of 3.25% Milk fat and 8.3% SNF.
  - Per 100g, cow milk contains 87.99% water, 61.44 Kcal Energy, 3.29g protein, 3.34g fat, and 4.66g carbs.
- **Nutritive value of Buffalo Milk**
  - According to FSSAI, buffalo milk has a minimum of 5% Milk fat and 9% SNF.
  - Per 100g, buffalo milk contains 83.39% water, 96.62 Kcal Energy, 3.75g protein, 6.89g fat, and 5.18g carbs.

Nutritive Value of Human Milk

- According to FSSAI, human Milk has a minimum of 6% Milk fat and 9% SNF.
- Per 100g, human Milk contains 87.50% water, 69.56 Kcal Energy, 1.03g protein, 4.38g fat, and 6.89g carbs.

MODULE – 6
Vitamins

Introduction

The *vitamins* are natural and essential nutrients, required in small quantities, and play a significant role in growth and development, repair and healing wounds, maintaining healthy bones and tissues, properly functioning an immune system, and other biological functions.

The term *vitamin* was derived from *"vitamine,"* a combination word made up by *Polish scientist Casimir Funk* from vital and amine, meaning *amine of life*. He is considered the *Father of Vitamins* and *Vitamin therapy*.

Vitamin describes certain organic compounds the body needs, but the body cannot manufacture that. Vitamins are mainly obtained from our foods.

Definition

A *vitamin* is an organic compound required as a nutrient in tiny amounts by an organism.

An organic chemical compound is called a vitamin when an organism cannot synthesize sufficiently and must be obtained from the diet.

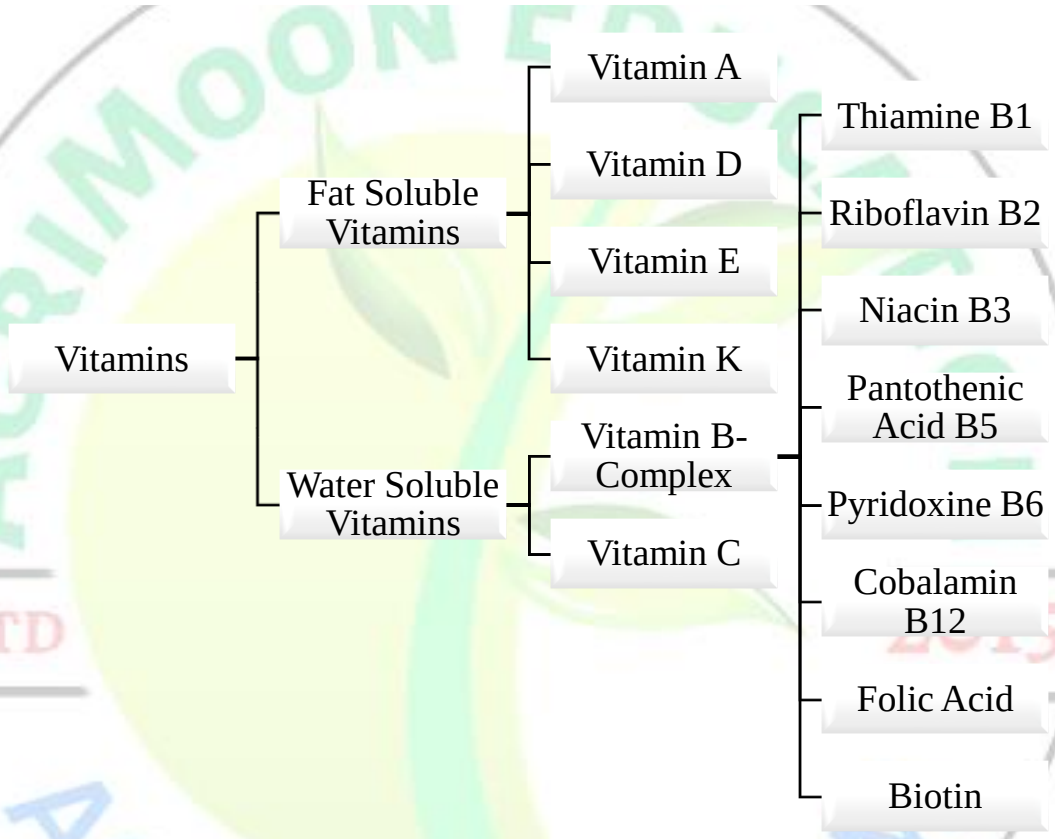
There are 13 different types of vitamins, all required for metabolic processes. They have diverse biochemical functions.

→ ***Biotin*** is a part of enzymes involved in making fatty acids.

Classification of Vitamins

- Fat-soluble vitamin
  - Fat-soluble vitamins are stored in the fat cells; as the name suggests, these vitamins require fat to be absorbed. Vitamins A, D, E, and K are fat-soluble vitamins.
  - Small amounts of vitamins A, D, E, and K are needed to maintain good health.
  - Most people do not need vitamin supplements.
  - Mega doses of vitamins A, D, E, and K can be toxic and lead to health problems.
- Water-soluble vitamin

- Water-soluble vitamins are not stored in our body as their excess gets excreted through the urine. Therefore, these vitamins need to be replenished constantly. Vitamins B and C are water-soluble vitamins.
- These vitamins are easily destroyed or washed out during food storage and preparation.
- The use of mega doses of these vitamins is not recommended.



- Three fat-soluble vitamins, i.e., Vitamin A, D, and E, are stored in appreciable amounts in the animal body. Except for vitamin B12, water-soluble vitamins are not well stored, and excess is rapidly excreted.
- A continual dietary supply of water-soluble vitamins and vitamin K is needed to avoid deficiencies.
- Fat-soluble vitamins are excreted primarily in the feces via the bile, whereas water-soluble vitamins are excreted mainly in the urine.
- Vitamin A and Vitamin D are Hormone Precursors, and Vitamin E and Vitamin K are Redox cofactors/antioxidants.

Vitamins, Source, Function, and Deficiency Diseases

Fat-Soluble Vitamins

Vitamins	Food Source	Functions	Deficiency Diseases
Vitamin A (Retinol)	Fish liver oils, dairy products, liver, most leafy vegetables, and carrots contain carotene that can be converted into retinol.	Needed for average growth and induce differentiation of cells. Essential for the immune system.	Dry Skin Night Blindness (Nyctalopia)
Vitamin D (Calciferol)	Fish oils, egg yolk, and butter. It can be made by the action of sunlight on the skin.	Promotes absorption of calcium from the intestine. Necessary for the formation of normal bones.	Rickets in children (soft bones that bend easily). Osteomalacia (painful bones) in adults.
Vitamin E (Tocopherol)	Vegetable oils, cereal products, whole grains, nuts, eggs, butter, etc.	The formation of red blood cells affects muscles and the reproductive system. Maintain healthy cholesterol levels.	Mild anemia and sterility.
Vitamin K (Phylloquinone)	Fresh, dark green vegetables. Also made by gut bacteria	Formation of prothrombin (involved in blood clotting)	Delayed clotting time. It may occur in newborn babies before their gut bacteria become established.

Water soluble vitamins

Vitamins	Food Source	Functions	Deficiency Diseases
Vitamin B1 (Thiamine)	Pork, cereals, nuts, seeds, yeast, whole grain	Essential in converting glucose to energy Important to nerve function.	Beri-Beri (Weakness of limb muscles)
Vitamin B2 (Riboflavin)	Milk, Milk products, leafy vegetables, eggs	Involved in the formation of RBC, Maintenance of body tissue, particularly skin, and eyes Essential for metabolizing carbohydrates, fats, and lipids.	Cracked skin, blurred vision
Vitamin B3 (Niacin)	Meat, whole grain, cereals, beans	Necessary for the nervous system, digestive system, and skin health	Pellagra (severe skin problem, diarrhea, dementia)
Vitamin B5 (Pantothenic Acid)	Whole grain cereals and legumes	Part of an enzyme needed for energy metabolism	Pellagra, dermatitis, diarrhea
Vitamin B6 (Pyridoxine)	Meat, fish, egg, vegetables	Used to build RBC and maintain nerve tissue Necessary for immune system functioning.	Skin problem, a nerve disorder.
Vitamin B9 (Folic Acid)	Leafy green vegetables, liver	Necessary to build nucleic acid, which is essential for making new cells, especially RBC	Anaemia

Vitamins	Food Source	Functions	Deficiency Diseases
Vitamin B12 (Cyanocobalamin)	Liver, Milk, fish, meat	Help build and maintain protective nerve sheath Needed for RNA and DNA synthesis.	Pernicious anemia, nerve disorder
Vitamin B7 (Biotin)	Vegetables, cereals, nuts, sweet potato, avocados, salmon, pork	involved in metabolism as a coenzyme that transfers carbon dioxide, an essential step in breaking down food, including carbohydrates, fats, and proteins, into energy.	Biotin deficiency is rare. Skin rashes, brittle nails, hair thinning and loss.
Vitamin C	Citrus fruits, tomatoes, leafy green vegetables	Protect cellular function Necessary for the immune system	Scurvy (bleeding of gums, teeth falling)

MODULE – 7
Hormones

Introduction

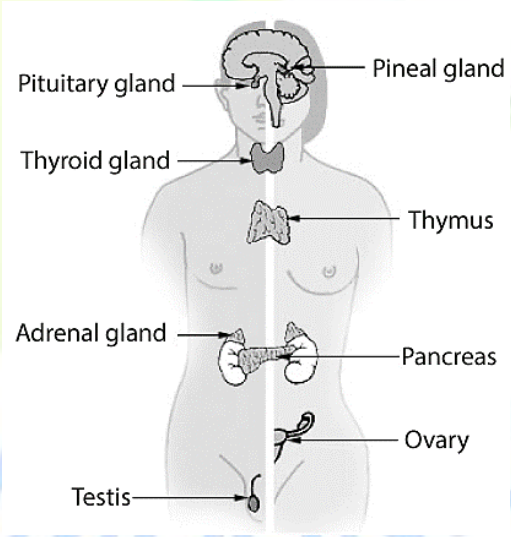
Hormones are chemical substances that act like messenger molecules that stream through the bloodstream. Hormones carry chemical messages from the glands, producing them to cells in different parts of the human body.

Definition

Hormones are chemicals synthesized and produced by specialized glands to control and regulate the activity of specific cells and organs. These specialized glands are known as endocrine glands.

Hormones are various chemicals released within the human body that regulate and control the activities of multiple organs. The introduction of hormones to the blood takes place via endocrine glands.

Location of Endocrine glands



- **Hypothalamus:** It controls the body temperature, regulates emotions, hunger, thirst, sleep, and moods, and allows the production of hormones.
- **Pineal**: Pineal is also known as the thalamus. It produces serotonin derivatives of melatonin, which affects sleep patterns.
- **Parathyroid**: This gland helps control the amount of calcium in the body.

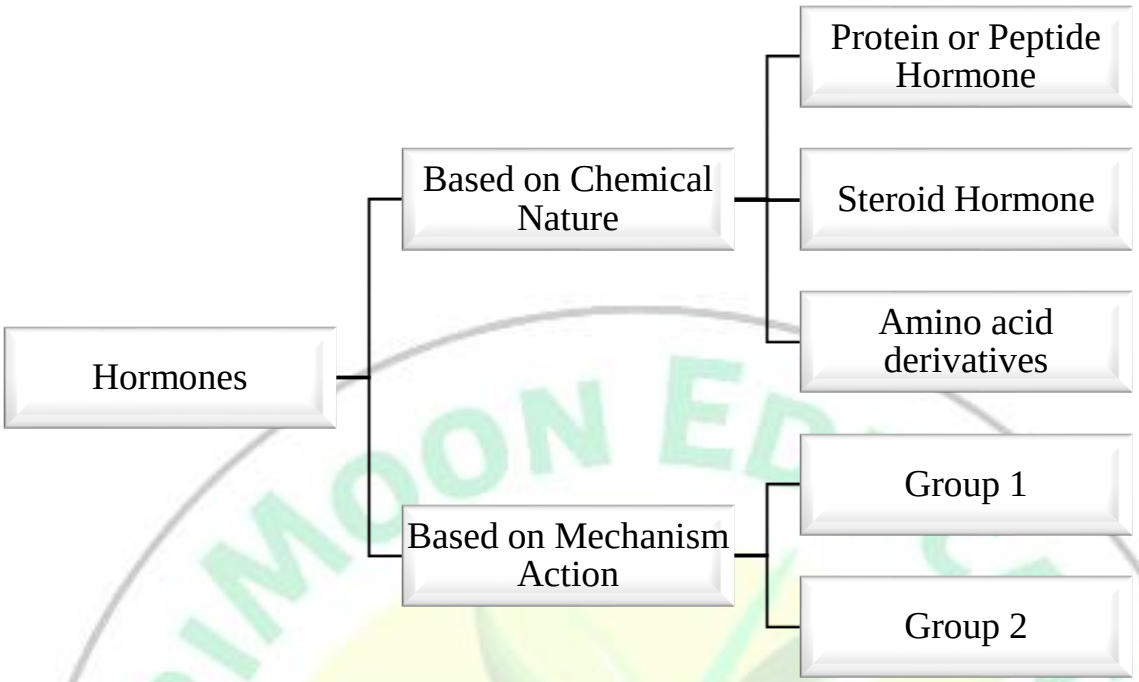
- **Thymus**: It helps in the production of T-cells, the functioning of the adaptive immune system, and the maturity of the thymus.
- **Thyroid:** It produces hormones that affect the heart rate and how calories are burnt.
- **Adrenal**: This gland produces the hormones that control the sex drive, cortisol, and stress hormone.
- **Pituitary**: It is also termed the "master control gland, "Because the pituitary gland helps control other glands. Moreover, it develops the hormones that trigger growth and development.
- **Pancreas**: This gland produces insulin hormones crucial in maintaining blood sugar levels.
- **Testes:** In men, the testes secrete the male sex hormone, testosterone. It also produces sperm.
- **Ovaries**: In the female reproductive system, the ovaries release estrogen, progesterone, testosterone, and other female sex hormones.

Function of Hormones

The following are some essential functions of hormones:

- Food metabolism.
- Growth and development.
- Controlling thirst and hunger.
- Maintaining body temperature.
- Regulating mood and cognitive functions.
- Initiating and maintaining sexual development and reproduction.

Classification of Hormones

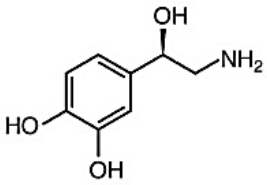
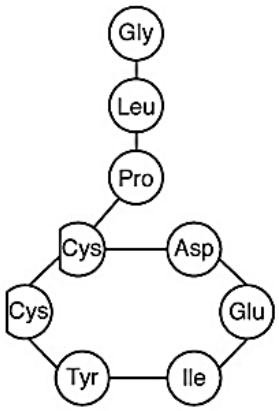
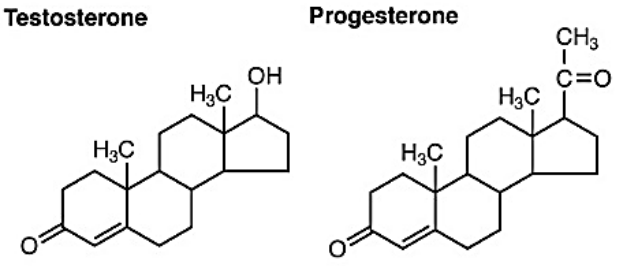


Based on Mechanism Action

- Group 1 Hormones
  - Group I hormones bind to the receptors present inside the target cells to form receptor hormone complexes. These hormone-receptor complexes act as intracellular messengers through which the biochemical functions of such hormones are mediated.
  - These lipophilic hormones mostly derive from cholesterol (except T3 and T4).
  - Androgens, Estrogen, Glucocorticoids, Calcitriol, etc., are a few examples.
- Group 2 Hormones
  - These hormones bind to the receptors present on the plasma membrane, also called cell surface receptors, and stimulate the release of specific molecules, namely **second messengers**, which, in turn, perform biochemical functions.
  - Thus, hormones themselves are the first messengers.
  - Group II hormones are further subdivided into three categories based on the chemical nature of the second messengers.
    - The second messenger is **cAMP**—E.g., ACTH, FSH, LH, PTH, Glucagon, Calcitonin, etc.

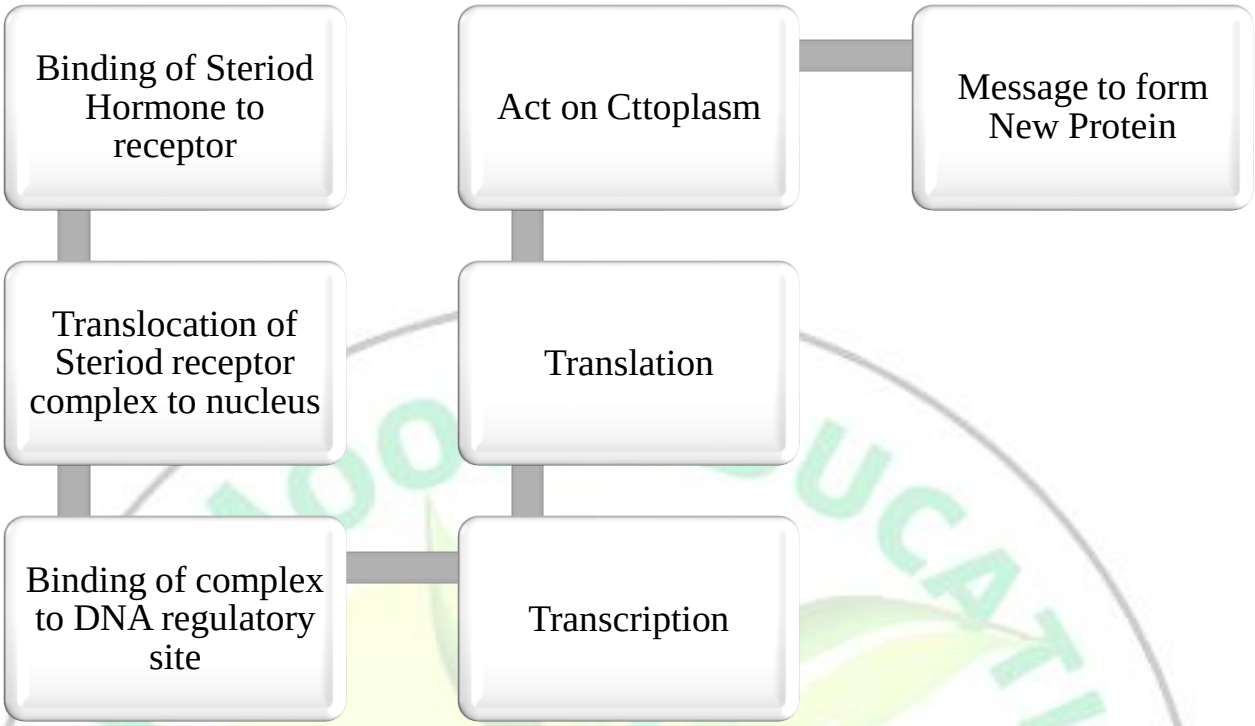
- The second messenger is **phosphatidyl-inositol/calcium**. E.g., TRH, GnRH, Gastrin, CCK etc.
- The second messenger is **unknown**. E.g., growth hormone (Somatotropin), Insulin, Oxytocin, Prolactin, etc.

Structure of different types of Hormones

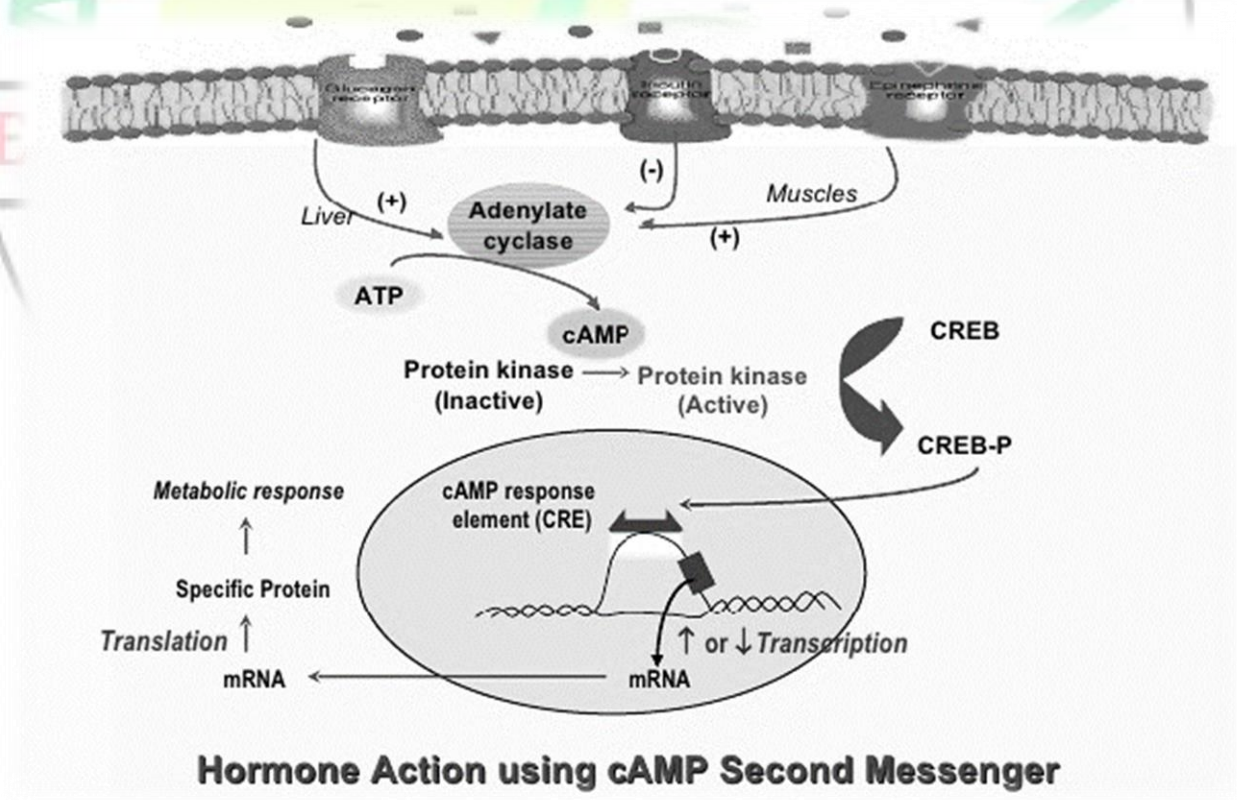
Hormone Class	Components	Example(s)
Amine Hormone	Amino acids with modified groups (e.g. norepinephrine's carboxyl group is replaced with a benzene ring)	**Norepinephrine** 
Peptide Hormone	Any chain of linked amino acids	**Oxytocin** 
Steroid Hormones	Derived from the lipid cholesterol	**Testosterone** **Progesterone** 

Mechanism of Action

- Mechanism of action of intracellular receptor hormones



- Mechanism of action of cell surface receptor hormones



Hormone Action using cAMP Second Messenger

- Adenylate cyclase system

  A series of events occur at the membrane level that influences adenylate cyclase activity, leading to cAMP synthesis. G-Proteins mediate this process, designed due to their ability to bind to guanine nucleotides.

- Action of cAMP

  → cAMP or **cyclic Adenosine 3', 5' monophosphate** is a ubiquitous molecule comprising adenine, ribose, and a phosphate (linked by 3', 5' linkage on ribose sugar).

  → Most **polypeptide hormones** perform their biochemical function, with cAMP as a second messenger.

  → Adenylate cyclase is a membrane-bound enzyme that converts ATP to cyclic AMP. Enzyme phosphodiesterase hydrolyses cAMP to 5'- AMP and makes it inactive.

  → The activity of adenylate cyclase is influenced by a series of events at the membrane level that leads to cAMP synthesis from ATP.

  → This process is mediated by **G- proteins**, which can bind to guanine nucleotides.

  → Once cAMP is formed, it performs its role in biochemical responses.

  → cAMP activates protein kinase A, a hetero-tetramer of 2 regulatory subunits (R) and two catalytic subunits (C).

  → cAMP binds to inactive protein kinase and results in the dissociation of R and C subunits.

  → The active subunit (C) catalyzes the phosphorylation of serine and threonine residues in **CREB (cAMP response element-binding protein)**.

  → CREB is a cellular transcription factor. Phosphorylated CREB (CREB-P) binds to specific DNA sequences called cAMP response elements (CRE), thereby increasing or decreasing the transcription of the genes, ultimately causing the biochemical response.

  → cAMP, however, does not act on all protein kinases. For example, a second messenger, diacylglycerol, acts on Protein kinase C.

- Dephosphorylation of Proteins

  → Protein phosphatases (a group of enzymes) carry out the hydrolysis and removal of phosphate groups added to CREB proteins by protein kinases once the biochemical response is carried out.

MODULE – 8

A biochemical aspect of postharvest storage, specifically food spoilage

Introduction

→ Fruits and vegetables, fresh or processed, form an **essential component of our diet,** and there is an ever-increasing demand for these.

→ India is the **world's top producer of fruits and vegetables**, and more emphasis is **needed to minimize past harvest losses**.

→ Currently**, 70-80%** of our production **goes to waste,** mainly during transportation and storage.

→ A clear understanding of **biochemical and physiological changes** in fruits and vegetables **during postharvest operations** will enable persons involved in handling, transportation, and storage operation to regulate specific critical parameters.

Biochemistry of postharvest storage

- Fresh fruits and vegetables play an **essential role in human Nutrition and health**, especially as sources of vitamins, minerals, and dietary fiber.
- Using plant **breeding and biotechnology** approaches, developing genotypes with enhanced nutritional quality and flavor quality is possible to encourage consumers to eat more fruits and vegetables.
- Climatic conditions, especially temperature and light intensity, strongly affect **the nutritional quality** of fruits and vegetables.
- **Maturity at harvest and harvesting** method influence the commodities **quality and extent of physical injuries**.
- **The delay between harvest and consumption** or processing can result in flavor and nutritional quality losses.
- **Maturity at harvest** is the most **crucial factor** determining **storage life and final fruit quality.**

- **Immature fruits are more** subject to shriveling and mechanical damage and are of inferior quality when ripened. Overripe fruits will likely become soft and mealy with an insipid flavor soon after harvest.
- In general, fruits become sweeter, more colorful, and softer as they mature.
- The **stage at which** the fruits and vegetables should be **harvested is crucial in determining** the market life, storage, transport, eating, and processing quality.
- There are two methods for determining harvesting maturity. They are (a) destructive and non-destructive and (b) physiological methods.

Harvesting Maturity

→ Harvesting maturity should meet the following criteria:

- It should be at a stage that will allow it to be at its peak condition when it reaches the consumer.
- It should be mature to develop an acceptable flavor or appearance.
- It should be at the size required by the market.
- It should not be toxic.
- It should have an adequate shelf-life.

Factors affecting the storage life

→ The natural limits to the postharvest life of all types of fresh produce are severely affected by other biological and environmental conditions:

- Temperature
- Water loss
- Mechanical damage
- Decay in storage

Biological factors involved in postharvest

- Respiration Rate
- Ethylene production
- Transpiration or water loss
- Physiological disorder
- Physical changes
- Pathological breakdown

❖ Respiration Rate

- It is the process by which stored **organic materials are broken down** into simple end products with a **release of energy**.
- Oxygen is used in this process, and carbon dioxide is produced. Food value (energy value) for the consumer is lost; it has reduced flavor quality, with sweetness especially being lost; and salable dry weight is lost (especially **important for commodities destined for dehydration**).
- The energy released as heat, known as vital heat, affects postharvest technology considerations such as refrigeration and ventilation requirements estimations.
- The **rate of deterioration** (degree of perishability) of fruits is generally **proportional to their respiration rate.**

❖ Ethylene production

- Ethylene, the simplest organic compound affecting plants' physiological processes, is a natural product of plant metabolism and is produced by all tissues of higher plants and some microorganisms.
- A plant hormone, ethylene regulates many aspects of growth development and senescence and is physiologically active in trace amounts (less than 0.1 ppm).
- Ethylene synthesis starts with the amino acid methionine, which ATP energizes to produce S- adenosyl methionine (SAM).
- The **key enzyme in the pathway**, ACC synthase, converts SAM to 1-aminocyclopropane-1carboxylic acid (ACC), converted to ethylene by ACC oxidase.

❖ Transpiration

- Water loss is the **leading cause of deterioration** because it results not only in direct quantitative losses (loss of salable weight) but also in losses in appearance (wilting and shriveling), textural quality (softening, flaccidity, limpness, loss of crispness and juiciness) and nutritional quality.
- The **dermal system,** i.e., cuticle, epidermal cells, stomata, lenticels, and trichomes, governs water loss regulation in the commodity.
- **The transpiration rate is influenced by internal or commodity factors** (morphological and anatomical characteristics, surface-to-volume ratio, surface

injuries, and maturity stage) and external or environmental factors (temperature, relative humidity, air movement, and atmospheric pressure).

- **Environmental factors involved in postharvest**
  - Temperature
  - Relative humidity
  - Air movement
  - Atmospheric composition
  - Ethylene

MODULE – 9
Probiotics and Cultured Dairy Products

Introduction

→ Probiotics are live microorganisms intended to have health benefits when consumed or applied to the body. They can be found in yogurt, other fermented foods, dietary supplements, and beauty products.

→ Also, Probiotics are made of good live bacteria or yeast that naturally live in your body.

→ Probiotics supplements are a way to add good bacteria to your body.

Microbe, to be called a probiotic, must have several characteristics. These include being able to:

- Be isolated from a human
- Survive in your intestine after digestion
- Have a proven benefit to you
- Be safely consumed

How do Probiotics work?

The main job of probiotics is to maintain a healthy balance in your body.

Probiotics keep you healthy by supporting your immune function and controlling inflammation. They help in the following:

- ☞ Help your body to digest food
- ☞ Keep harmful bacteria from getting out of control and making you sick.
- ☞ Create vitamins
- ☞ Help support the cells lining your gut to prevent harmful bacteria you may have consumed from entering your blood.
- ☞ Break down and absorb medications.

Some common types of Probiotics:

- ☞ *Lactobacillus*
- ☞ *Bifidobacterium*
- ☞ *Saccharomyces boulardii*

Probiotics and Cultured Dairy Products

→ The most common probiotic dairy products worldwide are various types of yogurt, other fermented dairy products, various lactic acid bacteria drinks, and a mixture of probiotic Milk and fruit juice.

→ The nutrition society found that the health benefits of fermented dairy products included improved digestion, anti-inflammatory effects, and the stimulation of antioxidants which can aid disease prevention.

Why have probiotic cultures become popular in dairy products?

- Probiotic foods are currently primarily found in fermented milk drinks and yogurt, which have limited shelf life compared to cheese. The incorporation of probiotic cultures in cheese offers the potential not only to improve health but also product quality.
- The particular bacteria added to regular Milk to make fermented Milk breaks down milk proteins and lactose sugar. It helps people digest Milk better, especially people with allergies to milk protein or people who are lactose intolerant.

The benefits of fermented milk products…

- Fermented dairy products and probiotic bacteria decrease the absorption of cholesterol. Whey proteins, medium-chain fatty acids, calcium, and other minerals may contribute to the beneficial effect of dairy food on the body's fat and body mass.
- Milk proteins, peptides, probiotic lactic acid bacteria, calcium, and other minerals can significantly reduce blood pressure.

❖ **Indian Traditional Foods**

- Fermented foods are a rich source of many probiotics strain ranging from probiotic bacteria to yeast.
- Several fermented Indian traditional foods use several different substrates as a base with different modes of preparation.
- In this category: pickles, lassi, dahi, kanji, etc.

❖ **Advantages of Fermented Dairy Products**

- Milk is a natural medium.
- Milk contains sufficient nutrients, like proteins, fats, etc., for the growth of probiotics.
- Acts as a carrier for probiotic bacteria.
- Milk is a good source of vitamins and minerals.

Prebiotics

- Nutraceuticals, which promotes the following flourishing of probiotics.
- Food substances reach the colon in intact form.
- The best-known prebiotic is Insulin, found in chicory.

MODULE – 10
Nutraceutical, Antioxidant, Food Toxin, and Anti-nutritional factors

Nutraceutical

Nutraceuticals are products derived from food sources or have bioactive compounds that offer potential health benefits beyond essential Nutrition. These products are often available in various forms, such as pills, capsules, powders, or beverages.

1. Definition: Nutraceuticals combine the terms "nutrition" and "pharmaceutical" and refer to products that provide health benefits beyond their fundamental nutritional value.
2. Health Benefits: Nutraceuticals are believed to have various health-promoting properties, such as antioxidant, anti-inflammatory, immune-boosting, cardiovascular support, and cognitive enhancement.
3. Natural Sources: Nutraceuticals are primarily derived from natural sources like fruits, vegetables, herbs, marine organisms, and other plant and animal-based materials.
4. Bioactive Compounds: These products contain vitamins, minerals, antioxidants, polyphenols, probiotics, omega-3 fatty acids, and more.
5. Common Examples: Some well-known nutraceuticals include vitamin C, E, green tea extract, probiotics, fish oil, glucosamine, and coenzyme Q10.
6. Regulation: The regulation of nutraceuticals can vary by country. In some regions, they may be classified as dietary supplements, which have less stringent regulations compared to pharmaceutical drugs.
7. Prevention and Wellness: Nutraceuticals are often associated with preventive health measures, promoting overall well-being and reducing the risk of chronic diseases.
8. Complementary Approach: Nutraceuticals are frequently used alongside conventional medical treatments to support and enhance their effects.
9. Scientific Evidence: While some nutraceuticals have substantial scientific backing for their health benefits, others may lack clinical solid evidence.

10. Individual Responses: The effects of nutraceuticals can vary from person to person, and not everyone may experience the same benefits.
11. Precautions: Although nutraceuticals are generally considered safe, some individuals may experience adverse reactions or interactions with medications. It is essential to consult a healthcare professional before starting any new supplement.
12. Market Growth: The nutraceutical industry has experienced significant growth in recent years as more people seek natural alternatives to traditional medicine.
13. Combination Products: Some nutraceuticals are formulated as combination products, combining multiple bioactive compounds to achieve specific health goals.
14. Anti-Aging: Nutraceuticals are often marketed for their potential anti-aging effects, promoting youthful skin, joint health, and cognitive function.
15. Nutrigenomics: This emerging field explores how nutraceuticals and Nutrition can influence gene expression and individual health outcomes.

While nutraceuticals can offer potential benefits, they are not meant to replace a balanced diet, regular exercise, or conventional medical treatments when needed. Always consult a healthcare professional before incorporating new supplements into your routine, especially if you have existing health conditions or take prescription medications.

Antioxidant

1. **Definition**: Antioxidants protect cells from oxidative damage caused by free radicals and reactive oxygen species (ROS). Free radicals are unstable molecules with unpaired electrons, and they can damage cellular components like DNA, proteins, and lipids, leading to various diseases and aging.
2. **Sources**: Antioxidants can be obtained from various natural sources, including fruits, vegetables, nuts, seeds, and beverages like green tea and red wine. Some common dietary antioxidants include vitamins C and E, beta-carotene, selenium, and flavonoids.
3. **Free Radical Scavenging**: Antioxidants work by neutralizing free radicals, preventing them from causing harm to cells. They donate an electron to stabilize the free radicals, thereby breaking the chain reaction of damage.

4. **Cellular Protection**: Antioxidants protect cells and cellular structures (e.g., cell membranes, mitochondria) from oxidative stress, which can result from environmental factors like pollution, radiation, and smoking, as well as normal cellular metabolism.
5. **Health Benefits**: Consuming antioxidant-rich foods has various health benefits, including reduced risk of chronic diseases like heart disease, cancer, and neurodegenerative conditions. Antioxidants also support the immune system and overall well-being.
6. **Vitamins with Antioxidant Properties:**
    - **Vitamin C (Ascorbic Acid)**: Water-soluble vitamin found in citrus fruits, strawberries, broccoli, and bell peppers.
    - **Vitamin E (Tocopherols and Tocotrienols)**: Fat-soluble vitamin found in nuts, seeds, vegetable oils, and leafy greens.
7. **Minerals with Antioxidant Properties:**
    - **Selenium**: A trace mineral found in nuts, seafood, and whole grains.
8. **Minerals with Antioxidant Properties:**
    - **Flavonoids**: Found in fruits, vegetables, and tea.
    - **Carotenoids**: Including beta-carotene (found in carrots, sweet potatoes) and lycopene (found in tomatoes).
9. **Synergy**: Antioxidants often work together synergistically, enhancing each other's effectiveness. A diet rich in diverse antioxidant sources can provide comprehensive protection.
10. **Supplements**: While consuming a diet rich in antioxidants is generally beneficial, antioxidant supplements may not always yield the same health benefits and, in some cases, can be harmful. It is best to get antioxidants from natural food sources.
11. **Balance**: Antioxidants are part of a balanced diet, but excessive intake may not necessarily lead to better outcomes. Moderation is essential.
12. **Antioxidant-Rich Foods**: Antioxidant-rich foods include berries (blueberries, strawberries, etc.), spinach, kale, dark chocolate, walnuts, green tea, and tomatoes.

Remember that while antioxidants are essential for overall health, they are just one aspect of a healthy diet. A well-rounded and varied diet and a healthy lifestyle support your body's defenses and promote well-being.

Food Toxins

1. Definition: A food toxin is a harmful substance or poison produced by microorganisms (bacteria, fungi, viruses) or naturally occurring in certain foods, which can cause illness or food poisoning when ingested.
2. Sources: Food toxins can originate from various sources, including contaminated raw materials, improper food handling, processing, and storage conditions.
3. Bacterial Toxins: Some bacteria produce toxins as a byproduct of their metabolism. Examples include:
    - Staphylococcus aureus: Produces heat-stable toxins, often found in dairy products, meats, and salads.
    - Clostridium botulinum: Produces botulinum toxin, causing botulism, commonly associated with improperly canned foods.
4. Fungal Toxins: Fungi can produce mycotoxins in foods, particularly grains, nuts, and dried fruits. Common mycotoxins include aflatoxin and ochratoxin.
5. Viral Toxins: Certain viruses can contaminate food, leading to illness. For instance, the Norovirus is a common viral cause of food poisoning.
6. Natural Toxins: Some plants and seafood naturally contain toxins that can be harmful if not properly processed or cooked. Examples include poisonous mushrooms and certain types of fish and shellfish.
7. Symptoms: The symptoms of food toxin ingestion can vary widely, but common signs include nausea, vomiting, diarrhea, abdominal pain, fever, and in severe cases, neurological symptoms.
8. Prevention: Proper food safety measures can help prevent food toxin-related illnesses:
    - Ensure proper cooking temperatures to kill harmful microorganisms.
    - Practice good hygiene and sanitation during food preparation.
    - Store food at appropriate temperatures to inhibit bacterial growth.

- Avoid consuming wild mushrooms or unfamiliar seafood without expert identification.
- Discard canned goods with bulging or damaged packaging.

9. Foodborne Illness Outbreaks: Occasionally, large-scale foodborne illness outbreaks occur due to contaminated food products, leading to public health concerns and investigations.
10. Reporting and Treatment: If food poisoning is suspected, seeking medical attention is essential. Healthcare providers can diagnose and treat foodborne illnesses, preventing complications and further spread of the toxin.

Remember that these points provide an overview of food toxins. Food safety is of utmost importance, and following proper food handling and preparation practices is crucial to minimize the risk of foodborne illnesses.

Anti-nutritional factors

Anti-nutritional factors (ANFs) are substances in certain foods that can interfere with the body's absorption or utilization of nutrients. They are compounds that are not harmful in themselves, but their presence in significant amounts can negatively impact the nutritional value of a diet.

1. Definition: Anti-nutritional factors (ANFs) are naturally occurring compounds found in various plant and animal-based foods that impede the digestion, absorption, or utilization of essential nutrients.
2. Occurrence: ANFs are commonly found in plant-based foods, such as grains, legumes, vegetables, and fruits. However, some animal-based foods can also contain ANFs, primarily in their plant-based diet.
3. Types: There are different types of ANFs, including: a. Protease Inhibitors: These hinder the digestion of proteins by blocking the action of digestive enzymes. b. Phytates (Phytic Acid): Found in grains and legumes, they reduce the absorption of essential minerals like iron, zinc, and calcium. c. Lectins: Bind to carbohydrates in the digestive tract, potentially causing damage to the gut lining and interfering with nutrient absorption. d.

Oxalates: Certain vegetables can hinder calcium absorption and other minerals. e. Tannins: These compounds can reduce protein digestion and interfere with iron absorption.

4. Health Implications: When ANFs are present in significant amounts and consumed regularly, they can lead to nutrient deficiencies and impaired growth and development.
5. Processing and Cooking: Some ANFs can be reduced or eliminated through processing techniques like soaking, sprouting, fermentation, and cooking. These methods can help degrade or inactivate the anti-nutritional factors, improving the food's nutritional value.
6. Balancing Diets: While ANFs can negatively affect many foods containing these compounds also provide valuable nutrients. A balanced diet that includes a variety of foods can help mitigate the impact of ANFs.
7. Animal Feed: ANFs can also affect livestock and poultry when present in their feed. Proper processing and formulation of animal diets are crucial to preventing negative impacts on growth and health.
8. Bioavailability: ANFs can reduce the bioavailability of certain nutrients, meaning that even if they are present in the diet, the body may not be able to absorb and utilize them effectively.
9. Human Adaptation: Over time, some populations have developed genetic adaptations to cope with ANFs in their traditional diets, reducing their adverse effects.
10. Moderation: In most cases, consuming foods containing ANFs is safe and healthy when part of a varied diet. The key is moderation and a diverse intake of nutrients from different sources.

It is essential to note that the impact of anti-nutritional factors can vary depending on an individual's unique nutritional needs, health status, and overall diet. When considering specific dietary choices, it is always best to consult a qualified healthcare professional or a registered dietitian for personalized advice.

Toxic elements

Toxic elements can harm living organisms when present in specific quantities. They can naturally occur or result from human activities, leading to various adverse health and environmental effects.

1. Mercury (Hg):
    - They are often released from industrial processes, coal burning, and waste incineration.
    - Accumulates in fish and seafood, posing a risk to human health through consumption.
    - It can cause neurological, cardiovascular, and reproductive problems.
2. Lead (Pb):
    - Commonly found in old paint, contaminated soil, and leaded gasoline (phased out in many places).
    - Children are particularly vulnerable to lead poisoning, which can impair brain development.
    - It can affect adults' nervous system, kidneys, and blood cells.
3. Arsenic (As):
    - Naturally present in the Earth's crust and released from mining and industrial processes.
    - Contaminates drinking water and food, especially rice and vegetables.
    - Chronic exposure can lead to skin, lung, and bladder cancer and cardiovascular issues.
4. Cadmium (Cd):
    - It was released from mining, smelting, and industrial processes.
    - Accumulates in crops like rice, leafy vegetables, and grains.
    - It causes kidney damage and bone demineralization and is classified as a human carcinogen.

5. Chromium (Cr):
    - It occurs in different forms, with hexavalent chromium being the most toxic.
    - They are used in various industrial processes like electroplating and stainless steel production.
    - Inhalation of hexavalent chromium can cause lung cancer, skin irritation, and other health issues.
6. Nickel (Ni):
    - Found in various industrial emissions, mainly from fossil fuel combustion.
    - Exposure can lead to respiratory problems, skin allergies, and lung cancer.
7. Copper (Cu):
    - Essential in small amounts for the body but toxic in excessive quantities.
    - Pesticides, industrial discharges, and plumbing can introduce excess copper into water sources.
    - High exposure can lead to gastrointestinal issues and liver damage.
8. Aluminium (Al):
    - Abundant in the Earth's crust and used in various industries and consumer products.
    - Excessive food or drinking water intake is a concern, potentially linked to neurological disorders.
9. Zinc (Zn):
    - Essential micronutrients, but high levels from industrial sources, can contaminate water.
    - Excess zinc can lead to gastrointestinal issues and interfere with copper absorption.
10. Selenium (Se):
    - Essential in small amounts but toxic in larger doses.
    - Environmental contamination can cause selenosis, leading to hair loss, skin lesions, and neurological problems.

Remember that the toxicity of these elements depends on the dose, route of exposure, and individual sensitivity. Proper regulation, monitoring, and management of toxic elements are crucial to safeguard human health and the environment.

Food additives

Food additives are substances added to food to maintain or improve its safety, freshness, taste, texture, or appearance.

1. Definition: Food additives are substances added to food during processing or preparation to enhance its quality, appearance, flavor, texture, or shelf life.
2. Preservatives: Additives like sodium benzoate, sorbic acid, and sulfur dioxide help prevent spoilage by inhibiting the growth of bacteria, molds, and yeasts.
3. Antioxidants: These additives, like vitamin C (ascorbic acid) and vitamin E (tocopherols), prevent the oxidation of fats and oils, extending the shelf life of products and preserving their color.
4. Flavor Enhancers: Commonly used additives like monosodium glutamate (MSG) and ribonucleotides amplify the taste of food, making it more Savory and appetizing.
5. Colorants: Food dyes such as tartrazine (yellow), carmine (red), and chlorophyll (green) are added to improve the appearance and visual appeal of various products.
6. Emulsifiers: Substances like lecithin and mono- and diglycerides stabilize water and oil mixtures, preventing separation and ensuring smooth textures.
7. Stabilizers and Thickeners: Additives like carrageenan and xanthan gum help maintain the texture and consistency of processed foods, such as dairy products and sauces.
8. Sweeteners: Artificial sweeteners (e.g., aspartame, sucralose) and natural sweeteners (e.g., stevia) add sweetness without adding extra calories.
9. Acidity Regulators: Additives like citric acid and sodium citrate help control and maintain the acidity or alkalinity of foods.
10. Bulking Agents: Ingredients like cellulose and maltodextrin add bulk or volume to certain foods, affecting their texture and mouthfeel.
11. Anticaking Agents: Prevent clumping in powdered or granulated substances, such as salt or powdered spices.

12. Humectants: Retain moisture and prevent foods from drying out, commonly used in baked goods and confectionery.
13. Fortification: Some additives, like folic acid and iodine, are added to foods to increase their nutritional value and prevent deficiencies.
14. Flavoring Agents: Natural or artificial Flavors are added to provide specific tastes or mimic natural Flavors that may be lost during processing.
15. Allergen Labelling: Food additives derived from common allergens like wheat, soy, or dairy must be clearly labeled on food packaging to help consumers with allergies or intolerances.

It is important to note that while many food additives are safe and well-regulated, some individuals may be sensitive to certain additives, and excessive consumption of certain additives may pose health risks. As such, it is advisable to maintain a balanced diet and be mindful of the ingredients listed on food labels.

Antibiotics

Antibiotics are medicines that fight bacterial infections in people and animals. They work by killing the bacteria or making it hard for them to grow and multiply.

Antibiotics can be taken in different ways:

- Orally (by mouth)
- Topically (by cream, spray, or ointment)
- Through an injection or intravenously

What do antibiotics treat?

Antibiotics treat certain bacterial infections, such as strep throat, urinary tract infections, and *E. colli*.

Do antibiotics treat viral infections?

Antibiotics do not work on viral infections, such as Colds, Flu, bronchitis, sore throat, etc.

What are the side effects of antibiotics?

The side effects of antibiotics range from minor to very severe. Some of the common side effects include:

- Rash
- Nausea
- Diarrhea
- Yeast infections
- Allergic reaction, etc.

Do antibiotics destroy your immune system?

Very rarely, antibiotic treatment will cause a drop in the blood count, including the number of white cells that fight infections. It corrects itself when the treatment is stopped.

MODULE – 11
Radionuclides in milk and milk products

Introduction

A radionuclide is a nuclide that has excess nuclear energy, making it unstable. This excess energy can be used in one of three ways:

- Emitted from the nucleus as gamma radiation
- Transferred to one of its electrons to release it as a conversion electron
- Used to create and emit a new particle from the nucleus.

Radionuclides

A radionuclide is an atom with an unstable nucleus. The atom's nucleus has excess energy released by radioactivity decay.

An unstable form of a chemical element releases radiation as it breaks down and becomes more stable. Radionuclides may occur in nature or be made in the laboratory.

Natural radionuclide includes the primordial radioactive elements in the Earth's crust, their radioactive decay products, and radionuclides produced by cosmic radiation interaction.

Radionuclides in water can concern human health because several are toxic or carcinogenic.

What do radionuclides do to humans?

Cancer is the significant effect of concern from radionuclides. Radium, via oral exposure, is known to cause bone, head, and nasal passage tumors in humans, and radon, via inhalation exposure, cause lung cancer in humans. Uranium may cause lung cancer and tumors of the lymphatic and hematopoietic tissues.

Radionuclides in milk and milk products

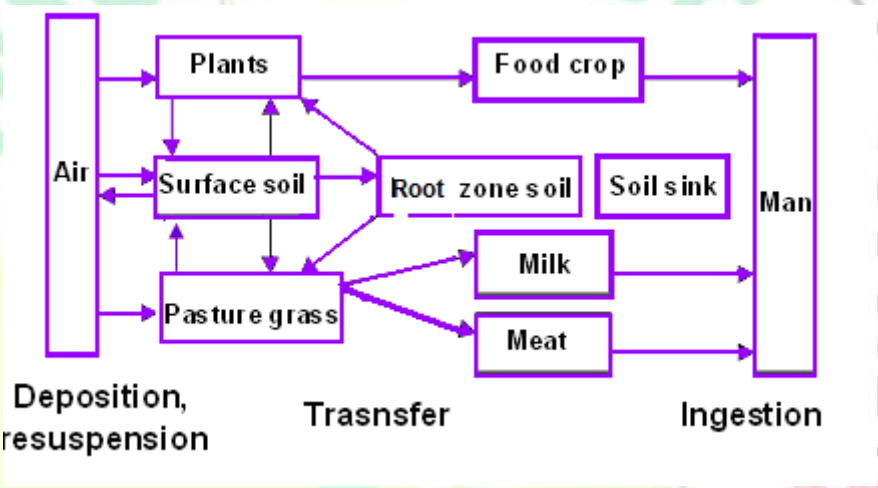
→ Using nuclear energy for beneficial purposes has become more common recently. Radionuclides are often secreted into the Milk by consuming contaminated feed and water and are ultimately found in milk and milk products.

→ The radionuclides in Milk, which result from the exposure of dairy cows to radioactive fallout, constitute a significant factor in assessing internal radiation in humans.

→ Evaluating the radionuclide intake of people from fallout contaminated Milk requires information about feed sources and milk distribution.

→ The most significant contamination would occur during nuclear fallout periods when cows graze, ingesting grass from contaminated soil. Even if they are kept indoors, milk contamination may occur by inhaling radionuclides or ingesting them through contaminated drinking water and feed.

→ There are different pathways through which radionuclides enter the human body. A general path of such contamination could be represented below:



❖ **Common radionuclides found in Milk**

Concerning Milk, radionuclides of specific interest are ^{134}Cs, ^{137}Cs, ^{131}I, ^{89}Sr, ^{90}Sr. They decay at different rates, and the does from these elements and other radionuclides are delivered differently.

MODULE – 12
Milk Intolerance and Hypersensitivity

Introduction

→ There is much confusion between milk allergy and lactose intolerance, both adverse reactions attributable to Milk.

→ The resulting symptoms may be quite different from or confusingly similar to each other.

Milk Intolerance

- Food intolerance is difficulty digesting certain foods and having an unpleasant physical reaction. It causes symptoms, such as bloating and tummy pain, usually a few hours after eating.
- Food intolerance is an adverse reaction to food that does not involve an immune response.
- The failure to digest lactose due to a deficiency of lactase leads to inefficient utilization of dietary lactose and disordered gastrointestinal physiology.
- Metabolic or biochemical abnormalities can alter the intermediary metabolism of a substance.

Lactose Intolerance

- Lactose intolerance means the body cannot easily digest lactose, a natural sugar in milk and dairy products. It is not the same thing as a food allergy to Milk.
- Lactose moving through the large intestine without being properly digested can cause uncomfortable symptoms such as gas, belly pain, and bloating.

❖ Causes of Lactose Intolerance

☞ Lactose intolerance occurs when the small intestine does not make enough of an enzyme called lactase. The body needs lactase to break down or digest lactose.

☞ Sometimes the small intestine stops making lactase after a short-term illness such as the stomach flu or as part of a lifelong disease such as cystic fibrosis.

☞ The small intestine sometimes stops making lactase after surgery to remove a part of the small intestine. In these cases, the problem can be either permanent or temporary.

- ☞ In rare cases, newborns are lactose-intolerant. A person born with lactose intolerance cannot eat or drink anything with lactose.

❖ **Symptoms of Lactose Intolerance**

- ☞ Symptoms of lactose intolerance can be mild to severe, depending on how much lactase your body makes.
- ☞ Symptoms usually begin 30 minutes to 2 hours after you eat or drink milk products.
- ☞ If you have lactose intolerance, your symptoms may include:
    - Bloating.
    - Pain or cramps.
    - Gurgling or rumbling sounds in your belly.
    - Gas.
    - Loose stools or diarrhea.
    - Throwing up.

❖ **Diagnosis**

- ☞ A doctor can usually tell whether you have lactose intolerance by asking about your symptoms. He or she may also ask that you avoid dairy products briefly to see if your symptoms improve.
- ☞ Sometimes doctors order a hydrogen breath or blood sugar test to confirm the diagnosis. These simple tests check to see if you are digesting lactose normally.

❖ **How is it treated?**

- ☞ There is no cure for lactose intolerance. However, you can treat your symptoms by limiting or avoiding milk products. Some people use Milk with reduced lactose or substitute soy and cheese for milk and milk products.

Phenylketonuria (PKU)

- ➢ It is a genetic disorder characterized by an inability of the body to utilize the essential amino acid phenylalanine.
- ➢ This enzyme is necessary to metabolize the amino acid phenylalanine to the amino acid tyrosine.
- ➢ When PAH is deficient, phenylalanine accumulates and is converted into phenylpyruvate (also known as phenyl ketone), which is detected in the urine.

- If the condition is left untreated, it can cause problems with brain development, leading to progressive mental retardation, brain damage, and seizures.
- In the past, PKU was treated with a low-phenylalanine diet.
- All PKU patients must adhere to a special diet low in phenylalanine. It requires severely restricting or eliminating foods high in phenylalanine, such as meat, chicken, fish, eggs, nuts, cheese, legumes, cow milk, and other dairy products.

Galactosemia

- Galactosemia is **a disorder that affects how the body processes a simple sugar called galactose**.
- A small amount of galactose is present in many foods. It is primarily part of a more significant lactose sugar found in all dairy products and many baby formulas.
- Classic galactosemia occurs in 1 in 30,000 to 60,000 newborns.
- Galactosemia type II and type III are less common; type II probably affects fewer than 1 in 100,000 newborns, and type III appears rare.

Causes of Galactosemia

- Galactosemia occurs due to **disruptions or changes (mutations) in the GALT gene resulting in a deficiency of the GALT enzyme**.
- It leads to abnormal accumulation of galactose-related chemicals in various body organs, causing galactosemia's signs and symptoms and physical findings.
- **There is no cure for galactosemia or approved medication to replace the enzymes**.
- Although a low-galactose diet can prevent or reduce the risk of some complications, it may not stop all of them.
- In some cases, children still develop problems such as speech delays, learning disabilities, and reproductive issues.

Milk Hypersensitivity

- Allergy is a hypersensitivity reaction defined as any unusual or exaggerated response to a particular substance, called an allergen, in a person sensitive to that substance.

- Allergies result from the reactions of the body's immunologic processes to "foreign" substances or physical conditions. The reaction is caused by an allergen, either alone or coupled with a hapten, that stimulates the production of antibodies.
- Subsequent exposure to previously sensitized antibody-producing cells may precipitate an allergic reaction. The symptoms range from sneezing to vomiting, headaches to hives, edema to diarrhea, and many more, some minor and some quite severe.
- These effects are believed to be due to histamine release by an immunologic reaction.
- The best treatment after the offending food or foods is identified is to plan an adequate diet that does not contain the allergen.

Milk Protein as an allergen

- Hypersensitivity to milk proteins is one of the leading food allergies and affects mainly but not exclusively infants, while it may also persist through adulthood and can be very severe.
- Different clinical symptoms of milk allergy have been established. The diagnosis of milk allergies differs widely due to the multiplicity and degrees of symptoms and can be achieved by skin or blood tests.
- Cow milk contains more than 20 protein allergens that can cause allergic reactions.
- Casein fractions and β-lactoglobulins (β-lg) are the most common cow milk allergens. Human Milk is free of β-lg, similar to camel milk. On the contrary, β-lg is a major whey protein in cow, buffalo, sheep, goat, mare, and donkey milk.
- Different procedures can reduce the allergenicity of cow milk proteins by heat or enzymatic treatments to some degree.
- Goat milk is less allergenic than cow milk because of the absence of α-S1 casein which is typical for goat breeds.

The immunological mechanism in milk allergy

IgE-Mediated CMA (Immediate Hypersensitivity)

- These are commonly mediated by a specific class of antibodies known as immunoglobins (IgE), which are typically generated as part of immune reactions to parasitic infections,

- ☞ However, partly understood reasons can also be generated following exposure to environmental agents, such as pollen, dust, and foods.

❖ **Non-IgE-Mediated CMA (Delayed Hypersensitivity)**

- ☞ These non-IgE-mediated reactions tend to be delayed, with the onset of symptoms occurring from 1 hour to several days after ingestion of Milk. Hence, they are often referred to as "delayed hypersensitivity."
- ☞ Several mechanisms have been implicated, including type-1 T helper cell (Th1) mediated reactions, immune complexes forming to activate Complement, or T-cell/mast cell/neuron interactions inducing functional changes in smooth muscle action and intestinal motility.

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